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IDENTIFYING PROCESS VARIATION VIA RISK-ADJUSTED OUTCOME

by

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DISSERTATION

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DOCTOR OF PHILOSOPHY

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in the

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of the

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DEDICATION

This dissertation is dedicated to my family:

To my parents Betty and Paul Dolter,

who, by their example, taught me the value of hard work;

To my sisters and brothers and sister- and brothers-in-law,

Jane, Patti, Peter, Paul and Ellen Dolter and Suzette Dolter, Tom Rohn and Dave Gordon

who supported me throughout the pursuit of this goal;

To my sister Beth Dolter,

who not only supported me,

but had to live with me through this endeavor;

and

To my nephew, Andrew Paul Dolter

who helped keep the endeavor in perspective.

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IDENTIFYING PROCESS VARIATION VIA RISK-ADJUSTED OUTCOME

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The purpose of this investigation was to examine the efficacy of using discharge abstract-based risk-adjustment of Department of Defense (DOD) coronary artery bypass graft surgery (CABGS) mortality to examine process differences between DOD medical centers. Inputs and processes of CABGS surgery were described and process differences between DOD medical centers with higher and lower risk-adjusted CABGS mortality rates were analyzed using a combination of case and control and descriptive research designs.

The research had two phases. Phase I consisted of secondary analysis of all DOD CABGS discharge abstract data in order to examine patient severity of illness (SOI). Phase IIA involved observation of the hemodynamic processes of CABGS personnel at each of 6 DOD medical centers: 2 case (higher mortality) and 4 control (lower and median mortality). Phase IIB involved written survey of DOD CABGS care personnel concerning hemodynamic knowledge and organizational processes. Phase IIC involved collection of CABGS SOI and care process data at case and control medical centers via retrospective chart audit.

The risk-adjusted model of CABGS mortality developed via logistic regression from the discharge abstract data included the variables of acute myocardial infarction, age, repeat CABGS, female sex, diabetes mellitus, and hypertension. The model was significant (p = .000) and demonstrated good calibration and discrimination. All DOD medical centers had actual mortality that was less than that predicted by the risk-adjustment: crude and risk-adjusted mortality rates were highly correlated (Spearman's *rho*= .93).

Significant (t-test) differences in CABGS care inputs and processes were noted between DOD medical centers with higher and lower risk-adjusted mortality including: provider pulmonary artery catheter knowledge ($p = .004$); cardiopulmonary bypass time ($p = .000$); aortic cross-clamp time ($p = .000$); and post-CABGS ($p = .001$) and hospital ($p = .000$) lengths of stay. Reliability and validity problems of DOD discharge abstract data were identified.

DOD discharge abstract-based risk-adjustment is possible and could be useful in quality improvement screening to identify outcome, input, and process outliers. Collection of clinical process data in conjunction with SOI risk-adjustment would give providers information for benchmarking their care and direction toward areas requiring improvement.

Suzanne Bakken Henry, Chair

Kathryn J. Dolter

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CHAPTER I

INTRODUCTION

Outcomes assessment is widely accepted in the evaluation of the quality of care (Donebedian, 1992; Lohr, 1988). Donebedian defines outcomes as "those changes, either favorable or adverse, in the actual or potential health status of persons, groups or communities that can be attributed to prior or concurrent care" (Donebedian, 1985). Outcomes are only used to draw inferences about the quality of the structure and process of the implemented care and must be confirmed by a further analysis of these components (Donabedian, 1992).

Outcomes of care can be classified as positive or negative. Negative outcomes of care include death, disease, disability, discomfort, and dissatisfaction, alternatively expressed as the positive outcomes of survival, health, functional status, comfort, and satisfaction (Lohr, 1988). Outcomes must be able to have a plausible causal connection to the processes of care (Blumberg, 1986). Connections between outcomes and processes of care decrease the longer the period between the outcome measurement and the process of care hypothesized to cause that outcome (Lohr, 1988). Assessment of outcomes should be focused on high cost, high volume procedures (JCAHO, 1991).

Comparison of outcomes between health care providers--health care institutions (hospitals), health care teams, or individual health care providers (physicians, nurses, etc.), allows the identification of provider of care "outliers." High outliers have a higher than expected incidence of the observed outcome, while low outliers have a lower than expected incidence of that outcome. If the outcome of care being studied is a negative indicator, high

outlier providers would be flagged for review of the structure and process components of that care to determine if the "predicted" quality of care differences actually exist.

Outcomes, however, "can be very misleading as indicators of quality" (Donebedian, 1992, p. 358). "The major difficulty is that any specific outcome we wish to use for assessing quality can be influenced by multiple factors, only one of which is medical care" (Thomas, Holloway, & Guire, 1993). McAuliffe (cited in Thomas, Hollaway, & Guire, 1993) describes the factors affecting the use of any specific outcome in comparing the quality of care between providers:

$$\text{Var(O)} = \text{Var(V)} + \text{Var(SE)} + \text{Var(RE)}.$$

In this equation describing the outcomes assessment process, Var(O) is the observed variability in patient outcomes across providers; Var(V) is the component of Var(O) "validly" attributable to quality of care differences between providers; Var(SE) is the systematic error related to differences in patient-specific characteristics between providers; and Var(RE) is the random error related to residual variability caused by unknown or unmeasured factors.

Patient-specific characteristics include the reason for patient admission: patient condition or severity of illness on admission (Blumberg, 1986); patient physiological reserve related to age, sex, nutrition and the type and number of comorbid conditions (Chao, 1993; Charlson, Pompei, Ales, & McKenzie, 1987; Knaus, Draper, Wagner & Zimmerman, 1986); and patient social and financial condition (DesHarnais, Chesney, Wroblewski, Fleming, & McMahon, 1988; Jones, 1993; Thomas, Hollaway, & Guire, 1993). These patient-specific factors are confounding variables in the assessment of patient outcomes. If identified and controlled, the remaining observed variation in outcome rates between providers is due to differences in provider quality of care and random error (Jones, 1993; Thomas, Hollaway, & Guire, 1993). If patient-specific characteristics are unmeasured, systematic error is introduced

into the evaluation of inter-provider outcomes. Patient-specific characteristics can be controlled for through development of risk-adjustment models based on clinical or administrative (discharge abstract) data.

The importance of outcomes assessment in the Military Health Services System (MHSS) and the difficulties inherent in accomplishing it have been outlined by Jennings (1993). Outcomes assessment using crude statistics has been judged inappropriate as it does not take into account provider patient population differences. Comparison of actual versus predicted outcome rates obtained via risk-adjustment modelling is being utilized in the civilian sector as a screening mechanism to identify quality of care and resource consumption outliers for purposes of directing quality improvement in-depth process reviews (Thomas & Longo, 1990). Risk-adjustment modelling of outcomes (RAMO) is being utilized at the federal, state and institutional levels (Iezzoni, Shwartz, & Restuccia, 1991). Only one clinical study of DOD-wide use of risk-adjustment monitoring of outcomes is known to have been utilized for purposes of identification of quality or resource outliers That study, conducted by the Department of Defense Civilian External Review Program, related to maternal-child outcomes (Forensic Medical Advisory Services, 1995).

Coronary artery bypass graft surgery (CABGS), a treatment for coronary heart disease is the epitome of the high cost, high volume procedure whose outcome should be monitored. In a 100% analysis of the Medicare Provider Analysis and Review files, a review of 8 commonly performed procedures revealed that CABGS ranked third in number of procedures performed (53,715), yet was the most costly, requiring $2,053,075,000 in Medicare payments (Riley, Lubitz, Gornick, Mentnech, Eggers, & McBean, 1993). Not only is CABGS high in monetary cost, it is also high in cost in terms of adverse outcomes with operative mortality (within 30 days post-procedure) ranging from 1-5% for heterogenous groups of patients to

38.5% for homogenous high-risk subsets of patients undergoing the operation (Hannan, Kilburn, O'Donnell, Lukacik, & Shields, 1990).

RAMO has been used in statewide and regional studies (Hannan, et al., 1990; Luft & Romano, 1993; O'Connor, Plume, Olmstead, Coffin, Morton, & Maloney, 1991) to screen institutions performing the high risk, high volume, high cost procedure of CABGS in order to identify those providers having higher than expected mortality rates. Although such studies have identified mortality outliers, quality of care follow-up investigations have been reported minimally with most reported investigations of CABGS mortality focusing on institution and surgeon characteristics such as volume (Hannan, O'Donnell, Kilburn, Bernard, & Yazici, 1989). No investigation of the post-operative care processes of nurse providers in institutions identified as having higher than expected CABGS mortality was found in the literature.

Post-operative care of the CABGS patient focuses primarily on attaining and maintaining hemodynamic stability in order to maintain graft patency, prevent graft disruption and ensure tissue perfusion (Gregerson & McGregor, 1989; Whitman, 1991). Monitoring and treatment of the hemodynamic parameters of arterial blood pressure and pulmonary artery pressures (PAP) is essential to the attainment and maintenance of hemodynamic stability. Nurses have the primary responsibility for monitoring these parameters and titrating physician ordered therapies to maintain them within physician-specified limits.

For hemodynamic measurements to be accurate, and therefore the treatment CABGS patients receive to be appropriate, the criteria for obtaining reliable and valid hemodynamic measurements must be met (Booker & Arnold, 1993; Bosseart, Demey, DeJongh, & Heytens, 1991; Bridges, 1993; Dolter, 1989; Enger, 1989; Gardner, 1993; Gardner, 1986; Gardner & Hujcs, 1993; Kern, 1993; Nadeau & Noble 1986; O'Quinn & Marini, 1983; Quaal, 1993; Vender, 1988; Wiedemann, Matthay & Matthay, 1985). Yet studies of nurse and physician

provider hemodynamic knowledge demonstrate that their knowledge of these reliability and validity requirements may be deficient (Bridges, 1991; Dolter, 1987; Iberti, Dailey, Liebowitz, et al., 1994; Iberti, Fischer, Liebowitz, Panarak, Silverstein, & Albertson, 1992; Kondrat, 1994; Sollek, 1988). No description of actual hemodynamic measurement or treatment practice variation among nurses and/or physicians or the relationship of hemodynamic knowledge to practice was noted in the literature.

Purpose

The purposes of this study were 1) to assess the validity of using administrative (discharge abstract) based risk-adjusted CABGS mortality as a screening mechanism to identify variations in CABGS practice potentially impacting on quality of care; 2) to describe variation in hemodynamic knowledge and hemodynamic measurement and treatment practices of nurses and physicians caring for CABGS patients at Department of Defense (DOD) medical centers performing this procedure; 3) to describe differences in hemodynamic monitoring knowledge and practice between DOD medical centers with higher than expected mortality and that at DOD medical centers with lower than expected CABGS mortality; and 4) to describe other characteristics and processes of DOD CABGS unit and care provider with varying CABGS mortality. It explored the use of DOD discharge abstract based risk-adjusted CABGS mortality to identify medical centers having the potential for post-operative CABGS patient care process variations, specifically focusing on the hemodynamic knowledge and post-operative hemodynamic measurement and treatment practices of nurses and physicians caring for these patients. Differences in hemodynamic knowledge and practice between DOD

medical centers with high crude mortality and DOD medical centers with low crude mortality will also be analyzed.

Research Questions

The research questions asked in this study were:

1) What are the differences between DOD medical center actual and predicted CABGS mortality rates?

2) What is the hemodynamic knowledge and hemodynamic measurement and treatment practice of nurses and physicians caring for CABGS patients in DOD medical centers?

3) What is the relationship between hemodynamic knowledge and hemodynamic measurement and treatment practice of nurses and physicians caring for CABGS patients in DOD medical centers?

4) Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher than expected CABGS mortality rates and DOD medical centers with lower than expected CABGS mortality rates? Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher crude CABGS mortality and DOD medical centers with lower crude mortality rates?

5) What are the other unit and provider characteristics and processes of DOD medical centers with higher than expected CABGS mortality rates and DOD medical centers with lower than expected CABGS mortality rates? What are the other unit and provider characteristics and processes of DOD medical centers with higher crude CABGS mortality rates and DOD medical centers with lower crude CABGS mortality rates?

Significance to Nursing and the MHSS: Extension of Previous Research

Currently, there is no known DOD or service use of discharge abstract based risk-adjustment monitoring of outcomes being utilized for purposes of identification of quality or resource outliers (Personal communication, A. Godfrey, Patient Administration Division, Office of the Surgeon General, February 14, 1994). Only one DOD use of clinical risk-adjustment monitoring of outcomes for the purpose of identification of quality outliers was noted; this was a one time study of risk-adjusted maternal-child adverse outcomes conducted by the DOD Civilian External Review Program (Forensic Medical Advisory Services, 1995). This study will in effect be a pilot study assessing the utility of using actual versus expected outcomes based on discharge abstract data as a screening mechanism for focusing the evaluation of the health care provided in the 148 hospitals and over 800 medical and dental clinics in the MHSS (Lanier & Boone, 1993).

Although there has been a case study describing the organizational processes in two civilian hospitals with differing actual versus expected mortality rates, this case study focused on general ICUs and not CABGS units (Zimmerman, Rousseau, Duffy, Devers, Gillies, & Wagner, 1994). The only study of civilian CABGS unit care process and sub-processes did not focus on postoperative organizational or treatment practices other than the physician "ownership" aspect of the postoperative process (Kasper, Plume, & O'Connor, 1992). No investigation of institutions with differing actual versus expected mortality has focused on the care processes of nurse providers. This study will extend actual versus expected CABGS mortality research by describing post-operative unit and provider characteristic and process variations in units with historically higher or lower actual versus expected patient outcome rates.

Research related to hemodynamic monitoring has been extensive, including hemodynamic knowledge of care providers using the device and the impact of the use of hemodynamic devices on outcome. Though hemodynamic knowledge of nurse and physician patient care providers has been described (Bridges 1991; Dolter, 1987; Kondrat, 1994; Iberti, et al., 1990; Iberti, et al., 1994; Sollek, 1988; Straw, Lovey, Woods, 1987), the hemodynamic knowledge of the DOD intensive care nurses or CABGS patient care providers has not been described. Demonstration of an inadequate knowledge base related to specific hemodynamic monitoring devices among nurses and physicians caring for DOD CABGS patients would imply the need for further staff orientation and staff development in this area, with the delineation of areas of weakness providing direction for remedial education; it might also imply the need for certification of competence prior to staff member usage of a particular hemodynamic device.

No research looking at the entire process of hemodynamic measurement and treatment process in actual patient care situations was located in a review of the literature. This study will extend the knowledge related to hemodynamic monitoring of nurses and physicians from studies of what care providers know about specific hemodynamic devices to how they utilize these devices and whether they adhere to the criteria for reliable and valid measurement with these devices. Demonstration of violation of the reliability and validity criteria for accurate measurement among nurse DOD CABGS patient care providers would imply the need for better communication of these criteria through targeted orientation and staff development efforts.

Research on the impact of hemodynamic monitoring on outcome has been related to the presence or absence of specific hemodynamic devices (American Society of Anesthesiologists, 1993; Technology Subcommittee of the Working Group on Critical Care,

1991) and whether therapy has been directed to normalization or supra-normalization of hemodynamic values (Shoemaker, Kram, Appel, & Fleming, 1990). No nursing research related to use of hemodynamic monitoring devices and patient outcome was noted. This research will broaden the scope of nursing research in the area of hemodynamic measurement from that of focusing on either nurses' knowledge related to hemodynamic measurement or the performance of one the minute steps of the hemodynamic measurement process. It will provide a more global look at the total hemodynamic measurement process and attempt to relate that process to patient outcome. It will describe actual hemodynamic practice relating it to patient outcome in the CABGS population.

CHAPTER II

LITERATURE REVIEW

Background and Significance

Coronary artery bypass graft surgery (CABGS) is a palliative treatment for coronary heart disease, the leading cause of death in the United States (AHA, 1993). CABGS is used in those individuals whose coronary heart disease is not amenable to medication or percutaneous transluminal coronary angioplasty. Health care resource consumption is greater for CABGS than for any other single treatment or procedure (Evans, 1993). In 1986 the average charge for a CABGS was estimated at $30,430 (ACC/AHA Task Force, 1991). Annual charges for CABGS amount to 12 billion dollars or 2% of the total cost of health care in the United States, assuming a charge of $40,000 per procedure and 300,000 CABGS per year (ACC/AHA, 1991).

In fiscal year 1994, there were 1,389 diagnosis related group (DRG) 106 and 107 procedures performed DOD-wide (Retrospective Case Mix Analysis System-Open Systems Environment (RCMAS-OSE), February, 1994). DRG 107 and 106 procedures describe CABGS procedures with and without cardiac catheterization during hospitalization and exclude CABGS procedures in which another open heart procedure such as valve replacement or aneurysmectomy was performed. Taking the civilian estimate of the average CABGS procedure cost as $30,430, total DOD expense for DRG 106 and 107 for fiscal year 1992 was $42,267,270. A recent cost analysis of DRG 106 CABGS with cardiac catheterization during

the hospitalization at Wilford Hall Air Force Medical Center, using "full cost" data from the Medical Expense and Performance Reporting System (MEPRS) showed an average cost of $32,078 per patient. In fiscal year 1993, DRG 106 was the costliest DRG at Wilford Hall with a total cost of $5.9 million dollars (Watkins, 1995).

Besides being one of the costliest surgical procedures performed in terms of economics, CABGS is also one of the costliest in terms of mortality. CABGS operative mortality (OM) ranges from 1-5% for heterogenous groups of patients to 38.5% for the homogeneous subset of patients undergoing their third reoperation (Hannan, et al, 1990). OM, defined as either in-hospital death or death within 30 days of the procedure to control for varying hospital discharge practices, has been studied extensively in CABGS. Most CABGS deaths occur early in the post-operative period with 30% occurring within the first 48 hours; 50% of deaths occur within the first 9 post-operative days (ACC/AHA, 1991).

DOD CABGS in-hospital mortality rates for the twelve medical centers performing this procedure for fiscal year 1994 ranged from 0% to 10% for DRG 107 CABGS and from 0% to 8.4% for DRG 106. Figures 2-1 through 2-3 depicts CABGS mortality for DRG 106, DRG 107 and combined DRG 106 and 107 data for FY 1991 through 1994. A study by the Department of Defense Civilian External Peer Review Program described a 3.6% mortality rate for elective CABGS (males 2.9% and females 6.9%) and a 17% mortality rate for "other" CABGS (males 17.3% and females 15.8%). "Other" CABGS being defined as emergent or "redo" CABGS or CABGS with concurrent open heart procedure--i.e., CABGS with valve replacement, CABGS with aneurysmectomy). Overall DOD CABGS mortality during this time period was 5.9% (Forensic Medical Advisory Services, 1993).

Because of its high economic and human life costs, CABGS has been and continues to be a focus of quality of care activities. CABGS has been or will be the focus of mandated

quality of care evaluations. It is currently one of eight of eleven procedures which can be designated for selection for required Peer Review Organization pre-admission and pre-procedure reviews (Institute of Medicine, 1990). CABGS operative mortality is also the focus of the Joint Commission on the Accreditation of Health Care Organization (JCAHO) number one cardiovascular care indicator currently undergoing beta site testing (JCAHO, 1991).

Theoretical Framework

This study will utilize the frameworks of quality of care (Donebedian, 1982; Lang & Clinton, 1984) systems to assess relationships between the inputs, processes and outputs/outcomes defining the post-operative CABGS patient care system. The total quality management principle of focusing on processes will be also be utilized (JCAHO, 1992). The output of DOD medical center CABGS mortality rates, adjusted for the input of patient-specific characteristics of severity of illness and risk, will be used as a screening mechanism to identify medical centers with outlier CABGS mortality for in-depth unit and provider characteristic and care process review (Figure 2-4). In-depth reviews will focus on hemodynamic assessment and intervention and organizational processes.

Unit and provider characteristics and care processes of medical centers identified as outliers will be examined to determine variations impacting on the quality of care. Medical centers with lower than predicted mortality (output adjusted for input) might be expected to have unit and provider characteristic and care process variations responsible for this positive outcome, which might be described and then emulated. Conversely, medical centers with higher than predicted CABGS mortality might be expected to have unit and provider characteristics and care process variations responsible for this negative outcome, which might be described and then improved.

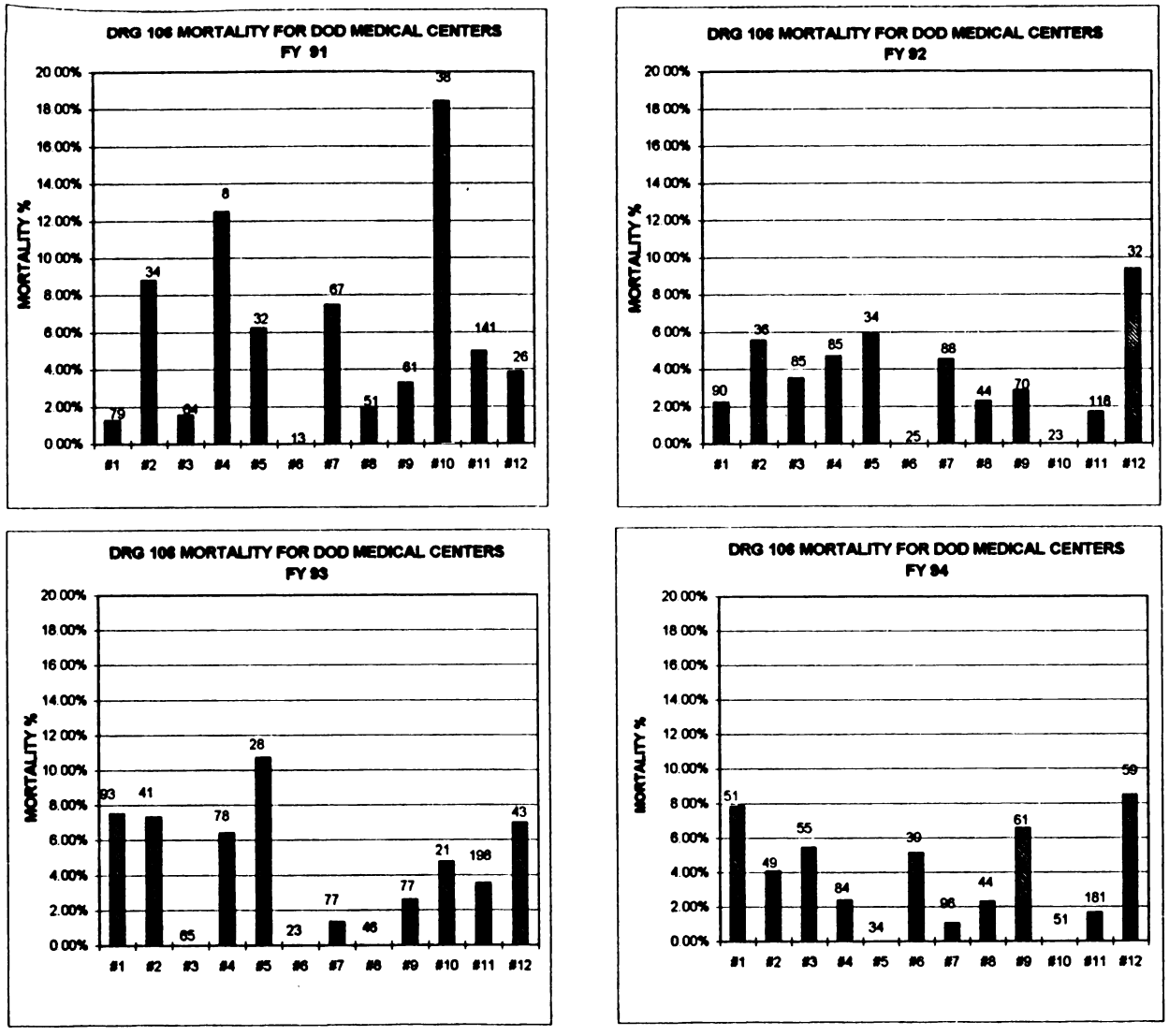

Figure 2-1. DRG 106 CABGS Mortality for DOD Medical Centers FY91 through FY94 (Site DRG volume shown above bar)

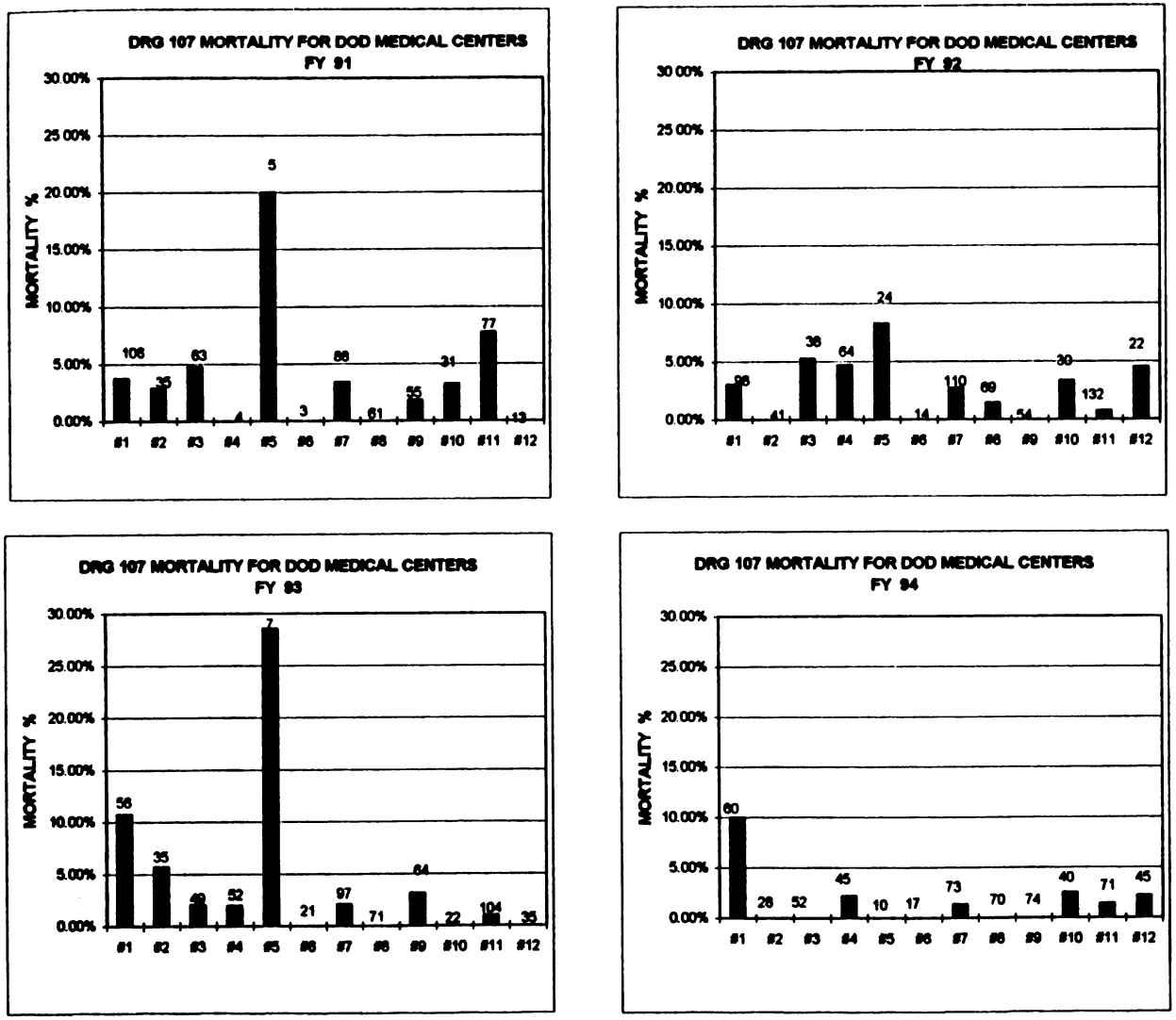

Figure 2-2. DRG 107 CABGS Mortality for DOD Medical Centers FY91 through FY94 (Site DRG volume shown above bar)

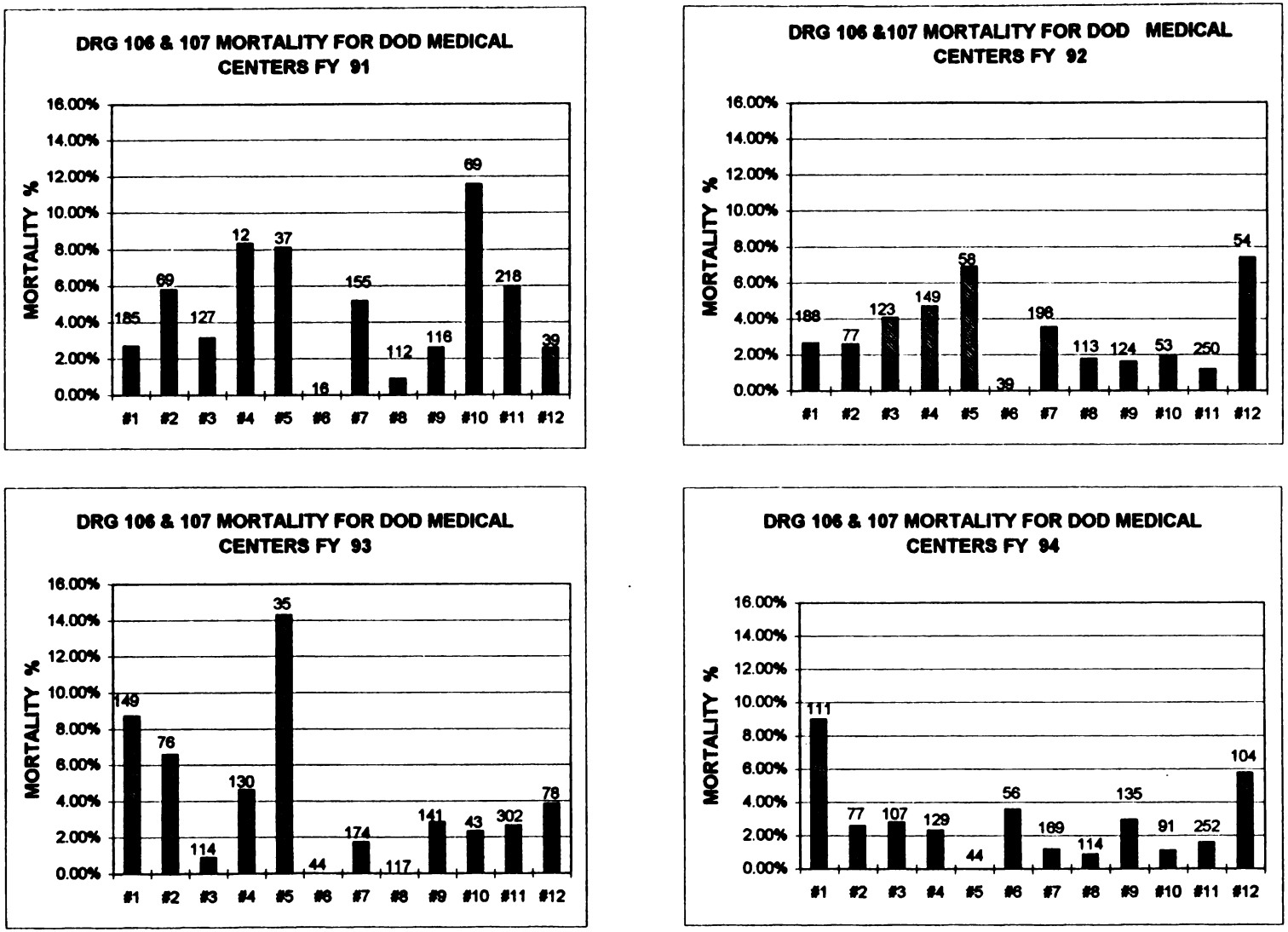

Figure 2-3. DRG 106 & 107 CABGS Mortality for DOD Medical Centers FY91 through FY94 (Site DRG volume shown above bar)

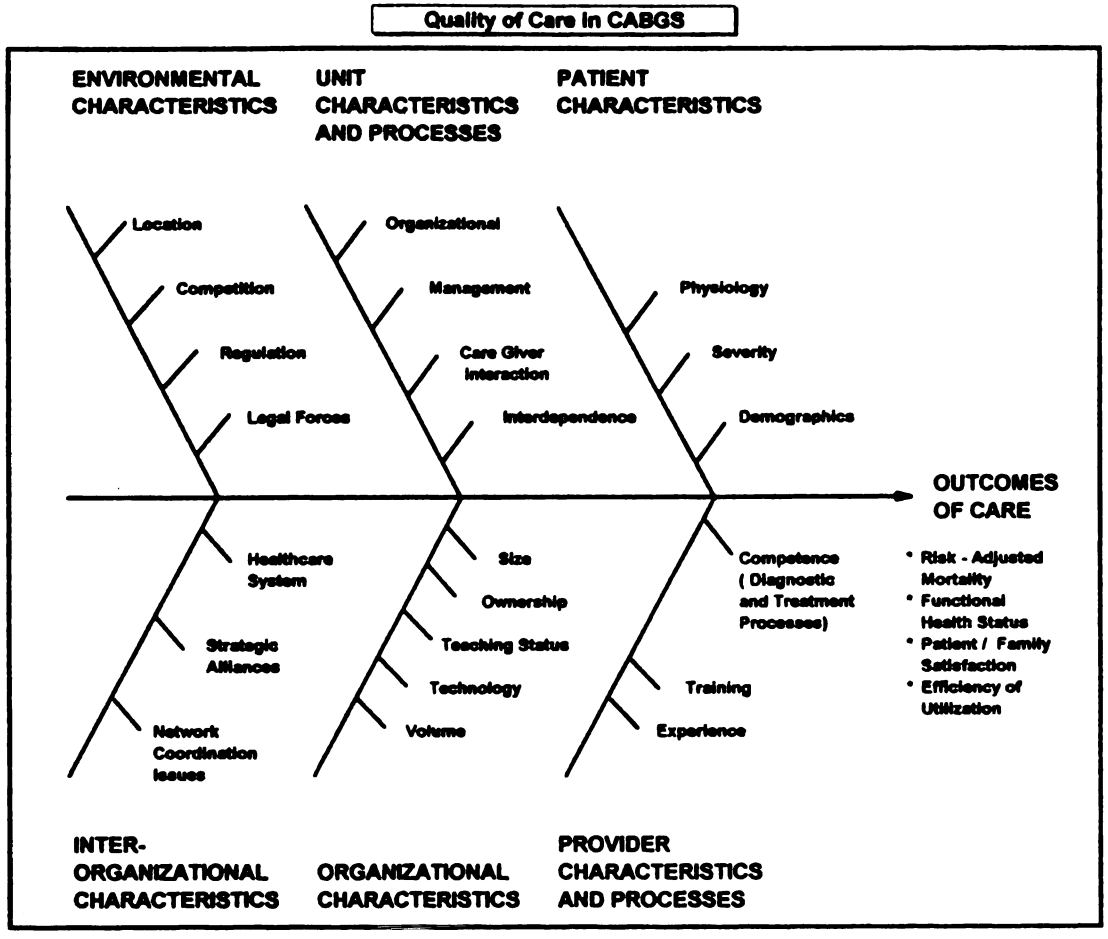

Figure 2-4. Organizational, Unit, Provider and Patient Characteristics Impacting on ICU Outcomes. Shortell, S. M., Zimmerman, J. E., Gillies, R., Duffy, J., Devers, K. J., Rousseau, D. M. & Knaus, W. A. (1992) Continuously improving patient care: Practical lessons and assessment from the National ICU Study. Quality Review Bulletin, 18(5). Oakbrook Terrace, IL: Joint Commission on Accreditation of Healthcare Organizations, 1992, p. 151. Reprinted with permission.

CABGS Quality of Care: CABGS Implementation Process Assessment

Quality assessment involves two components, technology assessment and performance assessment (Donebedian, 1992). Technology assessment is "the activities meant to determine the right things to do" (Donebedian, 1992, p. 356), while performance assessment is the "activities meant to determine if the known (or presumed) to be the right things to do (or the right ways to behave) have in fact occurred" (Donebedian, 1992, p. 356). Performance assessment involves a two step process of looking at the "evidence,"--the structure, process and outcomes of care, in order to ascertain that 1) "the best strategy of care was selected" and 2) "that it was implemented in the most skillful way" (Donebedian, 1992, p. 357). The first step of care is determining the appropriateness of care rendered, the second involves an evaluation of the implementation of that care. The majority of published quality assessment in CABGS has focused on the second step of quality assessment, the examination of the evidence related to the procedure to determine if it has been implemented in a skillful way.

CABGS Implementation Assessment:

Investigations Examining the Impact of Organizational Characteristics

Organizational characteristics have been hypothesized to impact on quality of care. Studies examining quality of care have often focused on the organizational characteristics of the hospitals. Hospital organizational characteristics which have been demonstrated as impacting on the quality of medical care provided in populations other than CABGS patients include volume (Luft, Bunker, & Enthoven, 1979); size, location, and teaching status (Hartz, Krakauer, Kuhn, Young, Jacobsen, & Gay, 1989; Keeler, Rubenstein, Kahn, Draper, Harrison,

& McGinty, 1992); and financial characteristics (Burstin, Lipsitz, Udervarhelyi, & Brennan, 1993; Hartz, et al., 1989).

The Impact of Volume on CABGS Outcome

Luft, Bunker, and Enthoven's classic study (1979) described an inverse relationship between volume and mortality in open-heart surgery, CABGS, vascular surgery, and transurethral resection of the prostate, with a demonstrated decrease of 25 to 41% in mortality at hospitals performing more than 200 of these operations per year after adjusting for case mix. This early study utilized the less precise hospital-level standardization method of case-mix adjustment for calculation of actual versus expected mortality.

This inverse relationship between hospital mortality rates and the volume of CABGS procedures performed, has been examined in several more recent studies (Hannan, et al., 1989; Hannan, Kilburn, Bernard, O'Donnell, Lukacik, & Sheilds, 1991; Hughes, Hunt, & Luft, 1987; Kelly & Hellinger, 1987; Luft, Hunt, & Maerki, 1987; Maerki, Luft, & Hunt, 1986; Sloan, Perrin, & Valvona, 1986; Showstack, Rosenfeld, Garnick, Luft, Shcaffarzick, & Fowles, 1987; Williams, Nash, & Goldfarb, 1991). Five of these studies found significantly lower mortality rates for hospitals performing higher volumes of CABGS (Hannan, et al., 1989; Hannan, et al., 1991; Hughes, Hunt, & Luft, 1987; Kelly & Hellinger, 1987; Showstack, et al., 1987), though Hannan, et al.'s (1989) only found the inverse relationship between hospital volume and mortality for surgeon performing less than 116 procedures. Two studies (Sloan, Perrin, & Valvona, 1986; Williams, Nash, & Goldfarb) found no significant relationship between hospital volume and mortality. Sloan, Perrin, & Valvona (1986) found that higher- and lower-mortality hospitals actually had lower volumes than hospitals with intermediate mortality rates.

Identified cut-points for hospital volume at which mortality is significantly higher below than above the cut-point include that of 200 by Luft, Bunker, Enthoven (1979) and Showstack, et al. (1987); 510 by Sloan, Perrin, & Valvona (1986); and 650 for the subgroup of low volume physicians performing ≤ 116 procedures by Hannan, et al. (1989). The American College of Cardiology and American Heart Association's Guideline for CABGS (1991) incorporate some of these results; recommendations are that hospitals perform a yearly minimum of between 200 and 300 CABGS.

Two hypotheses have been postulated as to the cause of the inverse volume-CABGS mortality relationship: 1) the practice-makes-perfect hypothesis--hospitals with more experience in performing CABGS will demonstrate a decrease in mortality statistics; and 2) the referral pattern hypothesis--surgeons/hospitals with better mortality statistics will have higher volumes due to more referrals. Only one study within the review timeframe investigated the causal linkage between volume and mortality (Luft, Hunt, & Maerki, 1987). Using simultaneous equations, these investigators established that both of these hypotheses provided valid explanations for the inverse relationship between volume and mortality.

The Impact of Size, Ownership, and Teaching Status on CABGS Outcome

In contrast to the findings of Keeler, et al. (1992) in non-CABGS patients, hospital size, type, sponsorship, and teaching status were found to be not significant in the examination of the impact of patient and hospital variables on in-hospital mortality in CABGS by Hannan, et al. (1989). Kelly & Hellinger (1987) also did not find hospital type, teaching status, or medical school affiliation to be predictive of mortality in their study. No study examining the relationship between CABGS mortality and hospital financial characteristics was located.

CABGS Implementation Assessment: Investigations Examining Operating Room and Postoperative Care Unit Characteristics and Processes.

Operating Room Characteristics and Processes Assessment

No investigations examining the impact of non-surgeon or non-anesthetist related operating room characteristics or processes on CABGS quality of care were found.

Post-Operative Care/Intensive Care Unit Characteristics and Processes

Unit characteristics have been hypothesized to affect the outcomes of intensive care patients (Shortell, et al., 1992). The level of physician and nurse collaboration has been shown to affect the outcomes of intensive care unit (ICU) patients; units with higher levels of nurse-physician collaboration have decreased patient mortality and decreased patient readmissions to the ICU (Baggs, Ryan, Phelps, Richeson, & Johnson, 1992; Knaus, Draper, Wagner, & Zimmerman, 1986; Zimmerman, Rousseau, Duffy, Devers, Gillies, & Wagner, 1994).

In a prospective examination of treatment and outcome in 5030 consecutively sampled intensive care units (coronary care units excluded) at 13 hospitals, Knaus, et al. (1986) concluded that differences in unit actual versus expected mortality rates, calculated via their APACHE II prognostic scoring system, were attributable to staff interaction and cooperation. No statistical analyses was presented to support these conclusion. Baggs, et al. (1992) prospectively examined interdisciplinary collaboration, as measured on their Decision About Transport Scale, and its effects on patient outcome (readmission and death) in 286 consecutive patients in one medical intensive care unit. Logistic regression was utilized to analyze the association between collaboration as reported by nurses and physicians and negative outcome controlling for severity of illness. Nurse reports of interdisciplinary collaboration were found to have a significant ($p < .02$) inverse relationship with patient negative outcome.

In a case study, Zimmerman, et al. (1994) contrasted organizational structure and processes at two teaching hospitals selected from a larger study of 42 hospitals on the basis of one having a significantly higher than expected mortality and the other having a significantly lower than expected mortality. Identification of whether the ICU risk adjusted mortality was high, low, or average was not distinguishable by on-site investigators despite in-depth structure and process reviews and interviews of nurse and physician staff. However, on-site evaluation occurred 17 and 13 months after the data collection on which the actual versus expected mortality determination were based, a time period in which both units demonstrated major organizational changes. Results and recommendations of the on-site surveys were presented to hospital chief executive officer to facilitate quality improvement at both facilities studied.

No analysis of CABGS intensive care unit organizational structure or process or their impact on CABGS patient outcome was noted in the literature.

CABGS Implementation Assessment:

Investigations Examining the Impact of Care Provider Characteristics and Processes

CABGS Anesthetist Characteristics and Processes.

Investigations of anesthetist processes on CABGS quality of care have focused on the impact of peri-operative myocardial ischemia (Slogoff & Keats, 1985; 1986); varying anesthetic agents (Tuman, McCarthy, Spiess, DaValle, Dabir, & Ivankovich, 1989; Slogoff & Keats, 1989); differing hemodynamic devices (Pearson, Gomez, Moyers, Carter, & Tinker, 1989; Tuman, McCarthy, Spiess, DaValle, Hompland, Dabir, & Ivankovich, 1989), and different anesthetists (Merry, Ramage, Whitlock, Laycock, Smith, Stenhouse, & Wild, 1992) on patient outcome.

Slogoff and Keats (1985, 1986) conducted two studies in which they prospectively examined the relationship between pre-operative new onset myocardial ischemia and post-operative myocardial infarction in CABGS patients. Pre-operative was defined as the time period from the arrival of the patient in the operating room until the beginning of cardiopulmonary bypass. In their two studies, they found a significant relationship between preoperative myocardial ischemia and postoperative myocardial infarction. Prevention of peri-operative myocardial ischemia was called for to avert peri-operative myocardial infarction.

In a another study, (Slogoff & Keats, 1989) examined differences in outcomes between patients randomized to one of four groups in which a different anesthetic agents was given to the patient during the CABGS procedure. No difference in incidence of postoperative myocardial infarction and outcome was found between the four groups. Tuman, et al. (1989) prospectively analyzed the responses of 1094 consecutive patients receiving one of four anesthetic agents. No significant difference was found in the incidence of pulmonary, renal, neurologic, or cardiac complications, in-hospital death or length of stay between any of the patient groups. However, these authors discovered several significant predictors of CABGS mortality through discriminant analysis of data collected on 24 patient and peri-operative management variables. These significant predictors included cross-clamp time, internal mammary artery graft, recent myocardial infarction, congestive heart failure, serious dysrhythmias, left main coronary artery disease, unstable angina, and New York Heart Association classification. The primary anesthetic agent, the anesthetist, and the use of a pulmonary artery catheter were among those variables found to be not significantly related to mortality in these CABGS patients. Discriminant analysis of the same 24 patient variables with peri-operative myocardial infarction as the outcome variable also did not include the variables of anesthetic agent, anesthetist, or use of the pulmonary artery catheter.

Pearson, et al. (1989) examined the effects of anesthetist use of central venous pressure monitor, pulmonary artery catheter with and without continuous mixed venous oxygen saturation measurement capability on outcome in a randomized clinical trial of 226 CABGS patients. No significant difference was noted between morbidity, mortality, and length of stay between patients assigned to the differing device groups. However, the group of patients monitored with pulmonary artery catheters with continuous mixed venous oxygen saturation measurement capabilities demonstrated significantly increased monitoring and laboratory costs as compared to other patient device groups. This study was marred by small sample size and significant crossover between groups (American Society of Anesthesiologists, 1993).

Tuman, McCarthy, Spiess, DaValle, Hompland, et al. (1989) also examined the efficacy of different hemodynamic devices in the peri-operative monitoring of CABGS patients. In a prospective study of 1094 consecutive patients monitored via central venous pressure monitors or pulmonary artery catheters, these authors found no difference in length of ICU stay, postoperative cardiac or non-cardiac complications, in-hospital deaths or hemodynamic aberrations. Study results are questioned related to the non-random design and the questionable comparability of groups on severity of illness (American Society of Anesthesiologists, 1993).

Merry, et al. (1992) examined the contribution of the anesthetist and the surgeon to the risk of adverse outcome as measured by death or increased aspartate amino transferase concentration (a blood test used to screen for the presence of acute myocardial infarction). Retrospective analysis of data was conducted on 1301 patients undergoing first-time isolated CABGS from January, 1984 through December, 1988. Univariate analyses indicated that the significant relationships existed between both anesthetist and surgeon and adverse outcome. However, only prolonged bypass time ($p < .01$) and anesthetist ($p = .05$) were significant

predictors of adverse outcome after controlling for 12 patient-specific variables when the data were analyzed via logistic regression. On their analysis of anesthetist differences, of the nine participating anesthetists only one anesthetist's outcomes were better than, and one anesthetist's outcomes were worse than the group mean. Findings of anesthetist differences could not be used to improve CABGS quality of care since the reason for the differences could not be ascertained. The authors called for prospective studies of outcomes so that causes of detected differences might be found.

CABGS Surgeon Characteristics and Processes

The surgeon characteristic of volume has been studied (Hannan, et al., 1989, 1992; Hughes, Luft & Hunt, 1987; Kelly & Hellinger, 1987). Surgeon processes that have been examined include cross-clamp time (Kirklin, Naftel, Blackstone, & Pohost, 1989; Slogoff & Keats, 1985, 1986; Tuman, et al., 1989), time on cardiopulmonary bypass (Kirklin, et al., 1989; Iyer, Russell, Leppard & Craddock, 1993) and surgeon's judgement of the technical quality of his operation (Slogoff & Keats, 1985, 1986). Surgeon volume was found to be not significant by Hughes, Hunt, & Luft (1987) and Kelly and Hellinger (1986), while Hannan, et al. (1989) found surgeon volume and logarithm of surgeon volume (1992) to be significant. In a presentation of analyses of CABGS risk factors by seven individual hospitals (Kirklin, et al., 1989), cross-clamp time and time on bypass were found to significant predictor of operative mortality in logistic regression analyses of data in 2 of 7 and in 1 of 7 institutions, respectively. Slogoff & Keats (1985, 1986) and Tuman et al. (1989) found aortic cross-clamp time to be predictive of postoperative myocardial infarction, and Tuman, et al. (1989) found it predictive of operative mortality in discriminant analyses in their studies concerning the relationship between anesthesia and CABGS outcomes. A univariate analysis of data from 12,003 first time CABGS patient records in Australia from 1978 to 1990, demonstrated a

significant time on cardiopulmonary bypass effect (Iyer, et al., 1993). The incidence of mortality was 16 times greater in patients on bypass an average of ≥ 100 minutes than that of patients whose mean bypass time was 48 minutes (Iyer, et al., 1993). Perfusion time was also predictive of operative mortality in the multivariate step-wise logistic regression analysis.

Aortic cross-clamp time and time on bypass, potentially a function of surgeon dexterity, may not be totally under surgeon control, but rather a function of the patient's severity of illness. With more severe coronary heart disease, the patient may require more anastomoses leading to longer cross-clamp and bypass times. Likewise a surgeon may have difficulty getting a patient off of bypass due to poor baseline left ventricular dysfunction. However, in risk-adjusted models of outcomes, variables that do not clearly precede the procedure should not be include in the model (Blumberg, 1986), as they will reflect provider process rather than pre-operative patient severity.

The more technical surgical process aspects of the type of graft and the methods of myocardial preservation and their impact on CABGS care quality have been also investigated (Lytle & Cosgrove, 1992). Type of graft has been demonstrated to affect both early and late mortality, with decreased graft failure noted in patients having internal mammary grafts (Ochsner, 1982; Kirklin, et al., 1989; Lytle & Cosgrove, 1992). Changes in myocardial preservation have been credited with the decrease in operative mortality seen in the decades since CABGS was initiated (Kaiser, 1982; Kirklin, et al., 1989; Lytle & Cosgrove, 1992).

Characteristics and Processes of Nurses Providing Intra-Operative CABGS Care

CABGS quality investigations have not studied the characteristics of nurses providing intra-operative care. No intra-operative CABGS nursing process studies were noted.

Characteristics and Processes of Nurse Providing Post-Operative CABGS Care

CABGS quality investigations have not studied the characteristics of nurses providing post-operative care. CABGS nursing process studies in the immediate postoperative period have focused on intervention effects on patient heart rate and rhythm (Stone, Talaganis, Preusser, & Gonyon, 1991); oxygenation (Banasik, Bruya, Steadman, & Demand, 1987; Chan & Jenson, 1992); oxygen consumption (Noll & Fountain, 1990; Shively, 1988); mediastinal bleeding (Duncan, Erickson, & Weigel, 1987; Banasik & Tyler, 1986); and rewarming (Howell, MacRae, Sanjines, Burke, & DeStefano, 1992; Rafalowski, 1987). No studies examining the effects of nursing process on other than these short-term outcomes were noted.

Assessment of postoperative nursing process impact on the more global quality outcome indicators of morbidity and mortality was not noted. Nor were there investigations into the linkage of short term outcomes to more global outcomes as there was by Slogoff and Keats (1985, 1986) in their studies linking preoperative myocardial ischemia and postoperative myocardial infarction.

Systematic assessment of the presence or absence of specific CABGS nursing/medical care protocols on patient outcomes--acknowledging the collaborative nature of ICU practice, has not been done. A case in point is the effect of nurse process of hemodynamic assessment/intervention on CABGS outcomes. Pre-operative hemodynamic instability has been noted to triple CABGS operative mortality (Kirklin, et al., 1989). The effect of postoperative hemodynamic instability on CABGS outcome has not been studied and there has been no study of the impact of nurse hemodynamic assessment/intervention processes on CABGS hemodynamic instability or on CABGS morbidity and mortality.

Collaborative Post-Operative CABGS Patient Care Processes

Examination of post-operative CABGS patient care processes has recently been the focus of investigation related to recent cost-cutting initiatives given impetus by the introduction of managed care. Many of these cost-cutting initiatives relate to decreasing length of CABGS patient hospital; decreasing CABGS patient hospital length of stay has been termed "fast-tracking." Changes in post-operative CABGS processes that have been advocated so that fast-tracking can occur include early (within 4 to 6 hours) discontinuance of endotracheal intubation, chest tubes and telemetry; use of alternative anesthetic and pain-control techniques such as administration of short-acting anesthesia, minimization of sedation and "voice-management" of patient discomfort; accelerated resumption of diet and activity level; and early transfer from the ICU (Emory, DuBois, Dixon, Arom, Eales, Huttner, Nelson, Gayes, Petersen, & Pritzker, 1995; McCarthy, Dimengo, Suszkowski, & Nissen, 1995; Deaton, Engelman, Weinntraub, Monette, Flack, & Rousou, 1995). CABGS length of stays resulting from the combinations of the above post-operative care process changes include reports of 5.6 day (McCarthy, et al., 1995) "less than 6 day" (Emery, et al, 1995) and 6.3 day lengths of stay. Descriptions of care process time decreases are single institution reports by large volume CABGS centers. The quality of care impact of these process changes was assessed; mortality and complication rates were reported and or summarized via descriptive statistics in these reports, but differences between pre- and post- process change morbidity and mortality rates was not reported. No description of DOD CABGS care processes was noted in the literature.

CABGS Implementation Assessment:

Investigations Examining the Impact of Patient Characteristics

Patient characteristics have been demonstrated to have an effect on quality assessment, in that they must be controlled so that quality assessment comparisons may be valid. If patient specific characteristic differences are not controlled for, inter- and intra- provider quality assessment comparisons may not reflect performance deviation but patient characteristic dissimilarities (Thomas, Holloway, & Guire, 1993). Patient specific characteristics which have been demonstrated to affect CABGS performance assessment include age (Grover, Hammermeister, Burchfiel, & the Cardiac Surgeons of the Department of Veterans Affairs, 1990; Hannan, et al., 1990; Higgins, Estafanous, Loop, Beck, Blum & Paranandi, 1992; Iyer, et al., 1993; O'Connor, Plume, Olmstead, Coffin, Morton & Maloney, 1992; Parsonnet, Dean, & Bernstein, 1989); gender (Hannan, et al., 1990; Iyer, 1993; Parsonnet, Dean, & Bernstein, 1989); payer status (Wenneker, Weissman, & Epstein, 1990; Young & Cohen, 1992); and pre-CABGS-procedure patient severity of illness (Geraci, Rosen, Ash, McNiff, & Moskowitz, 1993; Grover, et al., 1990; Hannan, et al., 1989; Hannan, et al., 1990; Hartz, Kuhn, Green, & Rimm, 1992; Hartz, Kuhn, Kayser, Pryor, Green, & Rimm, 1992; Iyer, et al., 1993; Kelly & Hellinger, 1986; O'Connor, et al., 1992; Parsonnet, Dean, & Bernstein., 1989; Williams, Nash, & Goldfarb, 1993) to include comorbid disease burden (O'Connor, et al., 1992).

Patient Demographic Characteristics

Age has been found to be a significant predictor of outcome in all clinically based heterogeneous large sample CABGS population OM and adverse event models reviewed (Geraci, et al., 1993; Grover, et al., 1990; Hannan, et al., 1990; Hannan, et al., 1991; Hartz, Kuhn, Kayser, et al., 1992; Higgins, et al., 1992; Iyer, et al., 1993; O'Connor, et al., 1992;

Parsonnet, Dean, & Bernstein, 1989). Gender was been found to be significant in 6 of the eight clinically based, heterogenous population CABGS OM and adverse event studies reviewed (Geraci, et al., 1993; Hannan, et al., 1990; Hannan, et al., 1991; Hartz, Kuhn, Kayser, et al., 1992; Higgins, et al., 1992; Iyer, et al., 1993; Parsonnet, Dean, & Bernstein, 1989).

Patient Payer Status

Wenneker, Weissman, & Epstein (1990) examined utilization of angioplasty, angiography, and CABGS in non-Medicare patients with circulatory disorders or chest pain in Massachusetts in 1985 to determine the effect of patient level of insurance on the quality of care provided. Utilizing logistic regression to control for demographic, clinical, and hospital factors, it was determined that the odds that privately insured patients with circulatory disorders or chest pain would receive CABGS was 40% higher than uninsured patients. The authors recommend further study of the effect of payer differences on outcome.

Young and Cohen (1992) retrospectively examined records of 4033 privately insured and Medicaid acute myocardial infarction patients in Massachusetts in 1987 to determine if they differed in their process of care (length of stay and procedure utilization). Controlling for clinical, demographic, and hospital variables these authors utilized linear regression to examine the relationship between payer status and length of stay and logistic regression to examine the relationship between payer status and procedure utilization (angiography, PTCA, CABGS). Length of stay was significantly greater for Medicaid patients than for privately insured patients. The odds of privately insured acute myocardial infarction patients having a CABGS were 73% greater than for Medicaid patients. The authors recommended the use of nationally representative samples to examine the effects of payer status on care quality and greater

analysis of the impact of clinical and non-clinical patient-specific characteristics on pattern of care in hospitals.

Severity of Illness

Severity of illness (SOI) measures are utilized to stratify patients according to their risk of a negative outcome, so that inter- and intra-provider outcomes might be better evaluated (Knaus, Wagner, Draper, Zimmerman, Bergner, Bastos, & Sirio, 1991). Early studies assessing the impact of SOI on CABGS outcomes, utilized administratively-based measures of SOI and found it to be significant (Hannan, et al., 1989; Kelly & Hellinger, 1986; Williams, Nash, & Goldfarb, 1993). These studies utilized Disease Staging, a commercial SOI system, which bases the patient's SOI on the diagnostic codes present in his discharge abstract. More recently, clinically-based, condition-specific SOI measures have been demonstrated to explain more of the variance in patient outcomes than administratively-based, or generic clinically-based models (Iezonni, Ash, Coffman, & Moskowitz, 1992). Clinically and administratively based CABGS-specific SOI risk adjustment models their description, development, and utilization will be discussed under CABGS outcomes.

CABGS Implementation Assessment: Investigations Examining CABGS Outcomes

CABGS Outcome: Operative mortality

OM, defined as either in-hospital death or death within 30 days of the procedure to control for varying hospital discharge practices, has been studied extensively in CABGS. Crude OM in heterogeneous groups of CABGS patients is 3.5% with ranges between 1-5%. Most deaths occur early in the postoperative period with 30% occurring within the first 48 hours; 50% of deaths occur within the first 9 postoperative days (ACC/AHA, 1991).

Crude OM has fluctuated markedly since widespread use of this technology began in the early 1970's. Initially higher CABGS OM was attributed to newness of the technique. Decreases in OM noted in the 1980's were credited to advances in myocardial preservation and anesthetic techniques (Grover, et al., 1990). The current trend of increasing OM is ascribed to the increasing baseline severity of illness of patients undergoing the procedure, increasing number of patients undergoing reoperations and the loss of what would have been low-risk CABGS patients to PTCA (Davis, Parascandola, Miller, Campbell, Myers, & Pae, 1989; Naunheim, Fiore, Wadley, Kanter, McBride, & Pennington, 1988; McGrath, Laub, Graf, & Gonzalez-Lavin, 1990). Crude OM has been demonstrated to vary markedly between community-wide (4-8%) and referral center (2-4%) assessments of OM (McDonald & Fitzgerald, 1992).

Significantly different crude OM rates have been noted in current studies of clinically meaningful subgroups undergoing the procedure including: women (Weintraub, Wenger, Jones, Craver, & Guyton, 1993); the elderly (Weintraub, Craver, Cohen, Jones, & Guyton, 1991); patients undergoing emergency CABGS post-PTCA (Buffet, Danchin, Villemot, Amrein, Ethevenot, & Juilliere, 1991); patients with low ejection fractions (Olsen & Niebuhr-Jergensen, 1993); and whether CABGS patients were classified as DRG 106 versus DRG 107 (CABGS with and without cardiac catheterization during the hospitalization for surgery, respectively) (Williams, Nash & Goldfarb, 1991). OM rates vary according to the population studied, the method used, and the timeframe in which the study was conducted.

Operative mortality is also a function of the presentation of the data and patient selection (Jones, 1989). An analysis of differences in 1985 Medicare stroke, pneumonia, myocardial infarction, and congestive heart failure patient in-hospital and 30 day death rates in New York and California was conducted (Jencks, Williams, & Kay, 1988). Results revealed

that California had significantly shorter length of stays and a lower in-hospital death rate, but a significantly higher 30 day mortality rate. However, cumulative mortality curves for the two states were identical. In-hospital death rates are dependent on length of stay patterns and are therefore biased in their representation of mortality (Jencks, Williams, & Kay, 1988). These authors recommend the use of 30 day mortality rates for the comparison of provider outcomes.

"Zero operative mortality means that the cardiac surgeon (center) has not yet performed enough of the procedures to experience a bad outcome, or that he (it) is operating on a number of patients who do not greatly benefit from the procedure because of their minimal cardiac disease" (Jones, 1989, p. 1989). Operative mortality is therefore a function of patient selection; optimal selection according to appropriateness guidelines will decrease mortality in the CHD population, but will probably serve to increase CABGS mortality.

CABGS Outcome: Complications

Complications of CABGS that have been identified include peri-operative myocardial infarction; stroke; coma of > 48 hour duration; respiratory failure requiring ventilation greater than 48 hours; acute renal failure or worsening of existing renal impairment; bacteremia; endocarditis; sternal wound infection; pulmonary embolism; bleeding requiring an unplanned return to surgery or transfusion of more than 6 units of whole blood or packed cells (Hammermeister, Burchfiel, Johnson, & Grover, 1990; Hartz, Kuhn, Kayser, et al., 1992; Geraci, et al., 1993; Higgins, et al., 1991). Other negative or adverse events that have been identified as occurring after CABGS include prolonged intensive care length of stay, readmission to ICU, requirement for ventricular assist device or intra-aortic balloon pump (Hartz, Kuhn, Kayser, et al., 1992; Geraci, et al., 1993). Complication rates of heterogeneous groups of CABGS are listed in Table 2-1. Complication rates also vary according to the population studied, the method used, and the timeframe in which the study was conducted.

Table 2-1.

CABGS Adverse Events Percentages

Adverse Event	Hammermeister, et al. (1990) N = 10,634 [Prospective study of VA patients receiving CABGS between April 1987 and March 1989. 73% of all patients undergoing CABGS during this timeframe]	Hartz, Kuhn, Kayser, et al. (1992) N (Hospital/Patient) = 18/1998 [Retrospective analysis of 69% of CABGS performed in Wisconsin Medicare population, March 1989 - April 1991] ()= Percent with that complication exclusively	Geraci, et al.(1993) N (Patient) = 2213 [Retrospective analysis of CABGS patients randomly selected from Medicare CABGS performed in 7 states between 1/85 -6/86]
Death	-	6.9 (2.5)	6.6
Renal Impairment	-	4.7 (1.1)	1.7
Long hospital and ICU stay	-	5.8 (1.6)	-
Myocardial Infarction	3.6	6.3 (3.3)	3.0
Congestive Heart failure	-	-	15
Bowel bleed	-	1.6 (0.5)	-
Endocarditis	.05	0.3 (0.2)	-
Stroke	-	4.2 (1.8)	1.8
Coma	1.6	-	2.6
Bacteremia	-	-	0.6
Wound Infection	(Mediastinitis) 1.6	-	0.8
Prolonged Mechanical Ventilation	7.8	-	3.9

Table 2-1--continued

Return to Surgery	Bleeding - 3.1 Requiring Bypass - 1.2	-	4.9
Transfusion of > 6 Units Whole Blood or PRBCs	-	-	9.6
One or More Adverse Events	15	21	33

Other CABGS Outcomes

Other outcomes of CABGS that have been studied include early (< 1 year) and late (> 1 year) mortality; freedom from angina; quality of life; functional status; psychosocial status; need for re-intervention; and graft patency. However, quality of care in CABGS is currently judged by the outcome of hospital operative mortality rates (ACC/AHA, 1991).

CABGS Implementation Assessment: Analysis of Risk-Adjusted CABGS Outcomes

Risk-adjustment of patient outcomes involves controlling for patient-specific characteristics which are the confounding variables in the assessment of patient outcomes. Risk-adjustment of outcomes, by controlling for patient-specific characteristics, allows inter-provider comparison for it "levels the playing field" and facilitates comparisons of "apples with apples" (Iezonni, 1994). If patient-specific characteristics are identified and controlled, the remaining observed variation in outcome rates between providers is due to differences in provider quality of care and random error (Jones, 1993; Thomas, Hollaway, & Guire, 1993).

If patient-specific characteristics are unmeasured, systematic error is introduced into the evaluation of inter-provider outcomes.

The Development of Risk-Adjusted Monitors of Outcome

Patient-specific characteristics can be controlled for through development of risk-adjustment models. A theoretical substruction of a risk adjustment model for the outcome of mortality is presented in Figure 2-5. Risk-adjusted outcome models may be developed using hospital level variables to adjust raw outcome rates or using indirect standardization of patient level data (DesHarnais, et al., 1988). Indirect standardization is currently the preferred and the most common method utilized to accomplish risk-adjustment (Blumberg, 1986; DesHarnais, et al., 1988). It involves dividing the observed provider outcome rate by an expected provider outcome rate calculated from a risk model that accounts for patient-specific characteristics (Thomas, Holloway, & Guire, 1993). More specifically:

> Indirect standardization . . . requires estimates of the expected outcome in a study population, based on the outcome experience of a standard population. To estimate expected outcome, the numbers of cases in the study population with risk-related attributes are multiplied by the probability of the outcome in a standard population with matching attributes. These expected outcomes in the study population are then compared with the observed number having that outcome in the same study population. . .The first step involves the development and testing of a risk-prediction model, while the second step is a study of the residuals of the observed less the expected outcomes of the study population. (Blumberg, 1986, p. 355).

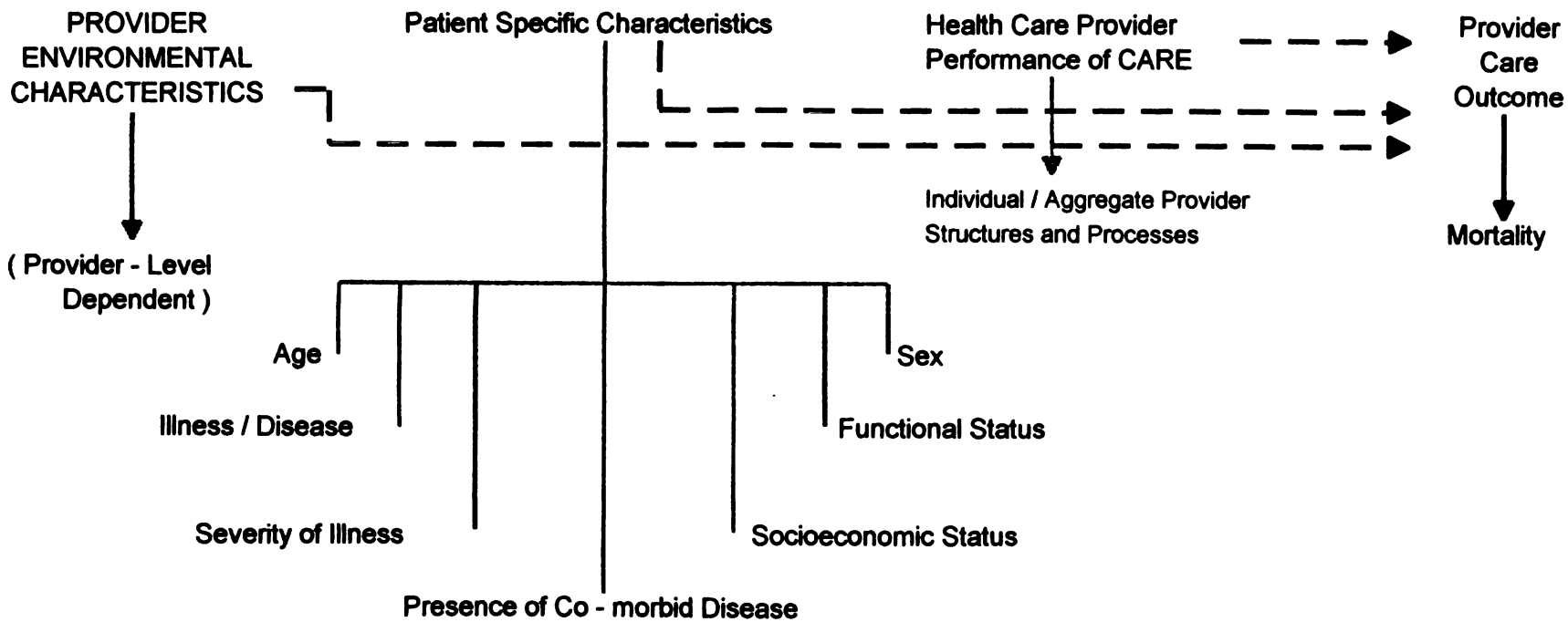

Figure 2-5. Risk-adjusted model of outcome for the outcome of mortality.

Even if patient specific characteristics are accounted for via risk adjustment modelling, observed differences between provider outcomes may not be caused by variation in provider quality of care. As stated in Chapter 1, the factors described by McAuliffe (cited in Thomas, Holloway, & Guire, 1993) as affecting the use of any specific outcome in comparing the quality of care between providers can be delineated by the following equation,

$$\text{Var (O)} = \text{Var(V)} + \text{Var(SE)} + \text{Var(RE)}:$$

Var(O) representing observed variability in patient outcomes across providers; Var(V) representing the component of Var (O) "validly" attributable to provider quality of care differences; Var(SE) representing the component of Var(O) attributable to systematic error of measurement related to differences in patient-specific characteristics between providers; and Var(RE) representing the random error of measurement related to residual variability in outcomes caused by unknown or unmeasured factors.

Misattribution of observed variations in outcomes to quality of care differences between providers can occur in 3 instances. In the first instance, when the outcome is actually unrelated to care, i.e. when Var(V) = 0 and systematic error is controlled for, provider differences relate to random error. Secondly, when Var(SE) is biased related to inaccurate weighting or measurement of patient specific characteristics, caused by model under- or over-specification, differences between providers will relate to a combination of quality of care differences, Var(SE) bias and random error. An example of this is when severity of illness is unmeasured in a risk adjusted model. This model would be biased against hospitals caring for sicker patients, since hospitals caring for sicker patients would have poorer outcomes (Dubois, Rogers, Moxley, & Draper, 1987). In the third instance, when Var(SE) includes patient specific factors that are the result of poor quality of care, differences that actually exist in provider quality of care will be masked, with providers differences again being caused by

random error. Including length of aortic cross clamp time and time on bypass in a risk adjustment model, as was done in one study of CABGS mortality (Iyer, et al., 1993), is an example of the third instance where a quality of care difference was used as a component of Var(SE). In these 3 instances providers may be misclassified as giving good or poor quality care (Thomas Hollaway, & Guire, 1993).

Risk-adjustment monitors of care are usually developed from large databases, usually via a three step process of 1) identifying risk factors via review of the literature; 2) conducting a univariate analysis to examine the correlation of identified risk factors with the outcome; and 3) using step-wise multiple or logistic regression or discriminant analysis to develop the "best" predictive model from the variables identified as having a significant correlation with the outcome in the univariate analysis.

To be valid, risk-adjustment models must meet certain requirements. A model must 1) contain only predictor variables that precede the condition or procedure under study--i.e., it must be process independent; 2) be based on accurate and reliable data; 3) be tested to ensure adequacy in controlling for patient specific characteristics; and 4) be periodically updated since predictor variables will change over time. A risk-adjustment model must not contain predictor variables that will later be used as a basis of comparison, i. e., a model containing provider characteristic predictor variables precludes using the model for comparing outcomes by provider characteristics (Blumberg, 1986).

Statistical assessment of a risk-adjusted model of outcome's (RAMO's) adequacy in controlling for patient characteristics--the bias of the model, is based on whether it is to be used to predict the outcome of individual patients or whether it is to be used to predict the outcome of groups of patients with similar characteristics--i.e., a provider's "group" of patients (Romano, 1993). Accurate outcome prediction at the individual and aggregate level

demonstrates the adequacy of the model's control for the heterogeneity of patient characteristics and appropriate exclusion provider or process related variables. Model bias at the individual level is assessed via measures of discrimination, while bias at the aggregate level is assessed via measures of calibration (Romano & Mark, 1994).

The receiver operating curve (ROC) is advocated at the most useful statistic with which to assess RAMO discrimination. The area under the ROC, The ROC characteristic (A_z or *c* statistic), is a number summarizing model discriminative ability. "It represents the proportion of all randomly selected pairs of observations with different outcomes (e.g., one death and done survivor) in which the patient who died had a higher expected probability of death than the survivor (Romano, 1993, p. 455). Values range from .5, where the model's ability to predict outcome is not greater than chance, to 1 where the predictive ability of the model is perfect. Other methods of assessing a RAMO's discriminative ability are Somer's D_{yx}-- a measure of the rank correlation between a RAMO's observed and predicted outcomes, and Brier's score--the model's mean squared prediction error.

Detection of RAMO bias at the aggregate level is via the assessment of model calibration. Calibration involves the examination of how much the predicted outcome rates differ from the observed outcome rates across groups of patient stratified by a given characteristic. Goodness-of fit is then assessed by the *C* statistic, which under the assumption that the fitted model is the correct model, will demonstrate model fit at *p* values greater than the selected level of significance (Hosmer & Lemeshow, 1989; Hosmer, Taber, & Lemeshow, 1991).

Risk adjustment can be done with or without the use of severity of illness measures. However, severity of illness measures are required for meaningful comparison of provider

outcomes or the Var(O) will reflect the unmeasured provider case-mix, Var(SE), rather than quality of care differences (Donabedian, 1992).

The importance of adequate risk adjustment in the comparison of provider outcomes has been emphasized since the Health Care Financing Administration's (HCFA) 1986 release of listings of providers whose crude mortality rates exceeded those predicted using hospital-level variable risk adjustment (DesHarnais, et al., 1988; Kouchoukos, Ebert, Grover, & Lindesmith, 1988). Even though HCFA moved to the use of patient-level variables in 1987, their new risk-adjustment model still did not include even a generic severity of illness measure (DesHarnais, et al., 1988). In one study, addition of a severity of illness measure caused remarkable improvement in the HCFA model's ability to predict mortality, demonstrated by an increase in the R^2 of the HCFA model from 2.5% to 21.5% (Green, Wintfeld, Sharkey, & Passman, 1990).

Severity of illness measures can be generic or condition-specific. Examples of generic severity illness measures include Apache III (Knaus, et al., 1991) and Medisgroups (Brewster, Karlin, Hyde, Jacobs, Bradbury, & Chae, 1992). An example of a condition-specific severity of illness measure is the Clinical Severity Score, risk-adjustment model developed at the Cleveland Clinic for use in the evaluation of mortality and morbidity associated with CABGS (Higgins, et al., 1992).

Risk-adjustment models can be constructed using either clinical or administrative databases. Green and Wintfeld (1993) describe problems inherent in the usage of administrative databases. In a re-abstraction of a stratified random sample of medical records for California's administrative database, extensive coding error was found, which when corrected resulted in significant changes in predicted mortality rates for 15 of the 29 hospitals studied. Their study of outcome evaluation capabilities in risk adjustment using administrative

databases also has implications for construction of risk adjustment models from invalid or unreliable data. Blumberg (1986) advocates that models should be built using actual measures rather than proxy measures of patient condition (Blumberg, 1986). Actual measures of patient status are only obtainable from clinical databases.

Risk-adjustment modeling using condition-specific severity of illness measures using clinical databases appears to be the ideal. However, the expense of the data extraction involved in condition-specific model specification and ongoing monitoring has led to research toward improvement of administrative database utility in specific conditions (Luft & Romano, 1993) and exploration of administrative database comparability to the clinical ideal (Green, et al., 1990; Krakauer, Bailey, Skellan, Stewart, Hartz, & Kuhn, 1992)

Risk-Adjustment Outcome Monitors as Quality of Care Screens

The use of risk-adjusted outcome models as screens to identify provider quality of care outliers is exemplified in a study by DuBois, et al., (1987). These investigators first identified providers having higher than predicted mortality and providers having lower than predicted mortality via the use of a risk-adjustment model which included a severity of illness measure. They then examined the care processes of these providers via both explicit and implicit process of care reviews. No quality of care differences were found on explicit review. However, implicit record review revealed significantly higher rates of preventable deaths at the high outlier hospitals.

In another study (Park, Brook, Kosecoff, Keesey, Rubenstein, & Keeler, 1990), hospitals with higher than predicted mortality rates and hospitals whose mortality rates were not higher than predicted (i.e., all other hospitals) were identified using a risk-adjusted model with a severity of illness measure. These hospitals demonstrated no quality of care differences on explicit review of the provider processes of care. Thomas, Holloway, & Guire (1993) also

found lack of demonstrated quality of care differences in peer review organization process reviews of the two of three conditions studied after high outlier providers were identified based on condition-specific risk-adjusted mortality rates. These investigators attribute the absence of process differences to a lack of validity of risk-adjusted mortality rates as quality of care indicators. They advocate establishing the validity of the quality/outcome relationship before inferences concerning provider quality are drawn.

Alternatively, the lack of demonstrated quality of care process differences might relate to the time lag between the determination of the risk-adjusted outcome and the process review. However, Luft and Romano (1993) have studied the risk-adjusted California hospital CABGS patient outcomes and found that having higher than expected mortality or lower than expected mortality is consistent for hospitals over several consecutive 6 month periods.

Risk-Adjustment Modelling in CABGS

CABGS patient-specific risk adjustment models for mortality and morbidity developed for populations after or including 1982 include those by Edwards, Clark, & Schwartz (1994); Geraci, et al. (1993); Grover, et al.(1990), Hammermeister, et al. (1990), Hannan, et al. (1990), Hartz, Kuhn, Kayser, et al. (1990), Higgins, et al. (1992), Iyer, et al. (1993), O'Connor, et al. (1992), Parsonnet, et al. (1989), Wright, Pifarre, Sullivan, Montoya, Bakhos, & Grieco (1987). These models are presented in Table 2-2 (CABGS RAMO for mortality) and Table 2-3 (CABGS RAMO for morbidity). Risk factors for CABGS mortality identified by the American College of Cardiology (Table 2-4) and in the multivariate analyses described above are listed by type (demographic, cardiovascular, comorbidity, physical examination, laboratory value and care process) in Table 2-5 through Table 2-10. The risk factors identified vary according to the population studied, the method used and the timeframe in which the study was conducted (Grover, et al., 1990; Iyer, et al., 1993; Parsonnet, Dean, & Bernstein, 1989).

Analysis of the CABGS RAMO for morbidity and mortality reveals that improvement is needed in the description of the model testing such as model goodness of fit statistical analyses. The proliferation of multiple clinical and administrative CABGS risk-adjustment models, with their attendant development and utilization costs, only serves to prevent inter-provider comparisons. The development of the Society of Thoracic Surgery database for risk-adjustment of mortality based on participation of member hospitals assists with inter-provider comparisons but has the drawbacks of being based on self-report data which may be collected retrospectively (dependent on the participating institution) with no reliability assessment of data input by outside evaluators. Two studies used a commercial severity of illness system, Medisgroups to develop their risk-adjustment model (Geraci, et al., 1993; Hartz, Kuhn, Rimm, et al., 1992). Use of a commercial severity of illness risk-adjustment substantially decreases costs of development.

Table 2-2.

CABGS-Specific Risk-Adjusted Models of Mortality

	Edwards, et al. (1994)	Grover, et al. (1990)
Population	Patients undergoing isolated CABGS at hospitals participating in the Society for Thoracic Database (academic, private practice, VA, military)	Patients undergoing CABGS at VA Hospitals
N	80,881	8,569
Study Period	January, 1980 to December, 1990	April 1, 1987 to March 31, 1989
Design	Dependent on participating institution	Prospective
Method of Analysis	Logistic regression (step-wise)	Logistic regression (step-wise)
Sample Mortality	3.2% (OM)	4.8% (Within 30 days)
Variables in Model	Age Female Renal failure CVA Cardiomegaly Time from MI Cardiogenic shock Antiplatelet therapy PTCA emergency Ejection Fraction Reoperation Coronary disease Left main disease	Prior heart surgery Priority of surgery NYHA functional class Peripheral vascular disease Age Pulmonary rales
Model Significance	Used Bayesian model of operative mortality to assess	Not reported
Purpose of Model Development	Development of a database for self-monitoring was a response to the HCFA release of CABGS raw mortality statistics--"a superficial treatment of a complex surgical problem"	"To improve quality assurance of CABGS by assessing pre-operative risk factors and relating them to operative mortality."

Table 2-2--continued

	Hannan, et al. (1990)	Higgins, et al. (1992)
Population	Patients undergoing cardiac surgery in New York State	Patients undergoing CABGS at the Cleveland Clinic Foundation
N	7,596	Building - 5,051 Testing - 4,069
Study Period	First 6 months of 1989	July, 1986 - June, 1988 (Building) July, 1988 - June, 1990 (Testing)
Design	Retrospective analysis of CSRS data	Retrospective - building Prospective - testing
Method of Analysis	Logistic regression	Logistic regression
Sample Mortality	4.9% (In-hospital)	2.5% (Death during hospital or within 30 days)
Variables in Model	Age Female gender Reoperations Ejection fraction MI within last 7 days Diabetes Dialysis dependent Disaster Congestive heart failure > 90% left main disease Valve operation Other operation	Emergency case Serum creatinine Reoperation Severe LV Dysfunction Mitral valve insufficiency Age per decade Hematocrit ≤ 0.34 COPD on medication Prior vascular surgery
Model Significance	Not reported	Building - Goodness of fit $p = .8$ Validation - $p = .3$
Purpose of Model Development	"To develop a method for assessing the quality of care provided by cardiac surgical centers."	Calculation of the expected rate of adverse events to assist in quality assurance and research

Table 2-2--continued

	Iyer, et al. (1993)	O'Connor, et al. (1992)
Population	Consecutive patient undergoing first-time isolated CABGS at Royal Adelaide Hospital, Australia	All patients undergoing isolated CABGS at 5 New England Medical Centers
N	12,003	3,055
Study Period	1978-1990	July, 1987 - April, 1989
Design	Retrospective chart review	Prospective
Method of Analysis	Logistic regression	Logistic regression
Sample Mortality	.99% (OM)	4.3% (In-hospital)
Variables in Model	Perfusion time Age Female sex Left ventricular function Unstable angina	Age Female sex (not significant) √BSA Comorbidity score Ejection fraction Left ventricular end diastolic pressure Priority at surgery
Model Significance	Not reported	Hosmer-Lemeshow $(C)_{(10\ df)}$ p = .689 Area under the ROC = .76
Purpose of Model Development	To identify factors which influence operative mortality and peri-operative MI.	To develop a clinical prediction rule to allow calculation of a clinical probability of death

Table 2-2--continued

	Parsonnet, et al. (1989)	Wright, et al. (1987)
Population	Patients undergoing cardiac surgery at Newark Beth Israel Medical Center, New Jersey	All CABGS performed at Loyola University Medical Center
N	3,500 (building) 1,332 (testing)	6,257
Study Period	1982-1987	1970-1984
Design	Retrospective - model building Prospective - model testing	Retrospective analysis of data in Loyola Open Heart Registry
Method of Analysis	Logistic regression	Discriminant analysis
Sample Mortality	?	1.1% - elective isolated CABGS 5.1% -emergency isolated CABGS
Variables in Model	Age Bypass only Bypass plus other procedure Elevated cholesterol Diabetes Catastrophic states Female gender Hypertension Left ventricular ejection fraction Mitral valve disease Obesity Pre-operative IABP Reoperation (Left ventricular aneurysm, Aortic valve disease, Family history Smoking, in model but not significant)	For All Isolated CABGS Emergency surgery Number of bypasses (negative correlation with OM) Number of myocardial infarctions Diffuse coronary artery disease 90% left main stenosis 70% left main stenosis Age
Model Significance	Not reported	Ability of discriminant function to correctly predict death was 17%.
Purpose of Model Development	"To devise a method of stratifying open-heart operations into levels of predicted mortality. . . to compare results in similar (risk) groups between institutions."	Identification of risk factors predictive of OM to better inform patients of their risk in CABGS.

Table 2-3

CABGS-Specific Risk-Adjusted Models of Morbidity

	Geraci, et al. (1993)	Hammermeister, et al. (1990)
Population	Medicare patients undergoing CABGS in one of seven states	Patients undergoing CABGS at VA Hospitals
N	2,213	10,634
Study Period	January 1985 - June 1986	April 1, 1987 - March 31, 1989
Design	Retrospective	Prospective
Method of Analysis	Logistic regression	Logistic regression
Sample Mortality	6.6% (30 day)	4.8% (Within 30 days)
Variables in Model	Prediction of any adverse event utilizing Medisgroups variables (death included): History of CABGS Emergent CABGS History of COPD Infiltrate on chest x-ray Pulse ≥ 110 Age Serum blood urea nitrogen ≥ 10.7 mmol/L Acute myocardial infarction at admit History of myocardial infarction Male One- or two-vessel disease	Prior heart surgery Creatinine NYHA functional class Surgical priority Age Pre-operative balloon pump Peripheral vascular disease Congestive heart failure COPD Cerebrovascular disease Diabetes
Model Significance	ROC c statistic = .64 Hosmer-Lemeshow = acceptable fit	Not reported
Purpose of Model Development	To develop a CABGS risk-adjustment model based on adverse events for quality monitoring purposes.	Part of a prospective program to use risk-adjusted outcome as a measure of Quality of care

Table 2-3--continued

	Hartz, Kuhn, Kayser, et al. (1990)	Higgins, et al. (1992)
Population	Medicare patient undergoing CABGS in Wisconsin	Patients undergoing CABGS at the Cleveland Clinic Foundation
N	1998	Building - 5,051 Testing - 4,069
Study Period	March, 1989 - April, 1991	July, 1986 - June, 1988 (Building) July, 1988 - June, 1990 (Testing)
Design	Retrospective	Retrospective - model building Prospective - model testing
Method of Analysis	Logistic regression	Logistic regression
Sample Mortality	?	2.5% (Death within 30 days)
Variables in Model	Implanted defibrillator Previous CABGS Creatinine > 2.0 mg/dl Valve surgery Coronary endarterectomy Cardiac support Heart failure on x-ray Three or more grafts Peripheral vascular disease Insulin dependent diabetic Enlarged heart on x-ray Female Age (each 10-year increase)	Emergency case Serum creatinine Reoperation Severe left ventricular dysfunction Mitral valve insufficiency Age per decade Diabetes, on medication Weight ≤ 65 kg. Hematocrit ≤ 34 COPD on medication Cerebrovascular disease Prior vascular surgery
Model Significance	Overlap index = .62	Build Goodness of fit P = .74 (good fit). Testing Goodness of Fit poor.
Purpose of Model Development	To develop a quality of care monitor based on complication rates	Calculation of the expected rate of adverse events to assist in quality assurance and research

Table 2-4

List of Patient Characteristics Identified as Risk Factors for CABGS Mortality Identified by the ACC/AHA (1991)

Risk Factor Category	Risk Factors
Demographic	Age (Older) Body Size (Smaller) Gender (Female)
Clinical Status	Angina Classification (More Severe) Unstable Angina Response to Stress Testing (More Severe) Acute Myocardial Infarction New York Heart Classification (I-IV) (Higher) Hemodynamic Instability (Grade 0 to 4) (More Severe)
Distribution and Severity of CAD	--
Left Ventricular Dysfunction	--
Aggressiveness of Atherosclerotic Process	Diffusely Diseased Coronary Arteries Peripheral Vascular Disease Cerebrovascular Disease Hyperlipidemia (More Severe) Age at CABGS (Younger)
Coexisting Disease	Diabetes Hypertension Pulmonary Disease (More Severe) Stroke Smoking
Surgical Factors	Date of Operation (At an Earlier Age) Pre-operative Myocardial Infarction Emergent versus Scheduled Surgery

Table 2-5

CABGS Mortality/Morbidity Demographic and Patient History Risk Factors Identified By Study

Risk Factor	Study/Studies* Identifying
Demographic variables	
Age	Edwards (1994); Geraci (1993); Grover (1990); Hammermeister, (1990); Hannan (1989; 1990; 1991; 1994); Hartz (each 10 year increase) (1990); Higgins (per decade) (1992); Iyer (1993); Kelly (1987); Luft (1993); O'Connor (1992); Parsonnet (1989); Showstack (age group) (1987); Williams (1991); Wright (1987).
Gender (Female unless otherwise specified)	Edwards (1994); Geraci (male) (1993); Hammermeister, (1990); Hannan (sex) (1989); Hannan (1990; 1991; 1994); Hartz (1990); Iyer (1993); Luft (1993); O'Connor (1992); Parsonnet (1989); Showstack (sex) (1987)
Race	Showstack (1987)
Patient history variables	
Admission status	Hannan (1989); Luft (transfer or emergency room abstract codes) (1993)
History of myocardial infarction	Hannan (1994); Geraci (1993); Hannan (1991); Wright (# of MIs) (1987)
Prior heart surgery	Edwards (reoperation) (1994);Geraci (CABGS) (1993); Grover (1990); Hammermeister (1990); Hannan (1991; 1994); Hannan (reoperations: 1, ≥ 2) (1990); Hartz (CABGS) (1990); Higgins (reoperations) (1992); Parsonnet (reoperation) (1989);
Prior vascular surgery	Higgins (1992)
Antiplatelet therapy	Edwards (1994)

Table 2-6

CABGS Mortality/Morbidity Cardiovascular Risk Factors Identified By Study

Risk Factor	Study/Studies* Identifying
Angina/Unstable angina	Grover (1990); Hammermeister (1990)Hannan (1991; 1994); Iyer (1993); Showstack (diagnosis code)(1987)
Acute myocardial infarction	Geraci (1993); Hannan (1990); Showstack (diagnosis code) (1987)
Recent MI	Edwards (< 21 days from CABGS)(1994); Hannan (within last 7 days)(1990)
Cardiogenic shock	Edwards (1994)
Left ventricular dysfunction (Ejection fraction)	Edwards (1994); Hannan (1991), (20-39%, < 20%) (1990); Higgins (severe LV dysfunction)(1992); Iyer (1993); O'Connor (ejection fraction; left ventricular pressure) (1993); Parsonnet (1989)
Disease condition/Stage	Hannan (1989); Williams (1991); Grover (NYHA)(1990); Hammermeister (NYHA)(1990)
Congestive heart failure	Grover (pulmonary rales)(1990); Hammermeister (1990); Hannan (1990; 1994), (intractable) (1991); Hartz (heart failure on x-ray) (1990); Luft (diagnosis code) (1993); O'Connor (left ventricular end diastolic pressure) (1992); Showstack (diagnosis code)(1987);
Pulmonary rales	Grover (1990)
Mitral valve disease	Hartz (1990); Higgins (insufficiency) (1992); Parsonnet (1989);
CABGS done as emergency procedure	Edwards (coronary disease; left main disease) (1994); Geraci (1993); Grover (priority of surgery) (1990); Hammermeister (surgical priority) (1990); Hannan (disasters) (1990; 1991), (cardiac catheterization crashes) (1991); Higgins (1992); Luft (date/catheterization procedure code relationship)(1993); O'Connor (priority at surgery) (1992); Parsonnet (catastrophic states) (1989) Showstack (presence of cardiac catheterization or angioplasty procedure codes) (1987); Wright (1987)

Table 2-6--continued

Pre-operative balloon pump	Hammermeister (1990); Hannan (1994); Hartz (cardiac support) (1990); Luft (procedure code) (1993); Parsonnet (1989)
Extent of CAD	Geraci (one or two vessel disease) (1993); Hannan (> 90% narrowing of left main trunk) (1990); Wright (diffuseness; 90%left main, 70% left main) (1987)
Hyperlipidemia	Parsonnet (elevated cholesterol) (1989);
Hypertension	Luft (diagnosis code) (1993); Parsonnet (1989)
Implanted defibrillator	Hartz (1990)

Table 2-7

CABGS Mortality/Morbidity Comorbidity Risk Factors Identified By Study

Risk Factor	Study/Studies* Identifying
Diabetes	Hammermeister (1990); Hannan (1990; 1991); Hartz (insulin dependent) (1990); Higgins (on medication (1992); Luft (diagnosis code) (1993); Parsonnet (1989);
COPD	Geraci (1993); Hammermeister (1990); Higgins (on medication) (1992); Luft (diagnosis code) (1993)
Renal failure	Edwards (1994); Geraci (BUN) (1993); Hammermeister (creatinine) (1990); Hannan (dialysis dependent) (1990; 1991); Hartz (creatinine) (1990); Higgins (creatinine)(1992); Luft (diagnosis code)(1993)
Chronic liver failure	Luft (diagnosis code) (1993)
Peripheral vascular disease	Grover (1990); Hammermeister (1990); Hartz (1990); Higgins (prior vascular surgery) (1992); Luft (diagnosis code)(1993)
Cerebrovascular disease	Edwards (CVA) (1994); Hammermeister (1990); Higgins (1992)
Obesity	O'Connor (1992); Parsonnet (1989)
Hematocrit (< 34)	Higgins (1992)
Coagulapathy	Luft (diagnosis code)(1993)
Degenerative neurologic disorders	Luft (diagnosis code)(1993)
Co-morbidity score	O'Connor (1992)
Number of secondary diagnoses	Hannan (1989)
Other major procedure during same hospitalization	Luft (procedure codes for vascular, abdominal, and miscellaneous "major procedures) (1993)

Table 2-8

CABGS Mortality/Morbidity Physical Exam and Laboratory Study Risk Factors Identified By Study

Risk Factor	Study/Studies* Identifying
Physical Exam Findings	
Heart rate > 110	Geraci (1993)
Pulmonary rales	Grover (1990)
Weight ≤ 65 kg	Higgins (1992)
√BSA	O'Connor (1992)
Laboratory/X-Ray Findings	
BUN	Geraci (1993)
Creatinine	Hammermeister (1990); Hartz (1990); Higgins (1992)
Hematocrit	Higgins (≤ 0.34) (1992)
Cholesterol (high)	Parsonnet (1989)
Infiltrate on chest x-ray	Geraci (1993)
Heart failure on x-ray	Hartz (1990)

Table 2-9

CABGS Mortality/Morbidity Process Risk Factors Identified By Study

Risk Factor	Study/Studies* Identifying
Number of grafts	Hartz (≥ 3 grafts); Wright (decreased)(1987)
Concurrent heart operation	Hannan (valve; other operation--not CABGS or valve) (1990); Hartz (coronary endarterectomy, valve) (1989; 1990); Luft (coronary endarterectomy, aneurysm procedure codes); Parsonnet (other) (1989)
Use of internal mammary graft	Luft (1993)
Perfusion time	Iyer (1993)
Surgeon volume	Hannan (1989; 1991)
Hospital volume	Hannan (1991); Showstack (1987); Williams (1991)
Length of stay	Williams (1991)

Table 2-10.

CABGS Mortality/Morbidity Non-significant Risk Factors Contained In a Model Identified By Study

Risk Factors	Study/Studies* Identifying
Aortic valve disease	Parsonnet (1989)
Left ventricular aneurysm	Parsonnet (1989)
Smoking	Parsonnet (1989)

Administratively-based CABGS patient-specific risk-adjustment models would be much less expensive to develop and implement, though their reliability and validity has been questioned. Hannan, Kilburn, Lindsey, & Lewis's (1992) comparison of New York State's administrative and clinical CABGS-specific risk-adjustment models demonstrated that the correlation between the risk-adjusted mortality rates for two models was only .75 to .80. The clinical model was felt to be the gold standard--the best predictor. However, these authors recommend that which type of model is used for risk-adjustment is dependent on the purpose for which it is used; administratively-based risk-adjustment might be acceptable for intra-provider monitoring, while only clinically-based models would be acceptable for inter-provider quality comparisons.

Correlations between crude and adjusted mortality and/or morbidity rates have ranged from .74 (Hannan, et al., 1992; Hartz, Kuhn, Kayser, et al., 1992) to .92 (O'Connor, et al., 1991) and .95 (Hartz, Kuhn, Green, & Rimm 1992). Investigations examining the difference between hospital ranking based on crude mortality rate versus risk-adjusted mortality rates found no significant difference in rankings, though several individual hospital crude and risk-adjusted mortality rates differed substantially (Hartz, Kuhn, Green, et al., 1992; Hartz, Kuhn, Kayser, et al., 1992). Cost-benefit analyses of the utility of risk-adjustment must be conducted to determine if the time and effort of the data collection and analysis is worthwhile.

Consensus is needed on one model including hospital, caregiver (surgeon, anesthetist, nursing unit) and patient-specific demographic, payer, and disease-specific variables so that providers may be compared. Risk-adjustment modelling based on adverse outcome rates versus rates of OM might be a more sensitive indicator of the quality of care (Hartz, Kuhn, Kayser, et al., 1992).

DOD use of risk-adjusted CABGS mortality was limited to one report of intra-provider operative mortality adjustment using a Bayesian statistical model (Edwards, Albus, Zatchuk, Graeber, & Barry, 1989).

Uninvestigated CABGS Post-operative Care Processes: Hemodynamic Monitoring and the Collaboration of ICU Nurses and Physicians

Hemodynamic Measurement and Treatment Practice

The competence of providers within the ICU in performing diagnostic and treatment processes impacts on ICU outcomes (Shortell, et al., 1992). Post-operative hemodynamic diagnostic and treatment processes are directed toward maintaining patient cardiac output and tissue perfusion with definite effects on CABGS outcomes.

Use of hemodynamic technology is the standard of care in many subsets of the critically ill to include the intra-operative and initial post-operative management of CABGS patients (ACP/ACC/AHA, 1990; European Society of Intensive Care Medicine, 1991; Matthay & Chatterjee, 1988). On the basis of directly measured pulmonary artery wedge (PAWP) and arterial blood pressures (ABP) and parameters derived from these measurements, critical care nurses and physicians assess their patients and titrate multiple therapies including diuretics, volume, contractility agents, vasodilators and vasopressors to improve patient tissue perfusion (Bossaert, Demey, DeJongh, & Heytens, 1991; Halfman-Franey & Bergstrom, 1989; Harper, 1992; Urban, 1993).

Hemodynamic monitoring is one of the primary surveillance/observation interventions of the critical care nurse (Titler, 1992). If hemodynamic measurement and treatment are not

performed correctly, adequate patient tissue perfusion will not be maintained, causing morbidity and mortality.

Pitfalls to Reliable and Valid Hemodynamic Measurement

Numerous pitfalls to reliable and valid measurement of hemodynamic pressures have been delineated to include violation of measurement requirements of PA monitoring (Dolter, 1989; Enger, 1989; Nadeau & Noble, 1986; Quaal, 1993; O'Quinn & Marini, 1983; Wiedemann, Matthay, & Matthay, 1985) (Table 2-11); of ABP obtained via sphygmomanometer (AHA, 1987; Anderson, Cunningham, & Maloney, 1993)(Table 2-12); and of ABP monitored via arterial line (Keckeisen & Monsein, 1991) (Table 2-13).

Research concerning the actual rate of PAWP technical errors in clinical practice has described error incidence ranging from 31 to 33% of PAWP measurements performed (Morris, Chapman, & Gardner, 1984; 1985). These technical errors related only to balloon inflation, dynamic response and PAWP confirmation errors, represent only a fraction of the technical errors that might occur since errors in zeroing, leveling and lung zone placement were not addressed.

Interpretive errors in PAWP measurement are another issue. Physician accuracy in interpretation of PAWP waveforms with respiratory variation ranged from 55 to 65 % (Komadina, Schenck, LaVeau, Duncan, & Chambers, 1991).

No ABP technical error rate research was noted. However, the questionable reliability of indirect ABP measurement was established in Wilcox's (1961) establishing the extent of interobserver variation in this procedure.

The reliability and validity effects of different methods of performing individual steps required for accurate ABP and PAWP measurement has also been heavily researched. Reviews of hemodynamic research in nursing (Cowan, 1990; Kinney, 1984; Quaal, 1988; van

Cott, Tittle, Moody, & Wilson, 1990) demonstrate that this has been nursing's focus. "Research on hemodynamics (is) . . . the most common type of study in cardiovascular nursing" (Cowan, 1990, p. 15). Patient positioning effects on hemodynamics accounts for 11% and cardiac output measurement studies account for 8% of all critical care nursing research performed between 1978 and 1988 (van Cott, et al., 1990). A flaw noted in all reliability and validity research reviewed was lack of explication of if and how measurement technical and physiologic measurement criteria were met, leaving results of these studies open to question. No nursing research has looked at the entire process of hemodynamic measurement and treatment process in actual patient care situations or its effects on patient outcomes.

Provider Knowledge Concerning Hemodynamic Measurements and Interventions

Nurse and physician knowledge concerning how to obtain reliable and valid hemodynamic measurement and how to treat hemodynamic measurements appropriately appears deficient (Bridges, 1991; Dolter, 1987; Iberti, et al, 1990; Iberti, et al., 1994; Kondrat, 1994; Straw, Lovey, & Woods, 1987; Sollek, 1988). The mean percentage correct obtained by nurses and physicians on tests of hemodynamic knowledge ranges from 54 to 67 per cent.

Table 2-11

Criteria Required for Reliability and Validity of PAWP Measurement By Reviewer

	Booker & Arnold (1993)	Bosseart, et al. (1991)	Bridges (1993)	Dolter (1989)	Enger (1989)
Technical Criteria					
1. Main PA placement	X		X	X	
2. Zone III lung placement	X	X	X	X	X
3. Zeroing	X*	X	X	X	X*
4. Leveling	X*	X	X	X	X*
5. Calibration	X		X	X	X
6. Dynamic Response Testing	X	X	X	X	X
7. Balloon inflation monitoring	X			X	X
8. No PEEP/ventilator disconnection			X	X	X
9. End-exhalation	X		X	X	X
10. Graphic recording recommendation	X		X	X	X
Physiologic Criteria					
1. PAd ≥ PAWP	X			X	X
2. No mitral disease		X		X	X
3. Heart rate < 120					
Physiologic Parameters Which Affect Interpretation					
1. Left ventricular compliance	X	X		X	X
2. Pulmonary compliance	X	X		X	X
3. Colloid oncotic pressure		X			X
4. Pulmonary capillary permeability					X
5. Juxtacardiac pressure	X	X			X
6. Medication		X			
7. Mitral valve disease	X	X		X	X

X = Criteria delineated in review. * = Zeroing and leveling described as one procedure

Table 2-11—continued

	Gardner (1993)	Gardner (1986); Gardner & Hujcs, 1993)	Kern (1993)	Nadeau & Noble (1986)
Technical Criteria				
1. Main PA placement	X		X	
2. Zone III lung placement assessment	X		X	X
3. Zeroing	X	X*	X	X*
4. Leveling	X	X*	X	X*
5. Calibration	X	X	X	X
6. Dynamic Response Testing	X	X	X	X
7. Balloon inflation monitoring			X	
8. No PEEP/ventilator disconnection	X			X
9. End-exhalation	X		X	X
10. Graphic recording recommendation		X	X	X
Physiologic Criteria				
1. PAd ≥ PAWP	X			X
2. No mitral disease				X
3. Heart rate < 120				X
Physiologic Parameters Which Affect Interpretation				
1. Left ventricular compliance			X	X
2. Pulmonary compliance			X	X
3. Colloid oncotic pressure				
4. Pulmonary capillary permeability				
5. Juxtacardiac pressure			X	X
6. Medication				
7. Mitral Valve Disease			X	X

X = Criteria delineated in review. * = Zeroing and leveling described as one procedure

Table 2-11--continued

	O'Quinn & Marini (1983)	Quaal (1993)	Vender (1988)	Wiedemann, Matthay, & Matthay (1985)
Technical Criteria				
1. Main PA placement				
2. Zone III lung placement assessment	X	X	X	X
3. Zeroing	X*	X*	X*	X
4. Leveling	X*	X*	X*	X
5. Calibration	X	X	X	X
6. Dynamic Response Testing	X	X	X	X
7. Balloon inflation monitoring		X		X
8. No PEEP/ventilator disconnection	X		X	X
9. End-exhalation	X		X	X
10. Graphic recording recommendation	X		X	X
Physiologic Criteria				
1. PAd ≥ PAWP	X		X	
2. No mitral disease	X		X	X
3. Heart rate < 120				
Physiologic Parameters Which Affect Interpretation				
1. Left ventricular compliance	X		X	X
2. Pulmonary compliance	X		X	X
3. Colloid oncotic pressure				X
4. Pulmonary capillary permeability				X
5. Juxtacardiac pressure	X		X	X
6. Medication			X	X
7. Mitral Valve Disease	X		X	X

X = Criteria delineated in review. * = Zeroing and leveling described as one procedure

Table 2-12.

Criteria Required for Reliability and Validity of ABP Measurements Obtained by Sphygmomanometer (AHA, 1987; Anderson, Cunningham, & Maloney, 1993)

Technical Criteria
1. Manometer with appropriate level of mercury
2. Manometer air vent unobstructed and open to air
3. Manometer air vent nut tightened
4. Bladder width 40 - 50% of upper arm circumference
5. Bladder placed appropriately: snugly, centered over artery, arm without clothing
6. Bulb exhaust valve unobstructed
7. Cuff tubing without kinks or leaks
8. Mercury meniscus at observer eye-level
9. Verification of patient systolic pressure by palpation prior to auscultation
10. Arm supported at heart level
11. Stethoscope bell used
12. Stethoscope bell placed lightly over brachial artery at antecubital fossa
13. 2 - 3 second rate of deflation
14. Systolic, muffling and diastolic pressure correctly ascertained (observer with adequate hearing in quiet environment)
15. Equipment not cold
Physiologic Criteria
1. Patient of normal weight
2. Patient without peripheral edema
3. Patient without peripheral vascular disease
4. Patient with normal systemic vascular resistance (no shock or hypothermia)
5. Patient at rest for 5 minutes
6. Patient without pain, anxiety, or discomfort

Table 2-13.

Criteria Required for Reliability and Validity of ABP Obtained by Direct Measurement (Keckeisen & Monsein, 1991)

Criteria
Technical Criteria
1. System zeroed to air
2. System calibrated
a. Electrically
b. Mechanically
3. System air reference transducer leveled to phlebostatic axis
4. System with adequate dynamic response
Physiologic Criteria
1. Patient without atherosclerosis
2. Patient without altered systemic vascular resistance (hypothermia, shock)
3. Site of catheter

Effects of Hemodynamic Measurements on Practitioner Diagnosis and Treatment Decisions

Research has been done comparing diagnoses and treatment decisions based on clinical assessment alone versus assessments guided by hemodynamic device measurements. These studies demonstrate that hemodynamic-based assessments often cause reevaluation of diagnoses and treatment based on clinical assessment alone (Celoria, Steingraub, Vickers-Lahti, Teres, Stein, & Fink, 1990; Steingrub, Celoria, Vickers-Lahti, Teres, & Bria, 1991; Eisenberg, Jaffe, & Schuster, 1982). PA catheter data obtained after initial clinical assessments caused physicians to alter their diagnoses in 30 to 55 per cent of patients. Hemodynamic measurement based assessments caused alterations in treatment in 40 to 60 per cent of patients from that based on initial clinical assessment.

Effect of Hemodynamic Device Presence or Absence

Reviews reveal that numerous prospective studies in varying critical care patient populations have been conducted to determine the effect of the presence of a hemodynamic

device on patient outcome (American Society of Anesthesiologists, 1993; Technology Subcommittee of the Working Group on Critical Care, 1991). Results are equivocal, with many of the studies having methodologic problems related to small sample sizes, lack of control for confounding variables, use of historical controls and inability to randomly assign patients to device versus no device groups. Shoemaker, Kram, Appel, & Fleming (1990) propose that inadequate use of hemodynamic measurements is also a problem in this hemodynamic research; the goal of the measurement treatment should not be to obtain normal hemodynamic values, but to obtain supranormal values.

Utilization of Hemodynamic Measurements

Two research studies concerning utilization of hemodynamic measurements in clinical decision making were found. One study demonstrated that data from PA catheters in CABGS patients was not utilized by physicians for fluid management decisions after the initial (24 hour) postoperative period, although the device was still in the patient and measurements were still being obtained (Pierson & Funk, 1989). Bruya and Demand (1985) found that treatment initiated for discrepancies between direct or indirect ABP differed by the experience level of the nurse caring for the patient; expert nurses based CABGS patient treatment decisions less on direct and indirect ABP discrepancies and more on other signs and symptoms of patient hemodynamic status--urinary output, intake and output records, central hemodynamic pressures, patient temperature, and hemoglobin and hematocrit levels.

Despite the profound impact of accurate hemodynamic measurement on critical care patient diagnosis and treatment and a demonstrated lack of nurse and physician knowledge concerning hemodynamic measurement and treatment, no research was found addressing actual clinical hemodynamic measurement and treatment practices.

Patients undergoing CABGS have hemodynamic lines placed routinely. CABGS patient monitoring and management in critical care is well delineated and homogenous (Ley, 1993; O'Brien-Norris, 1993; Osguthorpe, 1993). Variations in hemodynamic measurement and treatment knowledge and practice might be more readily identified in the CABGS population due to the overall relative homogeneity of the CABGS procedure.

Nurse-Physician Collaboration and Organizational Climate: Impact on the CABGS Care Process

Unit characteristics have also been hypothesized to affect the outcomes of care (Shortell, et al., 1992). As discussed previously, higher levels of physician and nurse collaboration have been shown to decrease intensive care unit (ICU) patient mortality and ICU readmission rates (Baggs, et al., 1992; Knaus, et al., 1986). "Taking into account differences in patient illness severity, variations in outcomes can be generally ascribed to differences in provider skills, functioning of health care teams, or the structure and processes of the larger organization in which the care is provided" (Shortell, et al., 1991).

On site analyses of organizational processes of ICUs with differing actual versus expected mortality rates has been done in the civilian sector via case study (Zimmerman, et al., 1994). No analysis of organizational processes of units performing CABGS was noted in the literature.

CABGS Implementation Assessments: Conclusions

CABGS is the epitome of the high risk, high volume procedure for the civilian sector and the military. Investigations of CABGS quality have focused on the outcome of operative mortality and the use of risk-adjusted operative mortality as a basis for inter-provider comparison. Yet investigators appear to be lost in a quagmire of CABGS risk-adjusted mortality model development with minimal proof of validity of OM as a quality of care indicator or usage of developed models for inter-provider comparison. Investigation of providers with higher-than-expected mortality providers has been studied only minimally in the civilian sector. The use of adverse events of morbidity and mortality, as exemplified by Hartz, Kuhn, Kayser, et al. (1992) may be a more valid and/or sensitive indicator of CABGS quality. OM or adverse-event risk adjustment model validity should be proven and investigations of CABGS practice variation based on their use should move beyond institutional characteristic investigations. Focusing on the more easily measured quality performance aspects of institutional characteristics associated with high CABGS OM rates needs to be accompanied by the more difficult investigation of process aspects of care. Processes of all caregivers involved in CABGS need to be investigated. The surgeon is not the only caregiver who might have an impact on CABGS OM or adverse events as demonstrated by Slogoff and Keats (1985, 1986). Nursing needs to become more global in its intervention focus with more research on their contribution to the survival and prevention of complications in patients undergoing this high-risk, high volume procedure. Nurses' contributions to CABGS outcome through their assessment of CABGS patient hemodynamic measurements and performance of interventions to obtain/maintain optimum CABGS patient hemodynamics need to be described.

This investigation will 1) describe the use of an administratively-based risk-adjustment model for CABGS mortality at DOD medical centers; 2) describe DOD CABGS nurse and collaborative post-operative CABGS care processes, specifically focusing on the processes of hemodynamic monitoring and intervention and collaboration; and 3) it will describe DOD CABGS patient care provider knowledge related to hemodynamic measurement and its association to CABGS care provider processes.

Study Questions

The questions this study proposes to answer are:

1) What are the differences between DOD medical center actual and predicted CABGS mortality rates?

2) What is the hemodynamic knowledge and hemodynamic measurement and treatment practice of nurses and physicians caring for CABGS patients in DOD medical centers?

3) What is the relationship between hemodynamic knowledge and hemodynamic measurement and treatment practice of nurses and physicians caring for CABGS patients in DOD medical centers?

4) Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher than expected CABGS mortality rates and DOD medical centers with lower than expected CABGS mortality rates? Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher crude CABGS mortality and DOD medical centers with lower crude mortality rates?

5) What are the other unit and provider characteristics and processes of DOD medical centers with higher than expected CABGS mortality rates and DOD medical centers with lower than expected CABGS mortality rates? What are the other unit and provider characteristics and processes of DOD medical centers with higher crude CABGS mortality rates and DOD medical centers with lower crude CABGS mortality rates?

CHAPTER III

METHODOLOGY

Research Design

Case control and exploratory descriptive designs were used to describe unit and provider characteristic and process variations in Department of Defense (DOD) medical centers with high crude CABGS mortality rates (cases) and DOD medical centers with low and medium crude CABGS mortality rates (controls). This design provided descriptive information on the medical center CABGS programs--the cases, and the potential predictor variables (unit and provider characteristics and hemodynamic organizational processes) of the presence or absence of the disease (high versus low crude mortality) (Hulley & Cummings, 1988).

Phases of the Research

The study consisted of 2 phases. Phase I involved the analysis of the input of CABGS patient severity of illness via analyses of DOD administrative data. Phase II involved the analysis of the inputs of CABGS unit and provider characteristics and the analysis of CABGS unit and provider processes. Phase II was further subdivided into Phase II-A, II-B or II-C defined by differences in the sample and/or the methods used during each sub-phase. These phases are summarized in Table 3-1. The settings, sampling techniques, data collection methods and data analysis procedures used will be described by research phase.

Table 3-1.

Phases, Sample Source, Methods, and Instruments

Phase	Sample Source	Method	Instrument(s)
Phase I	12 DOD medical centers which perform CABGS	- Secondary data analysis of DOD discharge abstract data	-California administratively-based CABGS mortality logistic regression model (Luft & Romano, 1993)
Phase II-A	All CABGS patient care providers at the DOD medical centers performing CABGS designated as cases or controls (n = 6)	- Observation	- Blood Pressure and Pulmonary Artery Pressure Assessment Checklists (Dolter, 1994) - Hemodynamic-Measurement Checklist (Dolter, 1994)
		- Knowledge tests	- BP Determination Questionnaire (Sollek, 1988) - Pulmonary Artery Catheter Knowledge Assessment Test (Dolter, 1987) - Pulmonary Artery Catheter Study Group Test (Iberti, et al., 1990)
		- Organizational questionnaire	- ICU Nurse Physician Questionnaire (Shortell, et al., 1991)
Phase II-B	All CABGS patient care providers at the DOD medical centers not designated cases or controls (n = 6)	- Knowledge tests	- BP Determination Questionnaire (Sollek, 1988) - Pulmonary Artery Catheter Knowledge Assessment Test (Dolter, 1987) - Pulmonary Artery Catheter Study Group Test (Iberti, et al., 1990)
		-Organizational questionnaire	- ICU Nurse Physician Questionnaire (Shortell, et al., 1991)

Table 3-1--continued

Phase II-C	All CABGS patients' charts from first 6 months of 1994 at Phase II-A Sites	-Chart audit	- Clinical Severity Score (Higgins, et al., 1992) - CABGS Care Checklist (Dolter, 1994) - Additional CABGS SOI Predictors

Phase I

Phase I involved secondary analysis of DOD databases discharge abstract data to attempt administrative risk-adjustment of DOD medical center CABGS mortality in order to identify and explore differences between medical center actual and predicted mortality.

Databases

Databases used to compile the relevant discharge abstract data included the DOD's Retrospective Case Mix Analysis - Open Systems Environment (RCMAS-OSE) database, the Army's Patient Administration System and Biostatistical Administration-2 (PASBA2) database, the Navy's Automated Quality of Care Evaluation Support System/ Composite Health Care System (AQCESS/CHCS) database, and the Air Force's Standard Inpatient Data Record (SIDR) database.

Human Subjects' Assurance

Phase I was exempt from human subjects' assurance. Permission for access to the DOD discharge abstract data in the RCMAS database was given by the Office of the Secretary of Defense for Health Affairs; the investigator directly accessed this database. Service CABGS discharge abstract data was provided through written request by each service's central medical information management center. Army discharge abstract data was provided by the PASBA, Fort Sam Houston, Texas. Navy data was provided by the Naval Medical Information Management Center, Bethesda, Maryland. Headquarters Air Force Medical Support Agency (HQ-AFMSA), Brooks Air Force Base, Texas provided the Air Force's discharge abstract data.

Database Reliability and Validity

Reliability of discharge abstract data is assessed via validation of ICD-9-CM codes and DRG assignments used in medical record abstraction; abstraction of a medical record by one medical records abstractor is compared against that of another. The reliability of DOD discharge abstract database was investigated in 1993 by Forensic Medical Services (FMAS) under the auspices of the DOD's Civilian External Peer Review Program (CEPRP). This study demonstrated a 15.6% rate of coding differences between the medical facility and FMAS coders in a stratified random sample of 28,383 cases. Discrepancies in DRG assignment were related to ICD-9-CM sequencing errors (2%); physician discharge summary or final note documentation error (10.9%); and coder error in ICD-9-CM assignment (7.1%) (Forensic

Medical Advisory Services, 1994). No reliability assessment of the individual databases could be ascertained.

Validity of database discharge abstract data relating to numbers of cases actually hospitalized for a certain diagnosis/procedure by a specialty can only be ascertained through comparisons of facility log register numbers with listings of patient register numbers for that procedure from the database. No such comparisons were noted as being done in DOD.

Sample

The population of interest was DOD CABGS patients. The intended sample was discharge abstract data for all DOD CABGS patients with admission dates between 1 January and 30 June 1994.

This timeframe was selected since it was expected to be the most recent timeframe for which discharge abstract data could be expected to be complete that would be relevant to current DOD CABGS patient care providers. Discharge abstract data completeness relates to physician compliance with patient medical record completion and promptness of patient administration chart abstraction and database entry. It was expected that discharge abstract data would be complete within 5 months following the end of the timeframe criterion (December 1994). Data greater than 2 years old would in all probability be irrelevant to current DOD CABGS health care providers as the health care provider teams would have entirely "turned-over."

Discharge data requested/required for the risk adjustment included patient register number (for record identification purposes) age at admission, gender, race, admission date, discharge date, source of admission, disposition, principal diagnosis, all secondary diagnoses,

principal procedure, all secondary procedures, and dates of procedures. Discharge abstract data was requested /provided by each service using the inclusion criteria of CABGS procedure (ICD-9-CM code 3610 through 3619) and date of admission between 1 January 1994 and 30 June 1994. Dates of procedures could not be provided by any source. DRG 106 and 107 were not used for identification of CABGS patients since this would not capture all CABGS performed (Blumberg, personal communication, July 1994).

The discharge abstract data required was not obtainable from RCMAS. The RCMAS database did not contain all the patient level data required for risk-adjustment--i.e., secondary diagnoses were not available, nor was the data in a readily usable form; available patient level data could only be obtained from RCMAS by register number, one variable at a time. The RCMAS database was used to verify the completeness of relevant discharge abstract data obtained from each service. Periodic successive queries relisting register numbers of patients whose abstracts met the inclusion criteria were performed. Register numbers in the successive RCMAS relistings missing from each service's database were identified. The discharge abstract information for the missing register numbers was then obtained from either the service's medical information authority through query for the missing register number(s) discharge abstract data or rerun of the original data request. If the service could not access the missing discharge abstract information it was obtained directly from the medical center where the procedure was performed through medical center provision of a copy of original discharge abstract(s).

Discharge abstract data was obtained for 100% of the 829 patient register numbers identified by a 23 June 1995 RCMAS register number listing by the study criteria.

Methods

Discharge abstract data was obtained in hard copy or ASCII format from each service and hand entered or transferred into a CRUNCH4 (1991) database. Diagnosis and procedure codes were transformed into patient severity of illness variables that have been identified in the literature as predictive of mortality.

Diagnosis and procedure codes were transformed into the ICD-9-CM defined severity of illness variables used in the Luft administratively- based logistic regression model for determination of actual versus predicted CABGS mortality (Luft & Romano, 1993; NAPS Document No. 05032) . The model was developed using administrative data from hospital discharge abstracts. That model was valid as measured by a fairly good receiver operating characteristic (ROC), C = .76 for risk adjustment of California CABGS discharge abstract data in a sample of 132,750 CABGS cases 115 hospitals between 1983 and 1989. (The ROC is a measure of predictive ability of a predictive or diagnostic instrument. ROC values range from .50, no discriminating/predictive ability, to 1.0, perfect discriminating /predictive ability (Hanley & McNeil, 1982; Swets, 1988)). The variables and procedure and diagnosis code variable definitions used by Luft are listed in Tables 3-2 through 3-5 along with modifications to the variable used in this analysis (Context Software Systems, 1995). Each table addresses each variable in the Luft & Romano (1993) model by type of variable used; Table 3-2--demographic, Table 3-3--diagnostic, Table 3-4--procedure and Table 3-5--interaction.

When possible, severity of illness variables identified by other researchers of CABGS mortality were also transformed into ICD-9-CM defined severity of illness variables. The variables with their ICD-9-CM definitions (Context Software Systems, 1995) are in listed in Table 3-6.

Table 3-2.

Luft Model Demographic Variable Exclusion/Modification in Model-Building with DOD Data

Variable Name	Description	Definition (ICD-9-CM Code)	Reason for Exclusion/Modification in Model-Building With DOD Data
FEMALE			Included
TRANS	Transfer in from acute care hospital or nursing facility	Source of admission denoted as acute-care hospital, skilled nursing facility, or intermediate care facility	Included
AGEXX	Represented 5 variables, AGE60, AGE65, AGE70, AGE75 AGE80	AGE60 = Pt age 60-64 yr. AGE65 = Pt age 65-69 yr. AGE70 = Pt age 70-74 yr. AGE75 = Pt age 75-79 AGE80 = Pt age ≥ 80	Included but as a continuous variable
EROPDEL	Admitted via emergency room or significant pre-operative delay	Emergency noted as source of admission or a delay in surgery (dependent on day of week patient admitted and whether or not patient catheterized during admission)	Modified to emergency admission only since date of admission often missing and date of procedures not included in DOD databases
YRXX	Year patient discharged	Patient discharged in year 1983 (XX = 83) through 1987.	Not applicable since only data from first 6 months of 1994 included in study

Table 3-3.

Luft Model Diagnosis Variable Exclusion/Modification in Model-Building with DOD Data

Variable Name	Description	Definition (ICD-9-CM Code)	Reason for Exclusion/Modification in Model Built With DOD Data
DIABETES	Juvenile- or adult-onset diabetes mellitus without complication	250.01, 250.1-250.9	Modified to include all diabetes: juvenile- or adult-onset with or without complications (ICD-9-CM codes 250.00 - 250.93)
COAG	Coagulapathies (except acute onset)	286.0-286.5, 286.7-286.9, 287.0-287.3, 287.5-287.9	Modified to 286.0-286.4, 287.0 -287.3, and 287.8-287.9 since 286.5 and 286.7-286.9 and 287.5 could be iatrogenic/not pre-procedure
NEURO1	Hereditary or degenerative neurologic disorders	330.341, 345, 358-359	Deleted since not noted in any other CABGS model
CHF	Congestive heart failure	398.91, 402.01, 402.11, 402.91, 428	Modified to include all heart failure: heart failure caused by hypertension--402.01, 402.11, 402.91, 404.01, 404.11 and 404.91.
HYPERTEN	Chronic hypertension (Except uncomplicated essential)	402-405	Changed to include all hypertension: uncomplicated, essential (401), hypertensive encephalopathy (4372).
ATHANEUR	Peripheral atherosclerosis or arterial aneurysm	440-442	Changed to include all atherosclerosis: peripheral vascular disease, 443.9 .
CLDREV	Chronic liver disease or sequelae thereof	571, 572.2-572.8	Unchanged
CRF	Chronic renal failure	585	Modified to include all renal failure: (from hypertension, 403.01, 403.11, 40391, 404.02, 404.12, 404.92, 404.03, 404.13, and 404.93

Table 3-4.

Luft Model Procedure Variable Exclusion/Modification in Model-Building with DOD Data

Variable Name	Description	Definition (ICD-9-CM codes)	Reason for Exclusion /Modification in Model as Applied to DOD Data
IMAALL	Internal mammary artery bypass	36.15-36.16	Does not meet patient specific characteristic criterion of pre-procedure
ENDARTSD	Concurrent open coronary endarterectomy	36.03 (same day as CABGS)	Does not meet patient specific characteristic criterion of pre-procedure
ANEURYSM	Concurrent repair of ventricular aneurysm	37.32 (same day as CABGS)	Does not meet patient specific characteristic criterion of pre-procedure. Changed to 414.10 which is the diagnosis
CATHPRE	Cardiac catheterization prior to CABGS	CABGS ≥ 1 day post 37.22-37.23 8853-88.57	Not included since procedure dates not available in DOD databases
CATHSAM	CABGS same date as Cardiac catheterization	CABGS same day as 37.22-37.23, 8853-88.57	Not included since procedure dates not available in DOD databases
ASSISTPRO	Prior implant of cardiac assist device	CABGS post-37.61-37.62	Not included since procedure dates not available in DOD databases
PROVAS	Major vascular procedure during hospital stay	38.1, 38.3-38.4, 39.0-39.1, 39.21-39.26, 39.29, 39.5	Does not meet patient specific characteristic criterion of pre-procedure: could be post-CABGS/iatrogenically caused
PROABD	Major abdominal procedure during hospital stay	45.0, 45.3-48.1, 48.3-48.9, 50.0-52.9, 54.1	Does not meet patient specific characteristic pre-procedure criterion could be iatrogenic
PROMISC	Miscellaneous major procedure during same hospital stay	32.0-32.9, 60.2-60.6, 81.0-81.8, 84.0-84.1, 84.3, 84.91	Does not meet patient specific characteristic pre-procedure criterion could be iatrogenic

Table 3-5.

Luft Model Interaction Variable Exclusion/Modification in Model-Building with DOD Data

Variable Name	Description	Definition (ICD-9-CM Code)	Reason for Exclusion/Modification In Model as Applied to DOD Data
HYPREG75	Interaction between HYPERTEN and age ≥ 75	See definitions for these 2 variables	Unchanged
ASSISG75	Interaction between ASSISTPR and age ≥ 75	See definitions for these 2 variables	Unable to use due to lack of procedure date for ASSISTPR
CHFERD	Interaction between CHF and EROPDEL	See definitions for these 2 variables	Unchanged
HYPERERD	Interaction between HYPERTEN and EROPDEL	See definitions for these 2 variables	Unchanged
ATHANERD	Interaction between ATHANEUR and EROPDEL	See definitions for these 2 variables	Unchanged
ANSDERD	Interaction between ANEURYSM and EROPDEL	See definitions for these 2 variables	Changed: used modified definition of ANEURYSM
ASSISERD	Interaction between ASSISTPR and EROPDEL	See definitions for these 2 variables	Unable to use due to lack of procedure date for ASSISTPR
CTHPRERD	Interaction between CATHPRE and EROPDEL	See definitions for these 2 variables	Unable to use due to lack of procedure date for CATHPR

Table 3-6.

Severity of Illness Variables Predictive of CABGS mortality Able to Be Defined by ICD-9-CM Definition

Variable	Definition (ICD-9-CM Code)
Race	
Prior heart surgery	V45.81, 414.02, 414.03 (CABGS); V45.1 (Heart transplant); V42.2 (Heart valve)
History of myocardial infarction	412, 414.8
Angina	411.1, 413.0 - 413.9
Unstable angina	411.1
Acute myocardial infarction / Recent myocardial infarction	410
Cardiomegaly	429.3
Hyperlipidemia	272.0 - 272.3
Mitral valve disease	394.0 - 394.9, 424
COPD	490 - 492.8, 493.2, 494
Cerebrovascular disease	437.0, 437.2
Obesity	278.0
Concurrent heart operation	35.00 - 35.73, 35.91-35.99, 36.03

The transformation statements used are in Appendix A. These transformations which defined the severity of illness variable by ICD-9-CM code(s) and then summed these codes across all 8 diagnosis and 8 procedure codes columns. Transformations were verified through

comparison with manual summations of frequencies for each diagnosis or procedure code applicable to that variable from all diagnosis and procedure code columns in a subset of the DOD data.

Data Analysis

Logistic regressions were run using the full modified Luft & Romano (1993) model to determine if it could be used for risk-adjustment of DOD CABGS mortality. Forward selection logistic regression of modified Luft variables was performed.

Bivariate analysis of all ICD-9-CM defined severity of illness variables was performed. Forward selection logistic regression of those ICD-9-CM severity of illness variables found significant in bivariate analyses was performed to identify any potential theoretically-based model that could be utilized for risk-adjustment of DOD CABGS mortality.

Phase II

Phase II involved the participation of each of the 12 DOD medical centers performing CABGS during fiscal years 1994 and 1995 (FY94 and FY95). The level of participation of a Phase II site varied dependent on its designation as either a Phase II-A/Phase II-C site or a Phase II-B.

Methods

Phase II-A involved in-depth review of patient care practices at six DOD medical centers (case = 2; control = 4), specifically focusing on nurse and physician hemodynamic and organizational practices. The six Phase II-A medical centers underwent a three week long in-depth review of their post-operative unit and provider characteristics and patient care processes, specifically focusing on hemodynamic practice and organizational process variations. This in-depth review included a combination of observation of provider hemodynamic assessment and intervention practices and survey of provider hemodynamic knowledge and organizational processes via questionnaire.

Phase II-B involved only the survey of hemodynamic knowledge and organizational processes via questionnaire at the 12 DOD medical centers which perform CABGS.

Phase II-C involved a description of CABGS patient care inputs, processes and outcomes via a chart audit of all CABGS patient records from the first 6 months of 1994 at the Phase II-A, case and control, medical centers.

Human Subjects' Assurance

The research study was reviewed by the human research committees of 13 institutions. The research study received initial approval from the University of California, San Francisco Committee on Human Research 28 on July 1994 (H2483-10731-01): approval of protocol modifications involving use of an information sheet rather than a consent form with provider questionnaires, addition of clinical variables to the Phase II-C chart audit, and deletion of a computer simulation was received on 18 January 1995 (H2483-10731A). Approval was also

received from: the Department of Clinical Investigation, Brooke Army Medical Center on 6 October 1994 (#C-94-157); the Institutional Review Committee, Dwight David Eisenhower Army Medical Center on 13 October 1994 (94-82); the Institutional Review Committee, Fitzsimons Army Medical Center on 6 September 1994 (94-701); the Department of Clinical Investigation, Madigan Army Medical Center on 6 October 1994 (95-009); the Clinical and Human Use Committees, Tripler Army Medical Center on 27 September 1994 (TAMC 72H94); the Department of Clinical Investigation, William Beaumont Army Medical Center on 23 September 1994 (WBAMC #94/39); Human Use Committee, Walter Reed Army Medical Center on 27 September 1994 (Work Unit # 7543); the Institutional Review Board and Animal Use Committee, 81st Medical Group on 11 October 1994 (47-94-EX); Institutional Review Board, Wilford Hall Medical Center on 6 December 1994 (95EX043); Nursing Research Committee, 74th Medical Group on 13 September 1994 (judged exempt from Institutional Review Board Review by the Chair on 27 September 1994); the Clinical Investigation Department, National Naval Medical Center on 3 March 1995 (B94-082); and the Scientific Review Committee, Naval Medical Center, San Diego on 7 November 1994. The twelve DOD medical center internal review boards were each notified of the protocol modifications relating to consent, chart audit, and computer simulation described above in December of 1994.

A convenience sample of unit providers caring for CABGS patients during the 2 week observation period were invited to participate. Providers were approached after an overview of the research during change of shift report or informal on-unit presentations. Provider subjects were selected from each site according to their desire to volunteer after meeting study inclusion and exclusion criteria and were invited to participate at the shift report presentations. Statistics on race of these providers was not available. Subjects could withdraw from the

project at any time without repercussion. The study posed minimal risk to the provider subjects.

The only involvement of patients in the study was via the chart audit of their medical record to gain descriptive data about unit care processes and that they were the object of the provider's hemodynamic practice.

No one at the medical centers had or will have access to any individual provider data. The questionnaires, tests, checklists and other forms used to collect data had only have unit, provider and patient identification numbers on them and are kept under lock and key since completion. Master lists of unit, patient and provider subjects and identifiers were kept separately from these forms, also under lock and key. The provider master lists were destroyed at the end of data analysis. Data were and will be accessible only to study personnel.

There were no direct benefits to participants in the study other than their test scores. The individual units may benefit from their process data and the comparisons of their data to other DOD medical center provided in the study results. Units will remain anonymous in any presentation of the study results except those designed for their own use.

Research Settings

The Phase II research settings were the 12 DOD medical centers where CABGS were performed in FY94 and FY95. The Phase II-A and II-B sites were specifically the intensive care units (ICUs) performing post-operative CABGS patient care management during 1994 and 1995. The Phase II-C site settings were the inpatient medical records department of these 12 medical centers.

Of the 12 Phase II ICUs that performed post-operative CABGS patient care in 1994 and 1995, three were dedicated thoracic-cardiovascular units, two were combined medical and surgical intensive care units, six were surgical intensive care units and one was a combined coronary care and cardiovascular intensive care unit. Military- physician/DOD-nurse teams performed the CABG surgery and post-operative patient care management at nine of the medical centers, while at two medical centers CABG surgery and post-operative patient care management was performed by civilian-contract physician/military physician/DOD nurse teams. One medical center had a civilian-contract physician/civilian contract nurse program in which the contract physician(s) performed the CABGS on a designated day of the week; the contract physicians and a their team of nurses managed the post-operative care of those CABGS patients for 24 hours, with follow-up care provided by in-house military physicians and nurses after the initial 24 hours period.

Sample

Phase II of the study has four units of analysis: the medical center CABGS unit, the CABGS patient, the individual CABGS provider, and the CABGS hemodynamic assessment and hemodynamic measurement-intervention event.

Phase II Sampling: The CABGS Unit as the Unit of Analysis

The CABGS unit is the collection of ICU nurses and physicians who perform post-operative CABGS patient care management and where that management occurs. The target population was the population of DOD CABGS units. The sample was comprised of the 12 DOD CABGS units in existence between 1 January 1994 and June 1995. All 12 DOD CABGS units were included in either Phase II-A and Phase II-C or Phase-IIB of the study.

Sampling related to the CABGS unit as the unit of analysis involved the sampling of DOD CABGS units for purposes of designating them as cases and controls (Phase IIA/IIC).

Six Phase II-A/II-C cases and control sites were sampled via population-based purposive sampling of the 12 DOD medical centers performing CABGS. DOD medical centers performing CABGS were designated a Phase II-A/Phase II-C site based on inclusion criteria of crude mortality, military service and volume of CABGS procedures performed. Potential Phase II-A/II-C (case or control) sites were selected on the basis of actual CABGS mortality rate; a potential site's crude mortality rate had to have been among the two highest, the two lowest, or the four median of the combined DRG 106 and 107 CABGS mortality rates for January through June of 1994 computed from the military's Retrospective Case Mix Analysis-Open Systems Environment (RCMAS-OSE) database in October of 1994.

Again rationale for this timeframe was that it was expected to be the most recent timeframe for which discharge abstract data -- on which DRG information is based--could be expected to be complete that would be relevant to current DOD CABGS patient care providers. As described previously, discharge abstract data completeness relates to physician compliance with patient medical record completion and promptness of patient administration chart abstraction and database entry. It was expected that discharge abstract data would be complete within 5 months following the end of the timeframe criterion (December, 1995). Data greater than 2 years old would in all probability be irrelevant to current DOD CABGS health care providers as the health care provider teams would have entirely "turned-over."

Use of high and low crude mortality rates allowed for the selection of those units with the greatest and least probability of having quality of care problems. Utilization of only DRG 106 and 107 CABGS patients ensured the comparability of the patient populations and thus their outcomes.

Actual case and control sites were then selected from the potential Phase II-A/II-C sites on the basis of equal representation of Army, Navy and Air Force CABGS units and representation of high, medium and low volume. The volume and mortality rates of the 12 DOD medical center CABGS sites for DRG 106 and 107 CABGS for FY94 as of October 1994 by which the Phase II-A sites were selected are listed in Table 3-7.

The remaining 6 DOD medical center CABGS sites not selected as cases or controls were designated Phase II-B only sites.

Case and control sites were to have been selected by their risk-adjusted outcomes from accomplishment of Phase I analyses: medical centers with higher than predicted mortality, lower than predicted mortality, and whose predicted mortality to was equal to the actual mortality were to have been the Phase II-A/II-C sites. However due to difficulties encountered in obtaining service discharge abstract and time constraints related to Phase II data collection initiation and completion, the Phase II-A/II-C sites were chosen on the basis of crude mortality as described above. The RCMAS database was re-queried in June 1995 concerning DRG 106 and DRG 107 mortality statistics for the January through June 1994 timeframe. Discrepancies between the October 1994 statistics (listed below) and the June 1995 statistics were noted; unreported records (including some deaths) in the October 1994 query had changed some of the medical centers' mortality rates. However, based on the Phase IIB site selection criteria, the same medical centers would have been chosen as cases and controls.

Table 3-7

DOD CABGS Medical Center Site DRG 106, DRG 107 and Combined DRG 106 and 107 Volume, Deaths and Mortality for January through June 1994 (RCMAS-OSE, October 1994)

Medical Center Site (* Denotes II-A/IIC Site)	DRG 106 Volume # of Deaths (Crude Mortality)	DRG 107 Volume # of Deaths Crude Mortality	Combined DRG 106 and DRG 107 Volume # of Deaths Crude Mortality
# 1*	28 2 (7.1%)	31 3 (10.3%)	59 5 (8.5%)
#2	25 1 (4%)	13 0 (0%)	38 1 (2.6%)
#3	30 2 (6.6%)	31 0 (0%)	61 2 (3.3%)
#4	40 2 (5%)	22 0 (4.5%)	62 2 (3.2%)
#5*	17 0 (0%)	5 0 (0%)	22 0 (0%)
#6	22 1 (4.5%)	7 0 (0%)	29 1 (3.4%)
#7	51 0 (0%)	36 0 (0%)	87 0 (0%)
#8*	20 0 (0%)	45 0 (0%)	65 0 (0%)
#9*	35 2 (5.7%)	43 0 (0%)	78 2 (2.6%)

Table 3-7--continued

#10	27 0 (0%)	15 1 (6.7%)	42 1 (2.4%)
#11*	95 2 (2.1%)	30 1 (3.3%)	125 3 (2.4%)
#12*	22 2 (9.1%)	19 0 (0%)	41 2 (4.9%)

Phase II Sampling: The CABGS Patient As the Unit of Analysis.

The CABGS patient is delineated by the pre-operative severity of illness, care process and outcome data abstracted from his/her medical record. The population of interest was CABGS patients. The intended sample consisted of Phase II-A/C CABGS patients with admission dates between 1 January 1994 and 30 June 1994.

CABGS patients were sampled at each site through listings of patient register numbers for all patients undergoing CABGS at that site with admission dates between 1 January 1994 and 30 June 1994 provided by each services central patient administration authority. Listings were produced through a search of the service's patient discharge abstract databases for ICD-9-CM procedure codes 3610 through 3619 in any procedure code position for the specified admission date timeframe. CABGS register number listings were provided for the relevant cases for the Army by the PASBA, Fort Sam Houston, Texas in October, 1994; for the Navy by the Naval Medical Information Management Center, Bethesda, Maryland in November, 1994; and for the Air Force by HQ-AFMSA, Brooks Air Force Base, Texas in November, 1994. Register number listings were obtained from the specific service's database rather than

DOD RCMAS-OSE database because it was felt that the services' data would be more inclusive since data is first entered into the service specific database and then transferred to RCMAS. Register number listings were then mailed to each Phase IIA/IIC site in December 1994, with the notification of the projected chart audit timeframe for that facility. All locatable medical records were pulled either by, or with the assistance of, inpatient medical records personnel at each site using that patient register number listing. The population of CABGS patients/medical records for the 1 January thru 30 June 1994 timeframe at the six Phase IIA/IIC sites was 433.

Phase II Sampling: The CABGS Care Provider as the Unit of Analysis.

The population of interest, intended sample and the procedures used for sampling relating to the CABGS care provider as the unit of analysis differed depending on the whether the providers were part of the questionnaire survey or the hemodynamic-process observation.

CABGS Care Provider Sampling: Phase II-A and Phase II-B Questionnaire Survey. The population of interest for the questionnaire survey was the DOD CABGS nurse and physician patient care provider. The intended sample consisted of a convenience sample of CABGS nurse and physician providers working in DOD hospitals between 1 January 95 and 15 June 1995. A CABGS nurse provider is defined as a registered nurse (RN) or CABGS assist personnel defined as able to provide care to a CABGS patient within his/her first 24 hours post-operatively by the site nurse manager. CABGS assist personnel, defined as ancillary personnel providing direct care under the direct supervision of an RN during the patient's first 24 hours post-operatively, are included in the CABGS nurse provider category. These assist personnel include licensed practical nurses (LPNs), medics, airmen and corpsmen. A CABGS physician provider is defined as a cardiothoracic surgeon, fellow in cardiothoracic surgery or a non-perfusionist physician assistant working in the cardiothoracic department.

Approximately 183 nurses, 35 CABGS assist personnel and 47 physicians were providing CABGS patient care in DOD during the 1 January through June 30 timeframe. Breakdown of the CABGS provider population is described in Tables 3-8 and 3-9. CABGS nurse and physician provider population estimates are based on CABGS unit nurse manager personnel counts given to the investigator during that unit's site visit. The nurse manager personnel counts are only good for the point in time in which they given due to the normal staff fluctuations within DOD relative to retirements, temporary duty assignments, ends of time in service, permanent changes of station, changes of duty assignments, and military schooling requirements.

Questionnaire survey packets with stamped, self-addressed envelopes for questionnaire return were distributed at each site to each DOD CABGS nurse provider through the unit's mailbox system except site 6. Physician questionnaires were hand-delivered either to one of the cardiothoracic physicians or to a non-physician member of their department (secretary or physician's assistant) for distribution at all sites except site 6. At site 6, the contract nurse/contract physician site, the provider questionnaires were handed to the nurse manager of the contract team for distribution to the nurses and physicians of that team.

Table 3-8

The DOD CABGS Nurse Population, January thru June 1995: Numbers and Types of CABGS Nurse Provider Personnel By Type

Survey Site	Military RN	Government Service (GS) RN	Agency RN	Contract RN	CABGS Assist Personnel (Medics / Corpsmen Airmen/ LPNs)	Total RN/ Total Assist
Site # 1	12	10	0*	0	0	22 / 0
Site # 2	7	10	0	0	0	17 / 0
Site # 3	2	9	0	0	0	11 / 0
Site # 4	6	7	0	0	0	13 / 0
Site # 5	9	2**	1	0	0	12 / 0
Site # 6	0	0	0	8	0	8 / 0
Site # 7	11	7	0	0	0	18 / 0
Site # 8	6	7	0	0	3	13 / 3
Site # 9	12	0	16	0	0	28 / 0
Site # 10	12	0	0	0	9	12 / 9
Site # 11	14	1	0	0	13	15 / 12
Site # 12	7	7***	0	0	10	14 / 10
Total #	98	60	17	8	35	183/35

* - Though Agency nurses were stated as not caring for CABGS, 2 were observed doing so.
** - Includes 2 Champus Reform Initiative RNs
*** - Includes 3 VA Share RNs

Table 3-9

The DOD CABGS Physician Population, January thru June 1995: Numbers and Types of CABGS Physician Provider Personnel By Type

	Military MD	Contract MD	Fellows	Non-Perfusionist Physician Assistant (Assist)	Total MD/ Total Assist
Site # 1	3	0	2	0	5 / 0
Site # 2	4	0	0	0	4 / 0
Site # 3	3	0	0	0	3 / 0
Site # 4	3	0	0	0	3 / 0
Site # 5	2	0	0	0	2 / 0
Site # 6	0	4	0	0	4 / 0
Site # 7	3	0	2	0	5 / 0
Site # 8	2	7	0	0	9 / 0
Site # 9	3	1	0	0	4 / 0
Site # 10	2	0	0	0	2 / 0
Site # 11	4	0	0	0	4 / 0
Site # 12	2	0	0	1	2 / 1
Total #	31	12	4	1	47/1

CABGS Care Provider Sampling: Phase II-A Observation. The population of interest for the observation portion of Phase II-A was DOD CABGS nurse providers. The intended sample were those DOD CABGS nurse providers working at the Phase II-A, case or control, medical centers between 1 January and 2 June 1995. The definition of the CABGS nurse provider for purposes of observation is the same as for the questionnaire survey described

above. The intended sample of Phase II-A CABGS nurse providers consisted of the 104 CABGS nurse providers working at Sites 1, 5, 8, 9, 11, and 12 during the specific timeframe.

A convenience sample of CABGS nurse providers at the Phase IIA sites was obtained for purposes of observing their hemodynamic-measurements reliability/validity assessment and hemodynamic measurement-intervention events was obtained at each Phase II-A site. CABGS nurse providers were approached for participation if they were providing care for a CABGS or CABGS/valve replacement patient within that patient's first 12 hours post-operatively during their site's 2 week observation timeframe. CABGS nurse providers were not approached for participation if either of 2 exclusion criteria were met 1) patient physiological or patient family situation instability or 2) previous observation of both first and second shift CABGS nurse providers. Patient physiological instability was defined as patients on left ventricular assist devices or those who had extreme difficulty being weaned from cardiopulmonary bypass; patient family situation instability was defined as a CABGS care situation in which the family was extremely distraught over the patient's condition/ situation (i.e., those undergoing emergency operations). Providers were not approached during these situations since the burden of observation on the provider or the patient's family in such a situation was judged to be too great--even though the patient and family were not being observed. Previous observation of first and second shift providers --defined as the first and second primary nurses caring for a CABGS patient within that patient's immediate 24 hour post-operative period- excluded those nurse providers from re-observation since no new provider information could be obtained. CABGS nurse providers were re-observed on a first-shift, if there was a potential for observation of a second shift provider who had not already been observed. Once observation of a CABGS patient's providers was initiated on the first-shift post-operatively, the

observation of the second was continued to 24 hours or until no hemodynamic interventions had occurred for greater than 2 hours.

Phase IIA observation of CABGS nurse providers meeting the selection criteria who agreed to participate consisted of sampling 1) a hemodynamic reliability/validity assessment event and 2) hemodynamic measurements and hemodynamic measurement-intervention events. Hemodynamic assessment reliability/validity checks were sampled utilizing the applicable hemodynamic assessment checklist (pulmonary artery, arterial line, or cuff pressure checklist) within the first 4 hours of the provider's shift when/if the provider performed that measurement. Hemodynamic measurements and measurement-intervention events were recorded using the Hemodynamic Measurement-Intervention checklist/database developed for recording and coding of these events (Appendix B). Provider hemodynamic measurements were recorded every 15 minutes from the patient's monitor except when the provider obtained paper recordings of hemodynamic measurements. When paper recordings of hemodynamic measurements were obtained measurements were recorded from the paper recording. Provider hemodynamic interventions were recorded whenever they occurred during his/her shift, with the measurement that was the basis of the intervention. Observation of hemodynamic measurement/intervention events was terminated if there were no hemodynamic interventions for greater than 2 hours (i.e., patient on straight-rate or no vasoactive drips and receiving no volume or medication boluses) and that provider's hemodynamic measurement reliability and validity assessment had been completed.

Whenever more than one provider was caring for the patient and there was difficulty determining the provider performing the reliability/validity assessment all providers involved in the hemodynamic-measurement reliability/validity check were recorded on the checklist. Attribution of the hemodynamic measurement reliability/validity assessment check for purposes

of description of that check was to the patient's primary nurse provider, for purposes of correlating hemodynamic knowledge and hemodynamic measurement performance the check was attributed to all providers recorded on the checklist.

Phase II Sampling: The CABGS Hemodynamic Assessment / Hemodynamic Measurement Intervention Event as the Unit of Analysis.

The population of interest was DOD CABGS hemodynamic assessment and hemodynamic measurement events. The intended sample was all CABGS hemodynamic measurements and measurement-interventions performed by CABGS nurse providers who met the Phase II-A observation described above.

Instruments

A substruction of the study variables (concepts and sub-concepts and the instruments for their measurement is presented in Tables 3-10, 3-11 and 3-12 (Dulock & Holzemer, 1991). Nine instruments and two demographic questionnaires (unit and provider) were utilized. They are listed below with their reported reliability and validity. Observation instruments are contained in Appendix B. Questionnaire packet instruments are in Appendix C along with other questionnaire packet item--cover letter and consent form. Appendix D contains the chart audit instrument. Letters granting permission for use of each instrument in this study are in Appendix E, as are other letters of permission related to the study. All instruments were used only after the provider had consented to participate in the study. Analyses of interrater reliability on appropriate instruments utilized Cohen's kappa.

The time burden of questionnaire and computer simulation completion for the physicians was estimated at 60 minutes and for the nurses was estimated to be approximately

90 minutes. Questionnaire and test completion was off-unit unless on-unit completion was permitted by the unit nurse manager. On unit observation did not interfere with patient care.

Individual providers were given their hemodynamic test scores and furnished with a hemodynamic bibliography on request. Units were provided with descriptive statistics on each instrument administered. Individual provider data was confidential; the master tracking list was destroyed after data analysis was accomplished.

The Clinical Severity Score.

The Clinical Severity Score (CSS) (Higgins, et al., 1992) is a pre-operative risk assessment score developed at the Cleveland Clinic for predicting morbidity and mortality outcomes in CABGS patients, including patients with accompanying procedures such as valve replacements. Range of the CSS is from 0 - 33 with higher scores corresponding to greater morbidity and mortality. The score was developed from a logistic regression based risk-adjusted monitor of morbidity and mortality on 5051 patients undergoing CABGS at the Cleveland Clinic. Validity of the CSS for morbidity and mortality as evidenced by area under the receiver operating characteristics curve was .74 and .83 respectively. Interrater reliability was measured for 10% of the observations, as it was for all subsets of the chart audit data.

The CSS was just one measure utilized to assess pre-operative patient risk. CSS variables were obtained during the chart audit of CABGS patients who had their surgery at the medical center between 1 January and 30 June 1994 and during the 2 weeks of unit observation in order to describe the severity of illness of the observed CABGS care providers' patients.

Table 3-10.

Substruction of Study Input Variables: Concepts, Sub-concept(s) and Instruments

Input Variable(s)	Concept(s)	Sub-concept(s)	Data Source(s)
Characteristics: Demographics	Unit	Volume of surgeries; dedicated CVICU or combined CVICU / SICU; overall staff mix; rank mix; staff mix caring for CABGS; average unit acuity (WMSN); CV CNS present / absent; RNs with ICU identifier; RNs with CCRN; RNs attending service critical care course; inservice hours provided per month; actual versus expected mortality category.	Unit Demographic Questionnaire
	Provider	Rank; years in service; years as RN; years in ICU; ICU identifier status; CCRN status; critical care education; hemodynamic education; inservices attended in past year.	Provider Demographic Questionnaire
Characteristic: Knowledge Concerning Hemodynamics	Unit	Mean provider hemodynamic knowledge (described below)	
	Provider	Blood pressure measurement knowledge	Blood Pressure Determination Questionnaire
		Pulmonary artery pressure measurement knowledge	PACKAT (RNs) PACSG (MDs)
Patient Severity	Severity of illness	Age; emergency case status; left ventricular status; reoperation status; valve status; presence/ absence of following: COPD, diabetes controlled with medication, anemia, cerebro-vascular disease, prior vascular surgery.	Clinical Severity Score

CVICU = Cardiovascular ICU
SICU = Surgical ICU
CV CNS = Cardiovascular CNS = Clinical Nurse Specialist
CCRN = Critical Care Registered Nurse Certification
WMSN = Workload Management System for Nurses Acuity System

Table 3-11.

Substruction of Study Process Variables: Concepts, Sub-concepts and Instruments

Process Variable(s)	Concept(s)	Sub-concept(s)	Data Source(s)
Nurse and Physician Care Processes	Hemodynamic assessment	Blood pressure assessment	- Cuff Pressure Assessment Checklist - A-line Pressure Assessment Checklist
		Pulmonary artery pressure assessment	- Pulmonary Artery Pressure Assessment Checklist
	Hemodynamic Intervention	Hemodynamic intervention	- Hemodynamic Measurement Intervention Database
	Organizational Processes	Relationships, teamwork, leadership, management of disagreements, authority, perceived effectiveness, satisfaction, communications,	- Nurse-Physician Questionnaire (Short form)
	CABGS Care	CABGS Care Process Milestones	CABGS Care Checklist

Table 3-12.

Substruction of Study Output Variables: Concepts, Sub-concepts and Instruments

Output Variable(s)	Concept(s)	Sub-concept(s)	Data Source(s)
Morbidity			Morbidity / Mortality / Utilization Audit
Mortality			Morbidity / Mortality / Utilization Audit
Health Service Utilization	LOS, reoperations, routine medications and labs		Morbidity / Mortality / Utilization Audit CABGS Care Checklist

CABGS Care Checklist

The CABGS Care Checklist, developed by the investigator, is a checklist of patient milestones similar to a case management path. Items include length of time intubated; length of time on vasoactive drips; length of time on titrating vasoactive drips; length of time on bedrest; ICU length of stay; length of time mediastinal tubes in place. Content validity was established by submitting the checklist to two doctoral student nurses expert in CABGS patient care. Items were added, deleted or changed based on their input.

The CABGS Care Checklist was utilized to collect unit process variables obtained during the chart audit of all CABGS performed for the first six months of 1994 and the two weeks of unit observation in order to adequately describe unit care processes.

Hemodynamic Parameter Assessment and Treatment Checklists and Hemodynamic Measurement-Intervention Database.

The Cuff Blood Pressure, A-Line Blood Pressure and Pulmonary Artery Wedge Pressure Assessment Performance Checklists are criterion-referenced instruments developed by the investigator to measure provider assessment of these hemodynamic parameters. The Cuff Blood Pressure Checklist is based on American Heart Association guidelines (1987). The A-Line Blood Pressure and Pulmonary Artery Wedge Pressure Assessment Checklists were developed from an extensive review of the literature described in Chapter II. Content validity was established by submitting the checklist to two doctoral student nurses with extensive cardiovascular experience. Items were revised, added and deleted based on their input. Interrater reliability was measured for 10% of observations. The Hemodynamic Measurement/Intervention Checklist was also reviewed by the two doctoral student nurses. The Assessment Performance Checklists were utilized at the beginning of each shift to describe actual hemodynamic measurement practice. The Measurement-Intervention

Checklist/Database was utilized at the beginning of each shift and every 15 minutes while the patient's hemodynamics were being manipulated to describe actual hemodynamic intervention practice.

ICU Nurse-Physician Questionnaires

The ICU Nurse-Physician Questionnaires (Shortell, et al., 1991) are two 78 item Likert-type Questionnaires that have been utilized in the ICU environment to measure leadership, work place and facilities, organizational culture, coordination, communication, conflict management, team cohesion and perceived unit effectiveness. One questionnaire is designed to assess nurses, the other is designed to assess physicians. In one study of 1700 ICU provider respondents in a national sample of 42 ICUs, reliability (Cronbach's alpha) for the sub-scales ranged from .61 - .88. Convergent and discriminant validity was also established. The short forms of these instruments were used. The short forms have the organizational culture and work place and facilities sub-scales deleted.

This questionnaire was administered to each nurse and physician provider in order to assess unit organizational processes.

BP Determination Questionnaire.

The Blood Pressure Determination Questionnaire (BPDQ) (Sollek, 1988) is 34 item, multiple choice, criterion referenced questionnaire. It was developed at the University of Washington under Susan L. Woods and utilized in a study of blood pressure measurement knowledge in a systematic sample of 600 nurses in six Washington counties. The instrument has face and content validity. Internal consistency reliability was not calculated related to the inappropriateness of its measurement in criterion referenced tests.

This questionnaire was administered to each nurse provider in order to assess blood pressure measurement knowledge.

The Pulmonary Artery Catheter Knowledge Assessment Test.

The Pulmonary Artery Catheter Knowledge Assessment Test (PACKAT) (Dolter, 1987) is a 61 item multiple choice test developed to assess nurse knowledge of PAWP and CO measurement. Face and content validity have been established. Kuder-Richardson-20 for the entire test was .77 established in a random sample of 500 members of AACN.

This test was administered to each nurse provider in order to assess nurse knowledge of pulmonary artery catheter measurements.

The Pulmonary Artery Catheter Study Group Test.

The Pulmonary Artery Catheter Study Catheter Study Group (PACSG) Test (Iberti, et al, 1990) is a 31 item multiple choice test developed to assess physician knowledge of PA pressure measurement. Reliability and validity was established in a convenience sample of 496 doctors at 13 medical facilities. KR-20 for the test was .71. Construct validity was established via correlation of scores with physician level of training.

This instrument was administered to each physician provider in order to assess physician knowledge of pulmonary artery catheter measurement and intervention.

Severity of Illness/Morbidity/Mortality/Utilization Audit Form

Patient severity of illness, morbidity, and mortality and unit resource utilization data were collected on patients from the first six months of 1994 and the two week observation period via an audit for developed by Dolter (1994). Severity of illness predictor variables were compiled from the literature (previous tables Table 2-5 through Table 2-10). Morbidity definitions are taken from Higgins, et al.(1992). Mortality is defined as in-hospital mortality. Utilization data includes information concerning length of stay (ICU and total hospitalization); reoperations; non-autologous blood usage; number and type of vasoactive drips; type, number

and frequency of labs. The data was obtained from patient post-operative physician's orders and nurse and physician progress notes and flow-sheets written during the ICU stay.

Overview of Phase I and Phase II Procedures

The procedures for sampling access, internal review board and on-site data collection are outlined below. The timeline for these procedures is described in Table 3-13.

Medical Center/Unit Sampling, Access and Internal Review Board Procedures.

Medical center/unit sampling, access, and internal review board procedures included the following.

1) Human Subjects Approval. University of California, San Francisco Human Subjects was applied for and obtained.

2) Internal Review Board Applications. All 12 DOD medical centers Internal Review Board applications were completed and delivered. All medical center applications were for both Phase II-A and Phase II-B research.

3) Administrative Risk-Adjustment of DOD CABGS Mortality. DOD Medical Center CABGS actual versus expected mortality rate calculation was attempted using the Luft and Romano (1993) administratively based risk-adjustment model on the RCMAS-OSE database. However, the discharge abstract data required was not obtainable from all services within the projected timeframe required for study completion. Therefore the case and control medical centers were selected based on crude rather than risk-adjusted mortality rates Attempts at obtaining the required discharge abstract data continued throughout the study.

4) Site Visit Scheduling. The best time for the 3 week Phase II-A and 3 day Phase II-B site visits was negotiated with each Medical Center.

Table 3-13.

Study Timeline: July, 1994 through August, 1995

	JUL-DEC 94	JAN 95	FEB 95	MAR 95	APR 95	MAY 95	JUN 95	JUL/ AUG 95
Risk Adjustment of CABGS Mortality	--------							-----
UCSF IRB Approval	--------							
MEDCEN Site IRB Approvals	-------	-------	------	---				
Pilot Study		----						
MEDCEN # 9 Data Collection		----	---					
MEDCEN # 12 Data Collection			---					
MEDCEN # 8 Data Collection				---				
MEDCEN # 5 Data Collection				--	--			
MEDCEN # 11 Data Collection					---	---		
MEDCEN # 1 Data Collection						---		
Data Analysis / Write-Up							------	------

On-Site Unit/Provider Procedures.

Day 1. Providers were presented with an overview of the research at unit change of shift and volunteers were requested. Individual providers not able to attend the initial presentations were approached individually. Emphasis was on the voluntary nature of the participation and on the benefits of participation, i.e., feedback on their performance if desired.

Day 1 - 14. Individual provider hemodynamic assessment and interventions events were observed for 2 weeks. All nursing personnel caring for CABGS patients, whether professional or paraprofessional, were approached for participation.

Day 15-21. Individual provider demographic, organizational and knowledge tests were delivered to the participants for completion and mailback at their convenience. All questionnaires were stapled together within an envelope along with the applicable information sheets and/or consent forms and a stamped addressed envelope for questionnaire mailbox to the investigator. Nurse provider questionnaire packets were delivered by the principal investigator who placed them in each nurse's mailbox at each Phase II-A and Phase II-B site, except at the contract-physician/contract nurse site where they were given to the nurse manager of the contract-nurse team. Physician questionnaires were given to either the Cardiothoracic Department's secretary or local principal investigator at each site.

Unit demographic data collection and the chart audit was also accomplished during this timeframe.

Measurement Plan

The measurement plan for the post-operative unit and provider characteristics and processes is described in Table 3-14.

Table 3-14.

Measurement Timetable for One Medical Center

	Week 1-2	Week 3
Unit	Chart audit: - CABGS Care Checklist - Severity of Illness Morbidity/ Mortality/ Utilization Audit Unit Administrative Demographics	Chart audit: - CABGS Care Checklist - Severity of Illness Morbidity/ Mortality/ Utilization Audit Unit Administrative Demographics
Nurse	Observation: - Hemodynamic Assessment Checklists - Hemodynamic Measurement-Intervention Database	Questionnaire Packet Delivery: - Nurse Demographic - ICU Nurse - BPDQ - PACKAT
Physician		Questionnaire Packet Delivery: - Physician Demographic - ICU Physician - PACSG Test

Data Analysis

1) What are the differences between DOD medical center actual and predicted CABGS mortality rates?

Actual versus predicted CABGS mortality and crude mortality for each DOD medical center were determined. Differences in the rank-ordering of the 12 DOD medical centers were determined via Spearman's rho.

2) What is the hemodynamic knowledge and hemodynamic measurement and treatment practice of nurses and physicians caring for CABGS patients in DOD medical centers?

Descriptive statistics (means, standard deviations, range) were calculated by provider category

for hemodynamic tests and the measurement and intervention checklists. Hemodynamic knowledge tests had their reliability assessed via Kuder-Richardson 20.

3) Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher than expected CABGS mortality rates and DOD medical centers with lower than expected CABGS mortality rates? Professional nurses were divided into two groups based on whether they were providing care at medical centers with higher than expected CABGS mortality rates or at medical centers with lower than expected CABGS mortality rates. The hemodynamic knowledge tests (BPDQ and PACKAT) and hemodynamic checklist score means for these two groups were described and compared via t-test (α = .05 for this family of questions) when possible.

4) Are there differences between nurse hemodynamic knowledge and hemodynamic measurement and treatment processes at DOD medical centers with higher crude CABGS mortality and DOD medical centers with lower CABGS crude mortality rates? Nurses were also divided into two groups based on whether they were providing care at medical centers with higher crude mortality or lower crude mortality. Hemodynamic knowledge test scores and checklist scores for these two groups were described and compared via t-test when possible.

4) What are the other unit and provider characteristics and organizational processes that exist in DOD medical centers with higher than expected mortality rates and DOD medical centers with lower-than and equal-to expected CABGS mortality rates?

Descriptive statistics were utilized to describe unit and provider characteristics and organizational processes for DOD medical centers with the highest actual versus expected

CABGS mortality and for DOD medical centers with lowest and median actual versus expected CABGS mortality.

5) What are the other unit and provider characteristics and organizational processes that exist in DOD medical centers with the highest crude mortality rates and DOD medical centers with median and lowest crude CABGS mortality rates?

Descriptive statistics were utilized to describe unit and provider characteristics and organizational processes for DOD medical centers with the highest crude CABGS mortality and for DOD medical centers with the median and the lowest crude CABGS mortality rate.

All nurse provider characteristic and process data were described and/or analyzed by professional category. Questions of differences and association were restricted to professional nursing personnel due to inadequate statistical power for the physician provider analyses.

CHAPTER IV

RESULTS

Results will be presented by study phase, Phase I and Phase II. Within Phase II, data will be presented by the input, process or outcome aspect of the Phase IIA/C CABGS unit being described. Presentation of Type I error, Type II error, reliability of instrumentation, sample demographics and analyses will be described as applicable to each phase and phase aspect.

Phase I: Description of DOD CABGS Units Using Administrative Input, Process and Outcome Data

Type I Error and Type II Error.

The α criterion for evaluating the significance for a risk-adjusted outcome model for DOD CABGS patients based on administrative data was set at .05. No formulas for computation of sample size requirements or power exist for logistic regression techniques (Hulley & Cummings, 1988). No discussion of power was noted in discussions of logistic regression in texts explaining the technique (Glantz & Slinker, 1990; Hosmer & Lemeshow, 1989). Sample size requirements discussed by Glantz & Slinker (1990) are dependent on the number and type of independent variables and relate to sample size requirement for model goodness of fit assessments; for a model with 8 dichotomous variables in the equation, the sample size required would be 2^6 (the number of cells required for model goodness of fit

assessment) X 5 (the minimum number of subjects per cell), or 320. No sample size requirements were discussed by Hosmer and Lemeshow (1989).

Reliability and Validity of the Databases Used.

Reliability of the DOD discharge abstract data was not able to be ascertained in this sample. A previous reliability had demonstrated a 15.6% coding error rate for DOD discharge abstract data (Forensic Medical Advisory Services, 1994). Validity of the DOD RCMAS-OSE database was assessed via comparison of listings of register numbers of CABGS patients by site from RCMAS to listings of CABGS patient register numbers obtained from facility logs from each site. Comparison of RCMAS CABGS register numbers against facility log (operating room, ICU unit, perfusionist, or cardiothoracic physician logs) register numbers of CABG surgeries performed revealed discrepancies. If the facility logs were correct, a total of 76 CABGS patient discharge abstracts are missing. A summary of discrepancies between RCMAS and facility logs is described in Table 4-1.

Some of the discrepancies probably relate to register number transcription errors--either within the log or by the investigator, or use of ICU rather than operating room, perfusionist or thoracic surgery logs since some patients die intra-operatively. Discrepancies can also occur related to when the RCMAS data was obtained and when the procedure/ hospitalization was performed; if the data is accessed within 6 months of the hospitalization or procedure it would probably not reflect all procedures performed due to the time required for physician completion of charts and chart processing by patient administration. Discrepancies noted in Table 4-1 should not be related to chart completion or processing since the RCMAS listing was obtained 1 year after the procedures were performed.

Table 4-1

Discrepancies Between Facility Log and RCMAS Listing of CABGS Patient Register Numbers

Site #	Number of CABGS Patient Register Numbers in RCMAS-OSE (June 1995)	Number of CABGS Patient Register Numbers in Facility Log	Number of CABGS Patient Register Numbers in Facility Log But Not In RCMAS	Number of CABGS Patient Register Numbers in RCMAS But Not In Facility Log (Number of CABGS Patient Register Numbers Related to Discharge Date After 30 June)
# 1[a]	69	66	0	3 (2)
# 2	48	Not Available	Not Available	Not Available
# 3[b]	64	62	3	5 (2)
# 4[c]	82	79	4	7 (4)
# 5[c]	27	27	1	1 (0)
# 6[b]	34	27	6	13 (3)
# 7[a]	103	104	14	13 (3)
# 8[a]	78	77	0	1 (0)
# 9[a]	84	85	3	2 (0)
# 10[a,d]	48	77	29	0 (0)
# 11[e]	139	134	5	10 (6)
# 12[b]	53	54	11	10 (1)

a = Intensive care unit (ICU) log used as facility log source
b = Operating room log used as facility log source
c = Thoracic Surgery physicians' log used as facility log source
d = Tricare/Resource Management log used as facility log source
e = Perfusionist log used as facility log source

A major discrepancy was found for site #10. This large discrepancy was investigated through request to that medical center for the discharge abstracts of the ICU unit log's register numbers that were missing from RCMAS. This investigation demonstrated that RCMAS did not contain 29 records which met the inclusion criteria; the records were coded with procedure codes 3610 through 3619 and admission was between 1 January and 30 June 1994. The Tricare/Resource Management team at that facility is currently investigating the cause of the large discrepancy. This discrepancy was investigated due to its magnitude; the other discrepancies were not investigated as they were beyond the scope of this investigation. However, the validity of RCMAS data is called into question.

Description of the Sample

Total Sample.

The CABGS case sample was predominantly male (82%) and Caucasian (87%); the average age was 61.6 (SD = 9.9). Most of the cases (75%) were elective admissions--admitted directly from sources other than the emergency room (ER); 20% were emergency admissions and 5% were transfers from other facilities. The principal diagnosis--"the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care" (Patient Management Information Corporation, 1993), in the majority (70.3%) of the CABGS cases was coronary artery disease (ICD-9-CM 414.0) followed by acute myocardial infarction, initial episode (ICD-9-CM) 410, with fifth digit equal to 1) (7.5%). The principal procedure for the majority of cases (93.1%) was a bypass anastomosis for heart revascularizaiton (ICD-9-CM 3610-3619). The principal DRG recorded for the majority of CABGS cases was DRG 106 (52.1%), followed by DRG 107 (38.1%). The majority of cases

were discharged home (95.5%), however 3.3% died during the inpatient stay and 1.1% were transferred or discharged to other medical facilities. The average length of stay for all cases was 14.7 (SD = 13.3). Demographic and outcome CABGS case variables are described in Table 4-2 and Table 4-3.

The incidence of severity of illness variable documentation in the discharge abstract is described in Table 4-4. Severity of illness predictors with an incidence greater than or equal to 5% include: hypertension (51.8%); angina (42.7%); unstable angina (29.7); hypercholesterolemia (29.2%); emergency admission (20.1%); history of myocardial infarction (MI) (18%); female sex (18%); acute MI (17%); chronic obstructive pulmonary disease (COPD) (9.1%); congestive heart failure (CHF) (8.2%); and transfer admission (5.0%). No DOD CABGS case was documented to have cerebrovascular disease in the discharge abstract.

Description of the Sample By Site.

Site 12 had the greatest number of female cases (30%), while Site 8 had the least. Though the majority of CABGS cases were Caucasian, 45% of Site 5's cases were non-Caucasian. The average age of CABGS cases ranged from 59.4 at Site 12 to 63.9 at Site 11. Emergency admissions ranged from 0% at Site 2 to 34% at Sites 4 and 11; transfer rates ranged from 0% at Sites 10 and 11 to 16% at Site 1. Coronary artery disease comprised the majority the principal diagnoses at each site, ranging from 46% of the principal diagnoses documented for CABGS cases at Site 7 to 86% of principal diagnoses documented at Site 11. DRG 106 was principal DRG assigned each case at Sites 2, 4, 5, 6, 7, 10, 11 and 12, while the majority of cases at Sites 1, 3, 8 and 9 were assigned DRG 107.

Site 1 had the greatest percentage of deaths (9%); Site 7 and 8 had the lowest. Site 12 had the greatest number of transfers (4%). Site 5 had the greatest number of patients

whose length of stay equaled or exceeded 30 days. Length of stays at each site ranged from 10.5 days at Site 8 to 25.6 days at Site 5.

Rates ranges of severity of illness variables documented in the discharge abstract include ranged as follows: angina- 11% (Site 5) to 65% (Sites 2 and 8); unstable angina (Angina, unsta)--7% (Site 5) to 44% (Sites 1 and 2); atherosclerosis or aneurysm (Ath Aneur)--0% (Site 6) to 17% (Site 7); CHF--2% (Site 10) to 12% (Sites 1 and 11); COPD--2% (Site 9) to 17% (Site 11); diabetes mellitus (DM)--15% (Sites 10 and 12) to 38% (Site 2); hypercholesterolemia (hyperchol)--16% (Site 11) to 49% (Site 8); hypertension (HPTN)-- 35% (Site 2) to 63% (Site 5); MI, acute--7% (Site 5) to 29% (Site 9); MI, history--4% (Site 2) to 30% (Site 11); obesity 0% (Site 3) to 7% (Site 5); repeat/redo CABGS--0% (Site 2) to 22% (Site 5); aortic valve disease (Valve, Aortic)--0% (Sites 5 and 8) to 9% (Site 7); mitral valve disease (Valve, Mitral)--0% (Site 5) to 15% (Site 6); and concurrent open heart surgery (Concur OHS)--0% (Sites 2 and 5) to 13% Site 10.

Description of the sample by site is contained in Table 4-5 (demographics), 4-6 (outcomes) and 4-7 (severity of illness variables).

Table 4-2

Demographic Characteristics of the 1 January Through 30 June 1994 CABGS Cases: Administrative Data (N = 829)

Variable	n (%)
Sex	
Female	149 (18.0)
Male	680 (82.0)
Race	
Caucasian	721 (87.0)
Negroid	56 (6.8)
Mongoloid	10 (1.2)
West Hemisphere Indian	1 (0.1)
Other	39 (4.7)
Unknown	2 (0.2)
Source of Admission	
Direct From ER	167 (20.1)
Direct From Other Than ER	621 (74.9)
Non-DOD to DOD Transfer	3 (0.4)
DOD Transfer: Transfer from Army	31 (3.7)
DOD Transfer: Transfer from Navy	4 (0.5)
DOD Transfer: Transfer from Air Force	3 (0.4)
Principal Diagnosis	
Coronary Atherosclerosis (CAD)	583 (70.3)
Acute Myocardial Infarction: Initial Episode (AMI: Ini.)	62 (7.5)
Acute Myocardial Infarction: Subsequent Episode (AMI: Sub.)	12 (1.5)
Intermediate Coronary Syndrome (Int. Cor Syn.)	44 (5.3)
Chronic Ischemic Heart Disease (ChronIsch HD)	44 (5.3)
Aortic Valve Disorders (AoValve Dis.)	16 (1.9)
Mechanical Complications of CAB Graft (CABGS Comps)	13 (1.6)
Unspecified Angina (Angina)	6 (0.7)
Unspecified Cardiac Disease (Unspec. HD)	7 (0.8)
Miscellaneous Diagnoses With Frequencies ≤ 5	42 (5.1)
Principal Procedure	
3521-3525: Replacement of heart valve	20 (2.4)
3610-3619: Bypass anastomosis for revascularization	772 (93.1)
3721-3723: Cardiac Catheterization	26 (3.1)
Other Miscellaneous Procedures With Frequencies ≤ 2	11 (1.3)
DRG	
104: Cardiac Valve Procedure With Cardiac Catheterization	9 (1.1)
105: Cardiac Valve Procedure Without Cardiac Catheterization	31 (3.7)
106: Coronary Bypass With Cardiac Catheterization	432 (52.1)
107: Coronary Bypass Without Cardiac Catheterization	316 (38.1)
108: Other Cardiothoracic Procedures	19 (2.3)
483: Tracheostomy Except for Mouth, Larynx or Pharynx Disorder	14 (1.7)
Other Miscellaneous DRGs With Frequencies ≤ 3	8 (1.0)

Table 4-2 -continued

	M (SD)
Age (years)	61.6 (9.9)

Table 4-3

1 January through 30 June 1994 DOD CABGS Outcomes: Administrative Data (N = 829)

Outcome	n %
Disposition	
Discharged Home/Returned to Duty	792 (95.5)
Left Against Medical Advice	1 (0.1)
Transfer to Army MTF / Navy MTF / ?	4 (0.5)
Discharge to Other Federal Facility	1 (0.1)
Discharge to Convalescent/Skilled Nursing/Psychiatric Facility	4 (0.5)
Died During Inpatient Stay	27 (3.3)
Process/Outcome	**M (SD)**
Length of Stay	14.7 (13.3)

Table 4-4

Frequency of Severity of Illness Variables For 1 January through 30 June 1994 DOD CABGS Cases: Administrative Data (N = 829)

Variable	n (%)
Admission, Emergency	167 (20.1)
Admission, Transfer	41 (5.0)
Angina	354 (42.7)
Angina, Unstable	246 (29.7)
Atherosclerosis or Aneurysm	92 (11.1)
Cardiomegaly	4 (0.5)
Cerebrovascular Disease	0 (0.0)
Coagulapathy	3 (0.4)
Congestive Heart Failure	68 (8.2)
COPD	75 (9.1)
Chronic Liver Failure	5 (0.6)
Chronic Renal Failure	9 (1.1)
Diabetes Mellitus	190 (22.9)
Hypercholesterolemia	242 (29.2)
Hypertension	429 (51.8)
Myocardial Infarction, Acute	141 (17.0)
Myocardial Infarction, History of	149 (18.0)
Obesity	19 (2.3)
Redo CABGS	37 (4.5)
Sex, Female	149 (18.0)
Valve Disease, Aortic	38 (4.6)
Valve Disease, Mitral	35 (4.2)
Ventricular Aneurysm	3 (0.4)
Procedures	
Valve Replacement, Concurrent	40 (4.8)
Ventricular Aneurysm Repair	2 (0.2)
Concurrent Heart Operation	52 (6.3)
Race	
Caucasian	721 (87.0)
Negroid	56 (6.8)
Mongoloid	10 (1.2)
West Hemisphere Indian	1 (0.1)
Other	39 (4.7)
Unknown	2 (0.2)
	M (SD)
Age (years)	61.6 (9.9)

Table 4-5

Demographic Characteristics of the 1 January Through 30 June 1994 CABGS Cases By Site: Administrative Data (N = 829)

Variable	Site 1 n % N=69	Site 2 n % N=48	Site 3 n % N=64	Site 4 n % N=82	Site 5 n % N=27	Site 6 n % N=34	Site 7 n % N=103	Site 8 n % N=78	Site 9 n % N=84	Site 10 n % N=48	Site 11 n % N=139	Site 12 n % N=53
Sex												
Female	18 (26)	13 (27)	9 (14)	12 (15)	6 (22)	4 (12)	14 (14)	8 (10)	19 (23)	5 (10)	25 (18)	16 (30)
Male	51 (74)	35 (73)	55 (86)	70 (85)	21 (78)	30 (88)	89 (86)	78 (90)	65 (77)	43 (90)	114(82)	37 (70)
Race												
Caucasian	63 (91)	44 (92)	57 (89)	75 (92)	15 (56)	29 (85)	85 (83)	66 (85)	73 (87)	46 (96)	122(88)	46 (87)
Negroid	6 (9)	3 (6)	6 (9)	4 (5)	1 (4)	4 (12)	14 (14)	6 (8)	4 (5)	-	4 (3)	4 (8)
Mongoloid	-	-	-	1 (1)	8 (30)	-	-	-	1 (1)	-	-	-
WestHemIndin	-	-	-	-	-	-	-	-	1 (1)	-	-	-
Other	-	1 (2)	-	2 (2)	3 (11)	1 (3)	4 (4)	5 (6)	5 (6)	2 (4)	13 (9)	-
Unknown	-	-	1 (2)	-	-		-	1 (1)	-	-	-	3 (6)
Admit Source												
Direct: ER	12 (17)	10 (21)	-	28 (34)	11 (41)	9 (26)	13 (13)	5 (6)	17 (20)	5 (10)	47 (34)	10 (19)
Direct: Not ER	46 (67)	35 (73)	61 (95)	53 (65)	12 (44)	24 (74)	79 (77)	72 (92)	66 (79)	43 (90)	92 (66)	37 (70)
Transfers	11 (16)	3 (6)	3 (5)	1 (1)	4 (15)	-	11 (11)	1 (1)	1 (1)	-	-	6 (11)

Table 4-5--continued

Principal Dx												
CAD	51 (74)	37 (77)	58 (91)	60 (73)	19 (70)	21 (62)	47 (46)	46 (59)	55 (65)	38 (79)	119 (86)	32 (60)
AMI: Initial	6 (9)	4 (8)	1 (2)	9 (11)	2 (7)	4 (12)	4 (4)	4 (5)	16 (19)	4 (8)	7 (5)	6 (11)
AMI: Sub.	-	1 (2)	-	-	-	1 (3)	2 (2)	1 (1)	-	-	3 (2)	5 (9)
Int Cor. Syn.	8 (12)	1 (2)	3 (5)	-	-	2 (6)	19 (18)	4 (5)	1 (1)	1 (2)	3 (2)	2 (4)
Chronilsch HD	-	-	-	1 (2)	4 (15)	-	19 (18)	16 (21)	4 (5)	-	-	2 (4)
AoValve Dis	2 (3)	-	-	4 (5)	-	-	3 (3)	-	3 (4)	2 (4)	-	-
CABGS Comp	1 (1)	2 (4)	-	-	-	1 (3)	-	3 (4)	4 (5)	1 (2)	-	1 (2)
Unspec. HD	-	-	-	4 (5)	1 (4)	-	1 (1)	1 (1)	-	-	-	-
Misc. Dx.	1 (1)	3 (6)	2 (3)	4 (5)	1 (4)	5 (15)	8 (8)	3 (4)	1 (1)	2 (4)	7 (5)	5 (9)
Principal Pro												
3521-3525	1 (2)	-	-	6 (7)	-	-	1 (1)	-	4 (5)	3 (6)	1 (1)	4 (8)
3610-3619	61 (88)	46 (96)	63 (98)	69 (84)	25 (93)	28 (82)	98 (95)	77 (99)	78 (93)	44 (92)	134 (96)	49 (92)
3721-3723	4 (6)	-	1 (2)	6 (7)	2 (7)	4 (12)	2 (2)	1 (1)	2 (2)	1 (2)	3 (2)	-
Othr Misc Pro	3 (4)	2 (4)	-	1 (1)	-	2 (6)	2 (2)	-			1 (1)	-
DRG												
104	1 (2)	-	-	1 (1)	-	-	3 (3)	1 (1)	-	1 (2)	1 (1)	1 (2)
105	1 (2)	-	1 (2)	6 (7)	-	-	4 (4)	1 (1)	5 (6)	4 (8)	6 (4)	3 (6)
106	28 (41)	28 (58)	32 (48)	45 (55)	18 (67)	23 (68)	51 (50)	24 (31)	37 (44)	27 (56)	95 (68)	25 (47)
107	32 (46)	15 (31)	64 (50)	26 (32)	5 (19)	9 (26)	36 (35)	51 (65)	42 (50)	15 (31)	30 (22)	23 (43)
108	5 (7)	3 (6)	-	2 (2)	-	1 (3)	3 (3)	1 (1)	-	1 (2)	3 (2)	-
483	1 (2)	1 (2)	-	2 (2)	3 (11)	-	4 (4)	-	-	-	2 (1)	1 (2)
Other DRGs	1 (2)	1 (2)	-	-	1 (4)	1 (3)	2 (2)	-	-	-	2 (1)	-
	M(SD)	M (SD)	M (SD)	M (SD)	M (SD)	M(SD)	M (SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Age	62.8 (8.6)	61.1 (8.1)	59.5 (10.5)	62.5 (9.9)	60.8 (10.1)	56.7 (8.1)	63.2 (11.1)	60.5 (11.8)	61.9 (9.2)	59.8 (9.2)	63.9 (9.1)	59.4 (9.6)

Table 4-6

Outcomes of the 1 January Through 30 June 1994 CABGS Cases By Site: Administrative Data (N = 829)

Variable	Site 1 n % N=69	Site 2 n % N=48	Site 3 n % N=64	Site 4 n % N=82	Site 5 n % N=27	Site 6 n % N=34	Site 7 n % N=103	Site 8 n % N=78	Site 9 n % N=84	Site 10 n % N=48	Site 11 n % N=139	Site 12 n % N=53
Disposition												
Home/RTD	62 (90)	46 (96)	61 (95)	77 (94)	26 (96)	32 (94)	100(97)	76 (97)	81 (96)	47 (98)	136(98)	48 (91)
Left AMA	-	-	-	-	-	-	-	1 (1)	-	-	-	
Trans DOD/?	-	-	-	1 (1)	-	-	1 (1)	-	-	-	-	2 (4)
D/C OthFed	-	1 (2)	-	-	-	-	-	-	-	-	-	-
D/C LongTerm	1 (1)	-	-	2 (2)	-	-	1 (1)	-	-	-	-	-
Died	6 (9)	1 (2)	3 (5)	2 (2)	1 (4)	2 (6)	1 (1)	1 (1)	3 (4)	1 (2)	3 (2)	3 (6)
Length of Stay > 30 Days	6 (9)	3 (6)	3 (5)	3 (4)	6 (22)	2 (6)	17 (17)	1 (1)	2 (2)	3 (8)	5 (4)	6 (11)
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Length of Stay	16.8 (15.3)	15.0 (11.7)	13.3 (7.3)	12.9 (9.3)	25.6 (20.6)	13.6 (10.5)	20.4 (19.1)	10.5 (5.4)	11.6 (8.4)	15.5 (18.0)	13.4 (12.7)	15.4 (12.1)

Table 4-7

Frequency of Severity of Illness Variables 1 January Through 30 June 1994 CABGS Cases By Site: Administrative Data (N = 829)

Variable	Site 1 n % N=69	Site 2 n % N=48	Site 3 n % N=64	Site 4 n % N=82	Site 5 n % N=27	Site 6 n % N=34	Site 7 n % N=103	Site 8 n % N=78	Site 9 n % N=84	Site 10 n % N=48	Site 11 n % N=139	Site 12 n % N=53
Admit: ER	12 (17)	10 (21)	-	28 (34)	11 (41)	9 (27)	13 (13)	5 (6)	17 (20)	5 (10)	47 (34)	10 (19)
Admit: Trans	11 (16)	3 (6)	3 (5)	1 (1)	4 (15)	-	11 (11)	1 (1)	1 (1)	-	-	6 (11)
Angina	36 (52)	31 (65)	8 (13)	26 (32)	3 (11)	15 (44)	51 (50)	51 (65)	38 (45)	19 (40)	62 (45)	14 (26)
Angina: Unsta	30 (44)	21 (44)	5 (8)	20 (24)	2 (7)	12 (35)	35 (34)	26 (33)	18 (21)	14 (29)	56 (40)	7 (13)
Ath or Aneur	7 (10)	7 (15)	9 (14)	14 (17)	1 (4)	-	17 (17)	7 (9)	8 (10)	4 (8)	15 (11)	3 (6)
Cardiomegaly	-	-	-	1 (1)	-	-	1 (1)	1 (1)	-	-	1 (1)	-
CerebvascDis	-	-	-	-	-	-	-	-	-	-	-	-
Coagulapathy	1 (2)	-	-	-	-	-	-	1 (1)	-	-	-	1 (2)
CHF	8 (12)	3 (6)	3 (5)	8 (10)	3 (11)	3 (9)	8 (8)	4 (5)	9 (11)	1 (2)	16 (12)	2 (4)
COPD	3 (4)	4 (8)	9 (14)	13 (16)	1 (4)	1 (3)	11 (11)	7 (9)	2 (2)	8 (17)	11 (8)	5 (9)
CLF	-	-	1 (2)	-	-	-	3 (3)	-	-	-	1 (1)	-
CRF	2 (3)	1 (2)	-	-	1 (4)	-	2 (2)	-	-	-	3 (2)	-
DM	21 (30)	18 (38)	16 (25)	13 (16)	5 (19)	9 (27)	19 (19)	18 (23)	19 (23)	7 (15)	37 (27)	8 (15)
Hyperchol	17 (25)	15 (31)	15 (23)	29 (35)	9 (33)	6 (18)	40 (39)	38 (49)	23 (27)	16 (33)	22 (16)	12 (23)
HPTN	39 (57)	17 (35)	26 (41)	43 (52)	17 (63)	15 (44)	59 (57)	44 (56)	48 (57)	25 (52)	74 (53)	22 (42)
MI, Acute	14 (20)	10 (21)	5 (8)	10 (12)	2 (7)	11 (32)	11 (11)	12 (15)	24 (29)	10 (21)	17 (12)	15 (28)
MI, History	14 (20)	2 (4)	8 (13)	15 (18)	5 (19)	7 (21)	19 (19)	14 (18)	8 (10)	8 (17)	41 (30)	8 (15)

Table 4-7--continued

Obesity	1 (2)	2 (4)	-	5 (6)	2 (7)	1 (3)	1 (1)	1 (1)	2 (2)	1 (2)	2 (1)	1 (2)
Redo CABGS	4 (6)	-	6 (9)	2 (2)	6 (22)	3 (9)	2 (2)	2 (3)	2 (2)	-	14 (10)	2 (4)
Sex, Female	18 (26)	13 (27)	9 (14)	12 (15)	-	4 (12)	14 (14)	8 (10)	19 (23)	5 (10)	25 (18)	16 (30)
Valve, Aortic	2 (3)	1 (2)	2 (3)	7 (9)	-	1 (3)	9 (9)	-	5 (6)	4 (8)	4 (3)	3 (6)
Valve, Mitral	2 (3)	1 (2)	2 (3)	5 (6)	-	5 (15)	3 (3)	7 (9)	1 (1)	2 (4)	6 (4)	1 (2)
VentAneurysm	-	-	-	-	-	1 (3)	1 (1)	-	-	-	-	-
Procedures												
Valve Replace	2 (3)	-	1 (2)	6 (7)	-	-	8 (8)	2 (3)	5 (6)	5 (10)	7 (5)	4 (8)
VentAneurysm	-	-	-	-	-	1 (3)	-	-	-	-	1 (1)	-
Concur OHS	4 (6)	-	1 (2)	9 (11)	-	1 (3)	9 (9)	3 (4)	5 (6)	6 (13)	10 (7)	4 (8)
Race												
Caucasian	63 (91)	44 (92)	57 (89)	75 (92)	15 (56)	29 (85)	85 (83)	66 (85)	73 (87)	46 (96)	122(88)	46 (87)
Negroid	6 (9)	3 (6)	6 (9)	4 (5)	1 (4)	4 (12)	14 (14)	6 (8)	4 (5)	-	4 (3)	4 (8)
Mongoloid	-	-	-	1 (1)	8 (30)	-	-	-	1 (1)	-	-	-
WesHemInd	-	-	-	-	-	-	-	-	1 (1)	-	-	-
Other	-	1 (2)	-	2 (2)	3 (11)	1 (3)	4 (4)	5 (6)	5 (6)	2 (4)	13 (9)	3 (6)
Unknown	-	-	1 (2)	-	-	-	-	1 (1)	-	-	-	-
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Age	62.8 (8.6)	61.1 (8.1)	59.5 (10.5)	62.5 (9.9)	60.8 (10.1)	56.7 (8.1)	63.2 (11.1)	60.5 (11.8)	61.9 (9.2)	59.8 (9.2)	63.9 (9.1)	59.4 (9.6)

Analysis of Inputs and Outcomes:

Logistic Regression Using Administrative Severity of Illness Variables

Bivariate logistic regression analyses of all potential severity of illness variables revealed that eight variables had p values less than the .25 criteria for inclusion in multivariate model-building (Hosmer & Lemeshow, 1989). The eight variables found to be significant were acute myocardial infarction ($p = 0.000$); diabetes mellitus ($p = 0.004$); hypertension ($p = 0.018$); concurrent heart operation ($p = 0.027$); hypercholesterolemia ($p = 0.075$); age ($p = 0.018$); female sex ($p = 0.133$); and repeat CABGS ($p = 0.147$). Results of the bivariate analyses are depicted in Table 4-8.

Multi-variate model building was performed using the CRUNCH4 (1991) logistic regression program using the variables found significant in the bivariate logistic regression analyses. The final model contains four statistically significant ($p < .05$) variables--age, female sex, acute myocardial infarction, and repeat CABGS, and two not statistically significant variables--hypertension and diabetes mellitus. Removal of the two non-statistically significant variables from the model results in marked model performance degradation as judged by assessment of model calibration and discrimination. The final model demonstrated significant calibration as evidenced by a high p value for the Hosmer-Lemeshow goodness-of-fit statistic ($p = .730$).

Calibration involves the examination of how much the predicted outcome rates differ from the observed outcome rates across groups of patients stratified by a given characteristic. The Hosmer-Lemeshow goodness-of-fit test stratifies patients/cases into 10 groups on the basis of their potential risk of the outcome and then compares the actual group outcomes to the group outcomes predicted by the model (Hosmer & Lemeshow, 1989; Romano, 1993).

Goodness of fit is then assessed with the *c* statistic, which under the assumption that the fitted is the correct model, will demonstrate model fit at p values greater than the selected level of significance (Hosmer & Lemeshow, 1989; Hosmer, Taber, & Lemeshow, 1991). The higher the p value the better the fit of the model.

Model discrimination is assessed via receiver operating characteristic (ROC) curve, Somer's D_{yx} and Cohen's κ. The ROC is advocated as the most useful statistic with which to assess prognostic model discrimination, and is felt to be equal in importance in the assessment of prognostic system adequacy to model calibration assessment (Lemeshow, Teres, Klar, Avrunin, Gehlbach, & Rappoport, 1993). The area under the ROC, is a number summarizing model discriminative ability. "It represents the proportion of all randomly selected of observations with different outcomes (e.g. one death and one survivor) in which the patient who died had a higher expected probability of death than the survivor" (Romano, 1993, p. 455). Values range from .5, where the model's ability to predict outcome is no greater than chance, to 1 where the predictive ability of the model is perfect. The ROC is a measure of model discrimination which is independent of the rate of the outcome that is being predicted, independent of the thresholds used to define the outcome and provides a common scale for the comparison of different prognostic and diagnostic systems (Ash & Shwartz, 1994; O'Connor, Plume, Olmstead, Coffin, Morton, & Maloney, 1992; Ruttiman, 1989; Swets, 1989; Hanley & McNeil, 1982). Somer's D_{yx}, a measure of the rank correlation between a model's observed and predicted outcomes and Cohen's κ are alternate measures of model discrimination.

The final model was statistically significant (Log Likelihood = -99.770, p = 0.000) and had good discrimination and calibration as judged by the Hosmer-Lemeshow goodness of fit (p = .73), area under the ROC (0.81), and Somer's D_{yx} (0.63). The value for Cohen's κ was low (0.09). The model misclassified 5 cases who died as living and 250 cases who lived as deaths.

The final model is presented in Table 4-9. Variables in the model which increase the risk of a CABGS patient's death included older age (Odds Ratio = 1.04), presence of acute myocardial infarction (Odds Ratio = 5.88), and repeat CABGS (Odds Ratio = 3.90). Three variables in the model lowered the risk of death; female sex (Odds Ratio = 0.40), hypertension (Odds Ratio = 0.42) and diabetes (Odds Ratio = 0.15)--though hypertension and diabetes were not statistically significant. The protective nature of serious co-morbid conditions has been noted in previous analyses of outcomes using administrative discharge abstract data (Iezzoni, 1994; Iezzoni, Foley, Daley, Hughes, Fisher, & Heeren, 1992; Jencks, Williams & Kay, 1988). One hypothesis for the benefit of having a co-morbid condition relates to the limitation on the number of fields for coding diagnoses in the discharge abstract, and that if a co-morbidity is listed, there were no other more severe co-morbidities or complications that required coding.

A multivariate logistic regression model was also built using the variables from the Luft and Romano (1993) administrative CABGS model. Regardless of their significance, all variables from that model were initially entered into the model; variables were then removed in a process of backward selection based on theoretical and sample considerations. The model that resulted is presented in Table 4-10.

The final model based on the Luft and Romano (1993) variables was also statistically significant (Log Likelihood = -105.398, $p = 0.0001$) and had good discrimination and calibration as judged by the Hosmer-Lemeshow goodness of fit ($p = .665$), area under the ROC (0.78), and Somer's D_{yx} (0.55). The value for Cohen's κ was low (0.07). The model did a better job of classification for cases that died than the previously presented model, misclassifying only 2 cases who died as living. However, it misclassified more cases who lived as deaths (342).

There were 5 variables in the final Luft-based model; two of these factors predicted an increased risk of death for the patient, while 3 of the variables were protective. One of the variables in the model was not statistically significant; removal of that variable severely diminished model calibration and discrimination. The variables which predicted an increased risk of a CABGS patient's death included older age (Odds Ratio = 1.04) and transfer admission (Odds Ratio = 5.67). The three remaining variables in the model which predicted a lower risk of death were the same as for the previous model and had similar odds ratios; female sex (Odds Ratio = 0.41), hypertension (Odds Ratio = 0.36) and diabetes (Odds Ratio = 0.12)--all were statistically significant.

Differences Between Actual and Actual Versus Predicted Mortality

The actual and actual versus predicted death rates for each of the twelve Department of Defense Medical Centers based on ICD-9-CM data are described in Table 4-11. The actual versus predicted death rates depicted were calculated based on the logistic regression model built using variables found significant on bivariate analyses. Rank correlation between medical center actual and actual versus predicted death rates computed using Spearman's *rho* was 0.923 ($p = .0000$).

Table 4-8

Severity of Illness Factors Considered and Bivariate Analysis Results (N = 829)

Variable	Occurrence %	p	Odds Ratio
Admission, Emergency	20.1	0.828	0.90
Admission, Transfer	5.0	1.000	1.00
Angina	42.7	0.543	0.78
Angina, Unstable	29.7	0.404	1.41
Atherosclerosis or Aneurysm	11.1	0.513	0.63
Cardiomegaly	0.5	0.606	0.00
Cerebrovascular Disease	0.0	------	---
Coagulapathy	0.4	0.655	0.00
Congestive Heart Failure	8.2	1.000	1.00
COPD	9.1	0.712	1.27
Chronic Liver Failure	0.6	0.564	0.00
Chronic Renal Failure	1.1	1.000	1.00
Diabetes Mellitus	22.9	0.004	0.12
Hypercholesterolemia	29.2	0.075	0.41
Hypertension	51.8	0.018	0.38
Myocardial Infarction, Acute	17.0	0.000	5.72
Myocardial Infarction, History of	18.0	0.940	1.04
Obesity	2.3	0.646	1.68
Redo CABGS	4.5	0.147	2.82
Sex, Female	18.0	0.133	0.51
Valve Disease, Aortic	4.6	0.510	1.70
Valve Disease, Mitral	4.2	0.446	1.86
Ventricular Aneurysm	0.4	1.000	1.00
Procedures			
Valve Replacement, Concurrent	4.8	0.179	2.58
Ventricular Aneurysm Repair	0.2	1.000	1.00
Concurrent Heart Operation	6.3	0.027	3.65
Race			
Non-Caucasian	13.0	0.343	0.53
Age		0.105	1.03

Table 4-9

CABGS Administrative Risk-Adjusted Model of Mortality Built With Variables From Bivariate Analyses With $p < .25$: Best Model Based on Assessment of Model Calibration and Discrimination

Variable	β	SEβ	p	Odds Ratio	95% Confidence Interval
Age	0.043	0.022	0.050	1.04	1.00 to 1.09
Acute myocardial infraction	1.771	0.417	0.000	5.88	2.60 to 13.31
Diabetes Mellitus	-1.900	1.035	0.066	0.15	0.02 to 1.14
Hypertension	-0.858	0.442	0.522	0.42	0.18 to 1.01
Repeat CABGS	1.361	0.673	0.043	3.90	1.04 to 14.58
Sex--Female	-0.921	0.457	0.044	0.40	0.16 to 0.98
Intercept	-4.598	1.628	0.005		

Log-Likelihood = -99.770, p = 0.000
Hosmer-Lemeshow Goodness-of-Fit Chi-Square = 5.251, p = 0.730
Area under the Receiver Operating Characteristic = .813
Somer's D_{yx} = .626
κ = 0.093, p = 0.000

Table 4-10

CABGS Administrative Risk-Adjusted Model of Mortality Built With Variables From the Luft and Romano (1993) Model: Best Model Based on Assessment of Model Calibration and Discrimination

Variable	β	SEβ	p	Odds Ratio	95% Confidence Intervals
Admission, Transfer	1.735	0.552	0.017	5.67	1.92 to 16.73
Age	0.042	0.217	0.053	1.04	1.00 to 1.09
Diabetes Mellitus	-2.102	1.032	0.042	0.12	0.02 to 0.92
Hypertension	-1.029	0.446	0.021	0.36	0.15 to 0.86
Sex--Female	-0.900	0.446	0.046	0.41	0.17 to 0.98
Intercept	-3.971	1.635	0.015		

Log-Likelihood = -105.398, p = 0.0001
Hosmer-Lemeshow Goodness-of-Fit Chi-Square = 5.842, p = 0.665
Area under the Receiver Operating Characteristic = .776
Somer's D_{yx} = .552
κ = .071, p = 0.000

Table 4-11

Comparison of Actual and Actual Versus Predicted Death Rates of DOD Medical Centers

Site	Number of Patients Who Died (Mortality Rate)	Ranking of Sites By Mortality Rate (Lowest Mortality (1) to Highest Mortality (12))	Number of Patients Predicted to Die By Logistic Equation[a]	Actual Versus Predicted Death Rate[b]	Ranking of Sites By Actual Versus Predicted Death Rate (Lowest Mortality (1) to Highest Mortality (12))
Site #1[c] n = 69	6 (8.7%)	12	32	0.188	12
Site #2 n = 48	1 (2.1%)	3.5	14	0.071	4
Site #3 n = 64	3 (4.7%)	9	18	0.167	9
Site #4 n = 82	2 (2.4%)	6	28	0.071	4
Site #5[d] n = 27	1 (3.7%)	8	6	0.167	9
Site #6 n = 34	2 (5.9%)	11	12	0.167	9
Site #7 n = 103	1 (1.0%)	1	27	0.037	1
Site #8[d] n = 78	1 (1.3%)	2	19	0.053	2
Site #9[d] n = 84	3 (3.6%)	7	35	0.086	6
Site #10 n = 48	1 (2.1%)	3.5	13	0.077	5
Site #11[d] n = 139	3 (2.2%)	5	42	0.071	4
Site #12[c] n = 53	3 (5.7%)	10	26	0.115	7

a = Logistic model used was that built with variables found significant on bivariate analyses
b = Actual versus predicted computed by formula (actual death rate / predicted death rate)
c = Site selected as case (highest mortality) site by Phase II criteria
d = Site selected as control (lowest and moderate mortality by Phase II criteria)

Phase II: Description of DOD CABGS Unit

Using Clinical Inputs, Process and Outcome Data

Description of Phase II study analyses of CABGS unit inputs, processes and outcomes will be by method used to obtain the data questionnaire, observation and chart audit.

Phase II Description of Input:

Assessment of Provider Hemodynamic Knowledge Via Questionnaire

Description of provider hemodynamic knowledge was via questionnaire. Provider knowledge assessment instruments included the BPDQ (Sollek, 1988) and the PACKAT (Dolter, 1987) for the assessment of the hemodynamic knowledge of CABGS nurse and CABGS assist personnel and the PACSG (Iberti, et al., 1990) for assessment of the hemodynamic knowledge of CABGS physician personnel. The BPDQ assessed knowledge of manual cuff measurement of blood pressure while the PACKAT assessed knowledge of pulmonary artery catheter measurement of pulmonary artery (PA) pressures. The PACKAT is a domain-referenced test, with different domains related to the different steps necessary for reliable and valid PA pressure measurement. The PACSG assesses knowledge of PA catheter measurement of PA pressures relevant to physician practice. All are multiple-choice questionnaires, with answers scored as correct or incorrect; missing items were scored as incorrect.

Type I Error: Provider Hemodynamic Knowledge.

Only two analyses relating to knowledge were to be performed: analysis of the CABGS nurse provider BPDQ and the PACKAT score differences between CABGS nurses

working in hospitals with the high crude and actual versus expected mortality and those working in hospitals with low crude and actual versus expected mortality. The α criterion was set at .025 (.05/2) to evaluate the significance of these differences, bringing the family-wise error rate to .05.

Confidence and Power: Provider Hemodynamic Knowledge

Fifty two nurse, three CABGS assist personnel and twelve physician CABGS care providers participated in the provider knowledge aspect of the study. Based on these actual sample sizes and the score standard deviations obtained for each instrument a 95% confidence level can be placed in the descriptions of hemodynamic knowledge mean score on the PACKAT and BPDQ for the combined CABGS nurse and CABGS assist sample and the CABGS nurse sample and the PACSG for the CABGS physician sample. A less than 90% confidence level can be placed in the description of CABGS assist provider BPDQ and PACKAT mean scores.

CABGS nurses were divided into high and low mortality groups based on 1) whether they were providing care in DOD CABG units with high or low crude mortality for CABGS identified by ICD-9-CM procedure codes 3610 through 3619 for the 1 January through 30 June 1994 timeframe (RCMAS-OSE, June 1995); or 2) whether they were providing care in DOD CABGS units with higher or lower actual versus expected (risk-adjusted) mortality for CABGS identified by ICD-9-CM procedure codes 3610 through 3619 for that same timeframe. Description of hemodynamic knowledge in these two CABGS nurse provider groups was preliminary to performance of t-tests to determine differences in hemodynamic knowledge test scores between these two groups. Based on knowledge test sample standard deviations and the sample size of each group (crude--high mortality = 18, low mortality = 22; actual versus expected--high mortality = 18, low mortality = 22), less than a 90% confidence level can be

placed in the PACKAT and the BPDQ mean scores in the high and low mortality groups of CABGS nurse providers. Table 4-12 describes the sample sizes required for a 95% confidence level based on the standard deviations for each instrument described in this study.

The sample size required for use of the correlation coefficient in studying the association between CABGS nurse provider hemodynamic knowledge and hemodynamic practice in the total nurse provider sample, conservatively estimating a minimal correlation of .4, a two-tailed α=.05 and β=.20, was 47. The actual sample size of 52 CABGS nurses providers would have been adequate if the nurses observed had been the nurses who completed the questionnaire surveys. However only 17 of the nurses observed performing pulmonary artery pressure assessments actually completed the Pulmonary Artery Catheter Knowledge Assessment Test (PACKAT); 10 of whom performed PAWP assessments and 7 of whom performed PAD assessments. Only 2 of the nurses observed performing cuff pressures completed the Blood Pressure Determination Questionnaire (BPDQ)-- this was related to lack of manual cuff performance at most sites. The sample was therefore inadequate to answer this question.

A sample of size of 30 per group would have been adequate (α = .025 one-tailed, β = .20) to detect hemodynamic knowledge differences between the nurse providers in DOD medical centers with higher crude CABGS mortality and nurses in DOD medical centers with lower crude CABGS mortality only if the effect size were .7 or better for each instrument. However, there were only 18 and 19 completed questionnaires (PACKAT and BPDQ) from the high crude and actual versus expected mortality DOD medical centers, respectively; there were 22 and 34 competed questionnaires from the low crude and actual versus expected mortality DOD medical centers, respectively. Based on the actual group sample sizes, the differences between the two groups' BPDQ scores (crude--.641; actual versus expected--.396)

and the standard deviation of the BPDQ score (3.9), the actual effect size was .16 for the crude mortality analysis and .10 for the actual versus expected analysis, resulting in a power of < .10 (α = .025 one-tailed) (Lipsey, 1990). Based on the actual group sample sizes, the difference between the two groups' PACKAT score means (crude--5.732; actual versus expected--5.947) and the standard deviation of the PACKAT score (8.1), the actual effect size for the crude mortality analysis was .64 and for the actual versus expected mortality analysis it was .66 standard deviation units for the PACKAT, resulting in a power of approximately .55 (α = .025 one-tailed) (Lipsey, 1990).

Table 4-12.

Confidence Levels for the Description of Hemodynamic Knowledge

Instrument	Desired Total Width of the Confidence Interval	Study Standard Deviation for that Instrument/Sample	Successive Standardized Widths of Confidence Interval (Desired Total Width/ Standard Deviation)	Sample Size Required for 95% Confidence Levels
PACKAT				
RN + ASSIST	6	8.1	.74	≈ 29
RN ONLY		8.1	.74	≈ 29
ASSIST ONLY		9.3	.54	≈ 53
PACSG	3	2.8	1.07	< 16
BPDQ				
RN + ASSIST	3	4.0	.75	≈ 29
RN ONLY		3.9	.77	≈ 29
ASSIST ONLY		3.1	.96	≈ 17

PACKAT = Pulmonary Artery Catheter Knowledge Assessment Test
PACSG = Pulmonary Artery Catheter Study Group Test
BPDQ = Blood Pressure Determination Questionnaire

Reliability of the Instruments Used to Assess CABGS Provider Hemodynamic Knowledge

Before test scores can be adequately evaluated, the reliability of the test itself must be assessed. Reliability analyses of the instruments used to assess provider knowledge were accomplished using ITEMRS, an item analysis program (Slaughter, 1987). Kuder-Richardson 20 is used for description of internal consistency when items of a questionnaire are dichotomously scored. Standards for the adequacy of the reliability of a test are dependent on how the measure is being used, with .70 considered adequate for basic research and .80 not adequate for applied research if the measure is being used for critical decisions, i. e., whether or not an individual will be admitted to college (Nunnally, 1978).

When tests are designed to measure more than one attribute reliability estimates should be determined for the sub-scales or sub-domains (Waltz, Strickland, & Lenz, 1991). The PACKAT is a domain-referenced test, with items clustered into sub-domains which address a certain aspect of pulmonary artery (PA) catheters; most address knowledge necessary to obtain reliable and valid PA measurements.

The internal consistency reliability estimates for the CABGS provider instruments for this sample and for their development samples are described in Table 4-13.

The internal consistency estimates for the full BPDQ (.589) and the PACSG (.57) in this sample are quite low, but are moderate for the full PACKAT. The internal consistency estimate for the all instruments are adequate since results are to be used only for purposes of description, with no decisions being made based on these scores. The low internal consistency reliability estimates noted for the PACKAT sub-domains may be a function of the low number of items within the sub-domains (Nunnally, 1978). Internal consistency was measured for the BPDQ since, even though its developer describes it as a criterion-referenced measure, it was used as a norm-reference measure in this study.

Table 4-13

Reliability Estimates For Instruments Used to Assess CABGS Provider Hemodynamic Knowledge

Instrument and Instrument Sub-Domains		Number of Items	Kuder-Richardson 20: This Sample	Kuder-Richardson 20: Development Sample
BPDQ	(N = 55)	34	.589	Not calculated[b]
PACKAT	(N = 55)	61	.838	.773[b]
Technical Aspects		23	.686	Not calculated[b].
Leveling			*	.181[b]
Square wave		3	.460	.498[b]
Waveform analysis		15	.602	Not calculated[b]
Balloon inflation		2	*	.00[b]
Physiology/Pathophysiology		17	.657	Not calculated[b]
Artifact		14	.659	.153[b]
Respiratory variation		5	.683	.218[b]
Lung zone		5	.532	.108[b]
Complications		2	.498	.00[b]
Cardiac output		12	.518	.586[b]
PACSG	(N = 12)	31	.57	.71[c]

* = Negative Kuder-Richardson 20 statistic obtained
a = Sollek (1988) development sample
b = Dolter (1987) development sample
c = Iberti, et al, (1990) development sample

Description of the Sample: Provider Knowledge.

The actual sample for the questionnaire survey was that portion of Phase II-A and II-B CABGS providers who returned completed questionnaires by 10 July 1995, one month after the last site's questionnaires had been distributed. A total of 52 nurse providers (28.4%), 12 physician providers (25%) and 3 CABGS assist personnel (8.8%) returned completed knowledge questionnaires within that time frame. Four nurse provider and 2 physician

provider completed knowledge questionnaires were returned after the 10 July deadline; these questionnaires were not included in this analysis.

CABGS nurse providers. The CABGS nurse provider sample (n = 52) was primarily female (70.6%) with an average age of 35.4. The nurse providers had on average 11.4 years of nursing experience, 7.9 years of critical care experience and 4.8 years of open heart surgery experience, with an average of 3 years of thoracic surgery experience on their current unit. Most of the nurses were baccalaureate (73%) or master's prepared (15.4%): 65% were critical care registered nurse certified (CCRN). The average number of weeks of intensive care nursing course attended was 7.3 weeks; the average hours of hemodynamic education attended was 35.4. Approximately 7 hours were devoted to hemodynamics during their orientation to their current unit.

The majority of nurse providers were military (59.6%), while 25% were civilian government service and 15% civilian agency. Of the military provider participants 51% were O-1 and O-2 (the youngest nurse corps officers--in terms of rank, generally having less nursing experience): 46% were 0-3 (more experienced nurse corps officers) with only 2% being of 0-4 or above (officers generally expected to have the most nursing experience). Ninety per cent of the military participants had their service's critical care skill identifier.

Demographic differences between CABGS nurses providing care at different sites were noted. Site 11 is the only site with more male respondents than female respondents. Site 10 and 11 respondents were all military nurses. Site 4 and Site 11 respondents ' highest nursing degree held was BSN or higher. Sites 1 and 12 had the lowest percentage of CCRN respondents--though that low was 43% of their respondents. Site 3 CABGS providers were the most mature (43.5 years old), and had the most nursing experience across all experience categories--total, intensive care, thoracic surgery, and thoracic surgery this unit.

Demographic descriptions of the total CABGS nurse provider respondent sample is contained in Table 4-14. Presentation of the demographics of CABGS nurse provider respondents by site for those sites with a greater than 20% response rate is in Table 4-15.

CABGS assist providers. The CABGS assist personnel (n = 3) who responded to the questionnaire were male (100%) and primarily military airmen, corpsmen or medics (66%). The average CABGS assist personnel was 36 years, with 7.2 years of nursing experience, 4.5 years of critical care experience and 4.5 years of open heart surgery experience, with 4.5 years of open heart surgery experience on their current unit. The assist personnel had an average of 11.5 hours of hemodynamic education and 51.5 hours of orientation to hemodynamic monitoring on their current unit. Description of CABGS assist provider respondents is contained in Table 4-16.

CABGS physician providers. CABGS physician provider personnel (n = 12) were military males; no civilian contract physician responded to the questionnaire. The average age of the physician provider was 42 years old. Most of the physician respondents were staff physicians (83%). who had an average of 7.5 years of thoracic surgery experience, performing an average of 66.4 CABGS in the six months previous to the initiation of the study (July-December 1994). The CABGS physician provider had attended an average of 45.3 hours of medical education devoted to hemodynamic monitoring. CABGS physician provider respondent demographics are presented in Table 4-17.

Table 4-14

Demographic Characteristics of the CABGS Nurse Provider Knowledge Questionnaire Sample (N = 52)

Variable	n (%)
Sex	
Female	36 (70.6)[a]
Male	15 (29.4)
Type of RN	
Military	31 (59.6)
Civilian, Government Service	13 (25.0)
Civilian, Agency	8 (15.4)
Military Rank	
Not Applicable	21 (40.4)
O - 2	6 (11.5)
O - 3	24 (46.2)
O - 4	1 (1.9)
Highest Nursing Degree Held	
Associate Degree	3 (5.8)
Diploma	3 (5.8)
BSN	38 (73.1)
MA/MS	8 (15.4)
Service Skill Identifier	
Not Applicable	21 (40.4)
Yes	27 (51.9)
No	3 (5.8)
Applied For/Pending	1 (1.9)
CCRN Certification	
Yes	34 (65.4)
No	18 (34.6)
	M (SD)
Age	35.4 (7.6)[a]
Years in service (if applicable)	6.5 (3.9)
Years of nursing experience	11.4 (6.5)
Years of critical care experience	7.9 (5.6)
Years of open heart surgery experience	4.8 (5.3)
Years of open heart experience this unit	3.0 (5.0)
Number of weeks of ICU course attended	7.3 (7.5)
Hours of hemodynamic assessment/intervention education	35.4 (42.6)
Hours of orientation devoted to hemodynamic monitoring	7.1 (11.2)

a = Includes 1 missing value.

Table 4-15

Demographic Characteristics of the CABGS Nurse Provider Questionnaire Sample: Sites With Greater Than a 20% Response Rate

Variable	Site 1 n (%)	Site 3 n (%)	Site 4 n (%)	Site 9 n (%)	Site 10 n (%)	Site 11 n (%)	Site 12 n (%)
Sex							
Female	4 (57)	3 (75)	4 (100)	9 (75)[a]	2 (50)	3 (43)	6 (86)
Male	3 (43)	1 (25)	0 (0)	2 (17)	2 (50)	4 (57)	1 (14)
Type of RN							
Military	3 (43)	1 (25)	3 (75)	4 (33)	4 (100)	7 (100)	5 (71)
Civilian, Government Service	3 (43)	3 (75)	1 (25)	0 (0)	0 (0)	0 (0)	2 (29)
Civilian, Agency	1 (14)	0 (0)	0 (0)	8 (66)	0 (0)	0 (0)	0 (0)
Military Rank							
Not Applicable	4 (57)	3 (75)	1 (25)	8 (66)	0 (0)	0 (0)	2 (29)
O - 2	1 (14)	0 (0)	1 (25)	1 (8)	1 (25)	0 (0)	1 (14)
O - 3	2 (29)	1 (25)	2 (50)	3 (25)	3 (75)	7 (100)	4 (57)
O - 4	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Highest Nursing Degree Held							
Associate Degree	1 (14)	0 (0)	0 (0)	1 (8)	1 (25)	0 (0)	1 (14)
Diploma	0 (0)	2 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BSN	6 (86)	1 (25)	4 (100)	10 (83)	2 (50)	4 (57)	6 (86)
MA/MS	0 (0)	1 (25)	0 (0)	1 (8)	1 (25)	3 (43)	0 (0)
Service Skill Identifier							
Not Applicable	4 (57)	3 (75)	1 (25)	8 (66)	0 (0)	0 (0)	2 (29)
Yes	2 (29)	1 (25)	3 (75)	4 (33)	3 (75)	7 (100)	4 (57)
No	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	0 (0)	1 (14)
Applied For/Pending	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
CCRN Certification							
Yes	3 (43)	3 (75)	4 (100)	9 (75)	2 (50)	5 (71)	3 (43)
No	4 (57)	1 (25)	0 (0)	3 (25)	2 (50)	2 (29)	4 (57)

Table 4-15--continued

	Site 1 M(SD)	Site 3 M(SD)	Site 4 M(SD)	Site 9 M(SD)	Site 10 M(SD)	Site 11 M(SD)	Site 12 M(SD)
Age	40.0 (9.9)	43.5 (9.8)	32.0 (7.7)	31.0 (4.2)	31.8 (5.1)	36.7 (4.6)	31.0 (5.6)
Years of nursing experience	13.6 (6.8)	21.1 (11.3)	9.6 (6.2)	7.9 (3.7)	9.0 (4.7)	12.9 (5.1)	7.1 (2.9)
Years of critical care experience	10.4 (6.0)	15.9 (11.8)	6.0 (2.8)	6.0 (3.4)	7.3 (5.2)	7.4 (2.4)	3.7 (2.8)
Years of open heart surgery experience	7.3 (6.0)	15.0 (12.4)	1.3 (0.6)	4.0 (2.1)	2.4 (2.5)	4.4 (1.8)	2.2 (1.7)
Years of open heart experience this unit	3.2 (4.0)	14.0 (13.3)	0.6 (0.2)	1.9 (1.3)	1.3 (0.8)	2.6 (1.6)	2.2 (1.7)
Number of weeks of ICU course attended	13.3 (9.3)	14.0 (2.8)	18.5 (3.8)	4.4 (2.9)	4.5 (1.7)	2.8 (1.8)	1.8 (0.4)
Hours of hemodynamic assessment /intervention education	34.3 (38)	89.3 (96.0)	37.3 (37.8)	35.6 (43.0)	20.0 (8.2)	23.0 (28.8)	17.3 (8.3)
Hours of orientation devoted to hemodynamic monitoring	2.2 (2.3)	13.0 (18.3)	1.0 (1.0)	5.3 (12.3)	7.0 (6.2)	11.9 (16.3)	10.8 (9.1)

a = Includes 1 missing value.

Table 4-16

Demographic Characteristics of the CABGS Assist Provider Knowledge Questionnaire Sample (N = 3)

Variable	n (%)
Sex	
Female	0 (0.0)
Male	3 (100.0)
Type of CABGS Assist	
Military	2 (66.7)
Civilian, Government Service	3 (33.3)
Military Rank	
Not Applicable	1 (33.3)
Enlisted	2 (66.6)
Professional Status	
Licensed Practical Nurse	1 (33.3)
Airman, Corpsman or Medic	2 (66.6)
Attended Service Critical Care Course	
Yes	2 (66.6)
Not Applicable	1 (33.3)
	M (SD)
Age	36.0 (13.5)
Years of military service (if applicable)	8.0 (2.8)
Years of nursing experience	7.2 (12.0)
Years of critical care experience	4.5 (0.9)
Years of open heart surgery experience	4.5 (0.9)
Years of open heart surgery experience this unit	4.5 (0.9)
Number of weeks of ICU course attended	1.5 (0.7)
Hours of hemodynamic assessment/intervention education	11.5 (2.0)
Hours of orientation devoted to hemodynamic monitoring	51.5 (68.5)

Table 4-17

Demographic Characteristics of the CABGS Physician Provider Knowledge Questionnaire Sample (N = 12)

Variable	n (%)
Sex	
Female	0 (0.0)
Male	12 (100.0)
Type of CABGS Physician	
Military	12 (100.0)
Civilian, Contract	0 (0.0)
Professional Status	
Resident	2 (16.7)
Staff	10 (83.3)
	M (SD)
Age	41.9 (7.7)
Years of thoracic surgery experience	7.5 (8.5)
Hours of medical education related to hemodynamics	45.3 (41.3)
Volume of CABGS Performed/Assisted	
January-June 1994	43.5 (24.2)
June-December 1994	66.4 (51.2)

Data Analysis: Provider Hemodynamic Knowledge.

CABGS nurse and CABGS assist providers Scores on the BPDQ ranged from 9 to 32 with a mean score of 18.4 and a standard deviation of 4.0 out of a possible 34 points for the combined CABGS nurse and CABGS assist sample. There were minimal differences between CABGS nurse and CABGS assist personnel when their scores were analyzed separately; CABGS nurse scores ranged from 9 to 32 with a mean of 18.5 and a standard deviation of 3.9, while CABGS assist personnel scores ranged from 14 to 20 with a mean 17.3 and a standard deviation of 3.1.

PACKAT scores for the combined nurse and assist personnel sample ranged from 12 to 54, with a mean of 33.8 and a standard deviation of 8.1 out of a possible 61 items. Again minimal difference were seen between CABGS nurse and CABGS assist personnel scores

when they were analyzed separately; CABGS nurse only scores ranged from 12 to 54 with a mean of 33.8 and a standard deviation of 8.1, while CABGS assist personnel scores ranged from 25 to 43 with a mean of 32.7 and a standard deviation of 9.3. Mean percentage correct for sub-domains of the PACKAT ranged from 32% to 80% for the combined nurse and assist personnel sample. Areas of weakness (< 50% mean percentage correct) concerning knowledge necessary to obtain accurate and valid PA pressure measurements identified by the PACKAT include lung zone (32%), artifact (45.5%) and square wave (47.9%).

Item analyses of the BPDQ demonstrated that 44% of the items had a low worth when evaluated by W, a weighted combination of the Davis difficulty index and the Davis discrimination index. Item analyses of the PACKAT found that 36% of the items were of low worth. In general, a discrimination index measures the relationship between item scores and total test scores. Discrimination indices are subject to sampling error, with smaller samples leading to greater sampling error; items found to be highly discriminating in one sample might be negative or weak in another (Ebel & Frisbie, 1986). A difficulty index is a measure of the number of the individuals who answered the item correctly, the higher the p value the easier the item. An item's difficulty index not only reflects the content of that item, but also reflects the group responding to that item (Ebel & Frisbie, 1986). Item difficulties are expected to between .25 and .50, for achievement tests. For domain-referenced tests, however, the content specifications dictate the difficulty of the items.

BPDQ and PACKAT test summaries for the combined and separate CABGS nurse and CABGS assist personnel samples are described in Table 4-18 and Table 4-19. Summary of test statistics for the PACKAT sub-domains are in Table 4-20.

CABGS physician provider. CABGS physician scores on the PACSG ranged from 22 to 31 with a mean score of 25.8 and a standard deviation of 2.8 out of a possible 31 points.

Item analysis for the PACSG demonstrated that 58% of the items had low worth (W) as defined by the ITEMRS program (Slaughter, 1987). Recognition of the dependence of discrimination indices on sample size and the dependence of difficulty indices on sample characteristics must be considered when evaluating the worth of an item. The PACSG test summary for the CABGS physician sample is described in Table 4-21.

Table 4-18

BPDQ Test Summary For CABGS Nurse and CABGS Assist , CABGS Nurse Only, and CABGS Assist Only Providers

Sample	Test Statistic/Descriptor (Number of Items = 34)	Values
CABGS Nurse and CABGS Assist (N = 55)	Median	18
	Mean	18.4
	Standard Deviation	4.0
	Highest Score	32.
	Lowest Score	9
	W[a]	
	Number of Items with Very High W	2
	Number of Items with High W	3
	Number of Items with Medium W	14
	Number of Items with Low W	10
	Number of Items with Very Low W	5
CABGS Nurse Only (N = 52)	Median	18.0
	Mean	18.5
	Standard Deviation	3.9
	Highest Score	32
	Lowest Score	9
CABGS Assist Only (N = 3)	Median	18
	Mean	17.3
	Standard Deviation	3.1
	Highest Score	20
	Lowest Score	14

W = A rough estimate of the worth of an item based on weighted combination of the Davis Discrimination Index and the Davis Difficulty Index. Obtained from ITEMRS, (Slaughter, 1987).

Table 4-19

PACKAT Test Summary For CABGS Nurse and CABGS Assist, CABGS Nurse Only, and CABGS Assist Only Providers

Sample	Test Statistic/Descriptor (Number of Items = 61)	Values
CABGS Nurse and CABGS Assist (N = 55)	Median	33
	Mean	33.8
	Standard Deviation	8.1
	Highest Score	54
	Lowest Score	12
	W[a]	
	Number of Items with Very High W	2
	Number of Items with High W	19
	Number of Items with Medium W	18
	Number of Items with Low W	10
	Number of Items with Very Low W	12
CABGS Nurse Only (N = 52)	Median	33.5
	Mean	33.8
	Standard Deviation	8.1
	Highest Score	54
	Lowest Score	12
CABGS Assist Only (N = 3)	Median	30
	Mean	32.7
	Standard Deviation	9.3
	Highest Score	43
	Lowest Score	25

W = A rough estimate of the worth of an item based on weighted combination of the Davis Discrimination Index and the Davis Difficulty Index. Obtained from ITEMRS (Slaughter, 1987).

Table 4-20

PACKAT Sub-Domain Scores For CABGS Nurse and CABGS Assist Personnel (N = 52)

Sub-Domain	Number of Items	Mean	Standard Deviation	Mean % Correct
Technical Aspects	23	14.6	3.3	63.3
Leveling	3	2.4	.6	80.0
Square wave	3	1.4	1.0	47.9
Waveform analysis	15	9.6	2.4	64.1
Balloon inflation	2	1.1	.5	55.5
Physiology/Pathophysiology	17	9.0	3.0	53.2
Artifact	14	6.4	2.6	45.5
Respiratory variation	5	3.3	1.5	66.6
Lung zone	5	1.6	1.3	32.0
Complications	2	1.5	.7	72.7
Cardiac output	12	7.0	2.1	58.0

Table 4-21

PACSG Test Summary For CABGS Physician Providers

		Test Statistic/Descriptor (Number of Items = 31)	Values
PACSG	(N = 12)	Median	25.5
		Mean	25.8
		Standard Deviation	2.8
		Highest Score	31
		Lowest Score	22
		W[a]	
		Number of Items with Very High W	7
		Number of Items with High W	2
		Number of Items with Medium W	4
		Number of Items with Low W	1
		Number of Items with Very Low W	17

W = A rough estimate of the worth of an item based on weighted combination of the Davis Discrimination Index and the Davis Difficulty Index. Obtained from ITEMRS (Slaughter, 1987).

Description of CABGS nurse provider hemodynamic knowledge: Sites with greater than 20% response rate. CABGS nurse provider BPDQ and PACKAT test statistics are described by site for each site having a greater than 20% response rate in Tables 4-22 and 4-23. Performance on individual PACKAT sub-domains is described by score mean and standard deviation for each site having a greater than 20% response rate in Table 4-24.

Table 4-22

BPDQ Test Statistics: Sites With Greater than 20% Response Rate and For All Sites Combined

Site	n	Response Rate (%)	Mean	Standard Deviation	Median	High Score	Low Score
# 1	7	31.8	18.7	2.0	18	22	17
# 3	4	36.4	17.0	2.6	17	20	14
# 4	4	33.3	16.3	4.2	18	19	10
# 9	11	39.3	17.1	4.0	16	24	11
# 10	4	33.3	21.5	8.1	20.5	32	13
# 11	7	46.7	19.9	4.1	20	25	14
# 12	7	50.0	19.7	1.8	20	22	18
All Sites	52	28.0	18.5	4.0	18	32	9

Table 4-23

PACKAT Test Statistics: Sites With Greater than 20% Response Rate and For All Sites Combined

Site	n	Response Rate (%)	Mean	Standard Deviation	Median	High Score	Low Score
# 1	7	31.8	32.4	4.0	35.0	37	23
# 3	4	36.4	30.0	7.0	30.0	33	28
# 4	4	33.3	32.5	6.2	33.5	39	24
# 9	11	39.3	36.1	8.1	38.0	50	22
# 10	4	33.3	37.0	8.0	38.5	45	26
# 11	7	46.7	40.4	10.5	38.0	54	28
# 12	7	50.0	28.1	8.5	30.0	36	12
All Sites	52	28.4	33.8	8.1	33.5	54	12

CABGS nurses providing care at Sites 10 and 11 obtained the highest mean scores on both the BPDQ and the PACKAT. While nurses providing CABGS care at Sites 3 and 4 obtained the lowest mean scores on the BPDQ, nurses providing CABGS care at Sites 3 and 12 obtained the lowest mean scores on the PACKAT.

Table 4-24

PACKAT Sub-Domain Mean and Standard Deviation: Sites With Greater than 20% Response Rate

Sub-Domain	Site 1 M (SD) n = 7	Site 3 M (SD) n = 4	Site 4 M (SD) n = 4	Site 9 M (SD) n = 11	Site 10 M (SD) n = 11	Site 11 M (SD) n = 7	Site 12 M (SD) n = 7
Technical Aspects (Items = 23)	14.1 (2.0)	12.8 (3.9)	15.8 (3.0)	15.6 (3.7)	15.5 (3.7)	16.6 (3.6)	13.1 (3.1)
Leveling (Items = 3)	2.6 (0.5)	2.0 (0.8)	3.0 (0.0)	2.5 (0.5)	2.0 (0.8)	2.3 (0.5)	2.3 (0.8)
Square Wave (Items = 3)	1.0 (0.8)	0.8 (1.0)	1.5 (1.0)	1.6 (0.7)	1.5 (1.3)	2.3 (0.8)	1.1 (1.3)
Waveform Analysis (Items =)	9.6 (1.6)	9.0 (2.6)	10.3 (2.4)	10.2 (2.8)	10.8 (1.9)	10.4 (2.3)	9.0 (2.0)
Balloon Inflation (Items = 2)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0	1.3 (0.5)	1.3 (0.5)	1.6 (0.5)	0.7 (0.5)
Physiology/ Pathophysiology (Items = 17)	8.4 (1.3)	8.0 (2.2)	7.0 (1.4)	9.4 (3.5)	10.3 (2.5)	11.6 (3.7)	7.6 (3.9)
Artifact (Items = 14)	6.3 (2.3)	6.5 (3.1)	6.5 (2.5)	7.1 (2.7)	8.0 (2.9)	7.0 (3.3)	5.0 (2.3)
Respiratory Variation (Items = 5)	3.1 (1.3)	4.0 (1.4)	4.3 (1.5)	3.6 (1.6)	4.0 (1.4)	3.3 (1.5)	3.0 (1.0)
Lung Zone (Items = 5)	1.7 (1.1)	1.8 (1.5)	1.0 (0.8)	2.4 (1.1)	2.0 (1.8)	1.7 (1.7)	1.0 (1.4)
Complications (Items = 2)	1.0 (0.8)	0.8 (0.5)	1.5 (1.0)	1.7 (0.6)	1.5 (0.6)	1.7 (0.8)	1.3 (0.5)
Cardiac Output (Items = 12)	7.0 (1.5)	7.0 (0.8)	7.0 (0.8)	7.3 (2.3)	7.0 (0.8)	8.3 (2.2)	5.3 (2.9)
Total Score (Items = 61)	32.4 (4.0)	30.0 (7.0)	32.5 (6.2)	36.1 (8.1)	37.0 (8.0)	40.4 (10.5)	28.1 (8.5)

Description of provider knowledge: DOD CABGS units with higher crude mortality versus DOD CABGS units with lower crude mortality. Differences in provider knowledge between medical centers with higher versus lower crude mortality rates will be presented in the analysis section of Phase II results after all questionnaire, observation and chart audit data have been described.

Description of Processes: CABGS Provider Organizational Processes

DOD CABGS providers' perceptions of their unit's/team's organizational processes were assessed via the Nurse Physician Questionnaire (Shortell, et al., 1991), an instrument of twenty-one sub-scales of 5-point Likert scale items. A score of 1 on an item represented a negative perception or judgement (strongly disagree, not at all likely) on organizational process sub-scale items and very dissatisfied on the job satisfaction sub-scale/item. A score of 5 on an item represented a positive perception or judgement (strongly agree, almost certain to happen) on organizational process sub-scale items and very satisfied on the job satisfaction sub-scale/item. The instrument's twenty-one sub-scales were comprised of nineteen sub-scales of between 3 and 8 items and one, 1-item, sub-scale--each assessing a different a different organizational process. Another 1-item sub-scale assessed provider job satisfaction.

Type I Error: Provider Organizational Assessment.

Four analyses relating to the organizational processes of nurse-physician collaboration were to be performed: analysis of the differences between CABGS nurse providers working in high and low crude mortality and high and low actual versus expected mortality medical centers on the between-group sub-scales of communication openness, communication accuracy, problem-solving, and conflict-avoiding of the Nurse Physician Questionnaire. High crude

mortality (Sites 1, 3, 6 and 12) and low crude mortality (Sites 2, 7, 8 10 and 11) medical centers are defined as greater than or equal to 4.7% and less than or equal to 2.4% mortality, respectively, for CABGS defined by ICD-9-CM procedure codes for the 1 January through 30 June 1994 timeframe. The higher actual versus expected mortality (Sites 1, 3, 5, 6 and 12) and the lower actual versus expected mortality (Sites 2, 4, 7, 8, 9, 10 and 11) medical centers were defined by their risk-adjusted CABGS mortality based on the ICD-9-CM procedure for the 1 January through 30 June 1994 timeframe. The α criterion was set at .0125 to evaluate the significance of each of these differences in mean sub-scale score, bringing the family-wise error rate for this question to .05.

Confidence and Power: Provider Organizational Assessment.

The sample size of 53 CABGS nurses was adequate to determine mean nurse provider organizational process assessment scores at the 95% confidence level (desired total width of the confidence interval = 1) for most subscales of the Nurse Physician Questionnaire for the CABGS nurse provider sample and for CABGS nurse providers when divided into 2 groups based on medical center mortality. The sample size of 12 CABGS physicians was adequate to describe CABGS physician provider organizational process assessment scores for most subscales of the questionnaire at the 90% confidence level (desired total width of the interval = 1). The CABGS assist provider sample was inadequate to describe CABGS assist provider organizational assessment scores at the 90% confidence level.

A sample of size of 30 per group would have been adequate (α = .025 one-tailed, β = .20) to detect organizational process differences between the nurse providers in DOD medical centers with higher crude CABGS mortality and nurses in DOD medical centers with lower crude CABGS mortality only if the effect size were .7 or better for each instrument. However, there were only 19 completed questionnaires from the high crude mortality DOD medical

centers and 18 completed questionnaires from the low crude mortality DOD medical centers. Based on the actual group sample sizes, the difference between the two groups' means on the relevant between-group sub-scales and the standard deviations of the relevant sub-scales, the actual effect size and power for each sub-scale was computed; there was inadequate power to detect a difference on any sub-scale.

Reliability of the Instrument Used to Assess CABGS Provider Perceptions of Organizational Processes

Reliabilities of all the sub-scales of the Nurse Physician questionnaire for the CABGS nurse provider sample ranged from .67 to .89. For the CABGS assist provider sample sub-scale reliabilities ranged from 0.0 to .98; low reliabilities (< .60) for the CABGS assist provider sample were noted on the within-group (nurse-nurse) communication openness sub-scale (0.0) and the between-group (nurse-physician) communication accuracy sub-scale. Reliability for the CABGS physician providers sample ranged from .17 to .90, with low reliabilities (< .60) noted on the perceived effectiveness at recruiting and retaining nurses (.17); the perceived budgeting authority of the medical director (.33); perceived unit/team effectiveness at recruiting and retaining physicians (.51); and perceived patient care decision authority of the nurse manager (.55). The reliabilities of the sub-scales being used to evaluate CABGS nurse provider differences between nurses working at high mortality and low mortality medical centers were all greater than .67. The reliabilites for each sub-scale for each of these provider groups is described in Table 4-25.

Description of the Sample: Provider Organizational Assessment.

Except for the addition of one nurse the CABGS nurse provider sample, responding to the provider organizational assessment questionnaire is essentially unchanged from that of the CABGS nurse provider sample who responded to the hemodynamic knowledge questionnaire.

The additional nurse provider was a Site 9, 28 year old, female, associate degree, agency nurse who had 6 years of nursing experience, 4 years of intensive care nursing experience and 2.5 years of open heart nursing experience. Table 4-26 summarizes the CABGS nurse provider sample. The CABGS nurse provider demographic description by site will not be reiterated.

Likewise, the CABGS assist provider sample who responded to the organizational assessment questionnaire is the same except for the addition of one female military provider (Table 4-27). These minor differences in the sample are related to one nurse provider and one CABGS assist provider not filling out the entire questionnaire packet.

The CABGS physician provider sample responding to the organizational assessment questionnaire is identical to the CABGS physician provider sample responding to the hemodynamic knowledge questionnaire.

Table 4-25

Reliability Estimates For Instruments Used to Assess CABGS Provider Assessment of CABGS Unit/Team Organizational Processes: ICU Nurse and ICU Physician Questionnaires

Instrument and Instrument Sub-Domains	No. of Items	Alpha: ICU Nurse Quest. CABGS Nurse (N=53)	Alpha: ICU Nurse Quest. CABGS Assist (N=4)	Alpha: ICU Physician Quest. CABGS Physician (N=12)	Alpha: ICU Research Project Sample[a]
Leadership					
Nursing leadership	8	.89	.98	.83	.87
Physician leadership	8	.87	.97	.87	.88
Communication					
Openness: Within groups	4	.76	0.0	.87	.83
Openness: Between groups	4	.67	.79	.83	.88
Accuracy: Within groups	4	.75	.87	.82	.78
Accuracy: Between groups	3	.72	.27	.62	.74
Timeliness	3	.79	.90	.76	.68
Coordination					
Unit relations with other units	4	.73	.78	.65	.75
Conflict Management					
Problem-solving: Within group	4	.76	.89	.80	.81
Problem-solving: Between group	4	.82	.96	.54	.82
Conflict-avoiding: Within group	3	.73	.89	.90	.72
Conflict-avoiding: Between group	3	.79	.96	.86	.76
Perceived Authority of Nurse Manager					
Budgeting authority	3	.82	.93	.77	-
Patient care decision authority	2	.79	.78	.55	-
Perceived Authority of Medical Director					
Budgeting authority	3	.82	.92	.33	-
Patient care decision authority	2	.86	1.00	.61	-
Perceived Unit/Team Effectiveness					
Recruiting and retaining nurses	2	.77	.97	.17	-
Recruiting and retaining physicians	2	.79	.97	.51	-
Absolute technical quality of care	5	.76	.91	.87	.75
Meeting family needs	1	-	-	-	-
Job Satisfaction	1	-	-	-	-

a = Reliability estimates are from Shortell, et al, (1991)

Table 4-26

Demographic Characteristics of the Registered Nurse Provider Organizational Questionnaire Sample (N = 53)

Variable	n (%)
Sex	
Female	37 (69.8)[a]
Male	15 (28.3)
Type of RN	
Military	31 (58.5)
Civilian, Government Service	13 (24.5)
Civilian, Agency	9 (17.0)
Military Rank	
Not Applicable	22 (41.5)
O - 2	6 (11.3)
O - 3	24 (45.3)
O - 4	1 (1.9)
Highest Nursing Degree Held	
Associate Degree	4 (7.5)
Diploma	3 (5.7)
BSN	38 (71.7)
MA/MS	8 (15.1)
Service Skill Identifier	
Not Applicable	22 (41.5)
Yes	27 (50.9)
No	3 (5.7)
Applied For/Pending	1 (1.9)
CCRN Certification	
Yes	35 (66.0)
No	18 (34.0)
	M (SD)
Age	35.3 (7.6)[a]
Years in service (if applicable)	6.5 (3.9)
Years of nursing experience	11.3 (6.5)
Years of critical care experience	7.8 (5.6)
Years of open heart surgery experience	4.7 (5.2)
Years of open heart surgery experience this unit	3.0 (4.9)
Number of weeks of ICU course attended	7.4 (7.4)
Hours of hemodynamic assessment/intervention education	34.7 (42.3)
Hours of orientation devoted to hemodynamic monitoring	7.0 (11.1)

a = 1 missing value

Table 4-27

Demographic Characteristics of the CABGS Assist Provider Organizational Questionnaire Sample (N = 4)

Variable	n (%)
Sex	
Female	1 (25.0)
Male	3 (75.0)
Type of CABGS Assist	
Military	3 (75.0)
Civilian, Government Service	1 (25.0)
Military Rank	
Not Applicable	1 (25.0)
Enlisted	3 (75.0)
Professional Status	
Licensed Practical Nurse	1 (25.0)
Airman, Corpsman or Medic	3 (75.0)
Attendance at Service Critical Care Course	
Yes	2 (50.0)
No	1 (25.0)
Not Applicable	1 (25.0)
	M (SD)
Age	33.8 (11.9)
Years of military service (if applicable)	8.2 (2.0)
Years of nursing experience	11.0 (6.2)
Years of critical care experience	4.0 (1.2)
Years of open heart surgery experience	4.0 (1.2)
Years of open heart surgery experience this unit	4.0 (1.2)
Number of weeks of service ICU course attended	1.5 (.70)
Hours of hemodynamic assessment/intervention education	11.5 (12.0)
Hours of orientation devoted to hemodynamic monitoring	51.5 (68.6)

Data Analysis: CABGS Nurse, Assist and Physician Provider Organizational Assessment.

CABGS nurse and CABGS assist providers. The fifty three CABGS nurse providers who responded to the ICU Nurse Questionnaire were generally positive about all organizational processes of care assessed by the questionnaire's sub-scales. Sub-scales were comprised of 5-point Likert scale items. Sub-scales item mean scores for the CABGS nurse providers ranged from 2.9 on one sub-scale--perceived unit effectiveness at recruiting and

retaining physicians, to 4.2 on four sub-scales--between group openness of communication; patient care decision authority of the medical director; unit/team technical quality of care effectiveness; and unit/team effectiveness at meeting family needs. Out of the 20 organizational process sub-scales, CABGS nurse providers had an item mean score less than 3 on only one sub-scale, while they had item mean scores greater than 4 on four sub-scales. DOD CABGS nurse providers had an item mean score on the job satisfaction sub-scale/item of 4.1.

The four CABGS assist providers who responded to the ICU Nurse Questionnaire were also positive about their unit/team organizational processes of care as assessed by that instrument. CABGS assist provider sub-scale item mean scores ranged from a low of 3.0 on one sub-scale --recruiting and retaining physicians, to a high of 4.8 on two sub-scales--perceived authority of the medical director concerning patient care and job satisfaction. Out of the 20 organizational process sub-scales, CABGS assist providers had no sub-scale item mean scores less than 3, while they had item mean scores greater than 4 on nine subscales. DOD CABGS assist providers had an item mean score on the job satisfaction sub-scale/item of 4.8.

CABGS physician provider. The twelve CABGS physician providers responding to the ICU Physician Questionnaire were also positive about unit/team organizational processes of care as assessed by that instrument. Sub-scale item mean scores for the CABGS physician providers ranged from a low of 2.5 on one sub-scale--perceived budgeting authority of the medical director, to a high of 4.5 on one sub-scale--between group communication openness. Out of the 20 organizational process sub-scales, CABGS physician providers had item mean scores less than 3 on 3 sub-scales, while they had item mean scores greater than 4 on 9 sub-scales. DOD CABGS assist provider had an item mean score on the job satisfaction sub-scale/item of 4.3.

Descriptive statistics for all the CABGS provider groups are contained in Table 4-28.

Table 4-28

Descriptive Statistics For Instruments Used to Assess CABGS Provider Assessment of CABGS Unit/Team Organizational Processes: ICU Nurse and ICU Physician Questionnaires

Instrument and Instrument Sub-Domains	ICU Nurse: CABGS Nurse (N = 53) M (SD)	ICU Nurse: CABGS Assist (N = 4) M (SD)	ICU Physician: CABGS Physician (N = 12) M (SD)
Leadership			
Nursing leadership	3.4 (1.1)	3.8 (1.6)	3.8 (1.0)
Physician leadership	3.4 (.93)	3.5 (1.6)	4.3 (.81)
Communication			
Openness: Within groups	4.0 (.83)	4.7 (.63)	4.3 (.73)
Openness: Between groups	4.2 (.80)	4.7 (.41)	4.5 (.63)
Accuracy: Within groups	3.6 (.89)	3.9 (1.3)	3.3 (.93)
Accuracy: Between groups	3.2 (1.1)	3.8 (1.5)	3.8 (.91)
Timeliness	4.2 (.60)	4.3 (1.2)	4.0 (.74)
Coordination			
Unit relations with other units	3.4 (.93)	3.6 (1.4)	4.1 (.71)
Conflict Management			
Problem-solving: Within group	3.4 (.78)	3.2 (1.0)	3.9 (.91)
Problem-solving: Between group	3.2 (.87)	3.4 (1.0)	3.4 (.80)
Conflict-avoiding: Within group	3.6 (.85)	4.3 (.85)	4.3 (.94)
Conflict-avoiding: Between group	3.8 (.76)	4.0 (1.5)	4.1 (.79)
Perceived Authority of Nurse Manager			
Budgeting authority	3.6 (1.3)	4.2 (1.0)	2.8 (1.2)
Patient care decision authority	3.3 (1.1)	3.9 (1.1)	3.4 (.88)
Perceived Authority of Medical Director			
Budgeting authority	3.2 (1.0)	3.6 (1.6)	2.5 (1.1)
Patient care decision authority	4.0 (1.0)	4.8 (.5)	3.7 (.85)
Perceived Unit/Team Effectiveness			
Recruiting and retaining nurses	3.1 (1.0)	3.4 (1.4)	2.8 (.98)
Recruiting and retaining physicians	2.9 (.83)	3.0 (1.8)	3.3 (.95)
Absolute technical quality of care	4.2 (.68)	4.5 (.90)	4.4 (.62)
Meeting family needs	4.2 (.73)	4.5 (.58)	4.4 (.66)
Job Satisfaction	4.1 (.99)	4.8 (.50)	4.3 (.88)

Description of unit/team organizational processes by site: Sites with greater than 20% response rates. CABGS nurse provider ICU Nurse Questionnaire sub-scale item statistics are described by site for each site having a greater than 20% response rate in Table 4-29. Shortell, et al (1991) stated that individual response might be aggregated to the unit level in this fashion. Their analysis of within-unit and between-unit responses for all instrument sub-scales at the 42 intensive care units in their sample demonstrated significantly less within-unit than between-unit variability for all instrument sub-scales.

Sites 1, 4, 9 and 12 had mean scores less than 3 on one or more subscales. Site 1 had mean sub-scale scores less than 3 on two subscales, the nursing leadership and unit relations with other units subscales. Site 4 had mean sub-scale scores less than 3 on four subscales, the perceived patient care decision authority of the nurse manager, perceived budgeting authority of the medical director, and unit/team perceived effectiveness at recruiting and retaining both nurses and physicians. Site 10 had mean sub-scale scores less than 3 on three subscales; perceived budgeting authority of budgeting authority of both the nurse manager and the medical director and unit/team effectiveness at recruiting and retaining physicians. Site 12 had mean sub-scale scores less than 3 on six subscales--physician leadership, between-group problem-solving, perceived budgeting authority of both the nurse manager and the medical director, and unit/team effectiveness at recruiting and retaining both physicians and nurses.

Sites 1 and 12, the units with the highest mortality for both the 1 January through 30 June 1994 timeframe and fiscal year 1994, had the lowest mean scores on the perceived unit/team effectiveness of the absolute technical quality of their care.

Description of provider organizational processes: DOD CABGS units with higher crude mortality versus DOD CABGS units with lower crude mortality. Differences in organizational processes between medical centers with higher versus lower crude mortality rates will be presented in the analysis section of Phase II results after all questionnaire, observation and chart audit data have been described.

Table 4-29

Descriptive Statistics For Instruments Used to Assess CABGS Nurse Provider Perceptions of CABGS Unit/Team Organizational Processes: Sites With Greater Than a 20% Response Rate

Instrument and Instrument Sub-Domains	ICU Nurse: Site # 1 (n =7) M (SD)	ICU Nurse: Site # 3 (n = 4) M (SD)	ICU Nurse: Site # 4 (n = 4) M (SD)	ICU Nurse: Site # 9 (n = 12) M (SD)	ICU Nurse: Site # 10 (n = 4) M (SD)	ICU Nurse: Site # 11 (n = 7) M (SD)	ICU Nurse: Site # 12 (n = 7) M (SD)
Leadership							
Nursing leadership	2.6 (1.1)	3.5 (1.5)	3.7 (1.2)	3.6 (1.1)	3.6 (1.1)	3.9 (0.6)	3.5 (1.0)
Physician leadership	3.4 (0.9)	3.9 (0.7)	3.6 (0.9)	3.5 (1.1)	3.4 (0.8)	3.5 (0.7)	2.8 (0.9)
Communication							
Openness: Within groups	4.2 (0.7)	4.1 (0.9)	3.8 (0.9)	4.1 (1.0)	4.2 (0.6)	4.1 (0.5)	3.5 (0.9)
Openness: Between groups	3.9 (0.7)	4.3 (0.8)	4.3 (0.7)	4.3 (0.9)	3.9 (0.8)	4.4 (0.7)	4.0 (0.8)
Accuracy: Within groups	3.3 (0.8)	4.3 (0.5)	3.1 (1.1)	3.8 (0.9)	3.4 (0.9)	3.7 (0.6)	3.6 (0.7)
Accuracy: Between groups	2.3 (0.7)	4.3 (0.5)	3.3 (0.8)	3.4 (1.1)	3.1 (1.1)	3.7 (0.8)	3.3 (1.1)
Timeliness	4.0 (0.4)	4.5 (0.6)	4.4 (0.5)	4.4 (0.6)	4.2 (0.6)	4.3 (0.5)	3.9 (0.8)
Coordination							
Unit relations with other units	2.9 (0.8)	3.6 (1.5)	3.3 (0.9)	3.6 (1.1)	3.6 (0.9)	3.8 (0.8)	3.1 (0.8)
Conflict Management							
Problem-solving: Within group	3.1 (0.8)	3.1 (0.9)	3.1 (0.9)	3.5 (0.8)	4.0 (0.7)	3.6 (0.6)	3.5 (0.6)
Problem-solving: Between group	3.3 (1.0)	3.3 (1.0)	3.1 (0.8)	3.3 (0.9)	3.7 (0.7)	3.6 (0.7)	2.6 (0.7)
Conflict-avoiding: Within group	3.8 (0.9)	3.3 (1.3)	3.4 (0.8)	3.4 (0.8)	3.8 (1.0)	4.0 (0.7)	3.5 (0.7)
Conflict-avoiding: Between group	4.0 (0.8)	4.0 (0.8)	3.5 (0.6)	3.8 (0.8)	3.6 (0.5)	4.3 (0.5)	3.4 (1.0)

Table 4-29--continued

Perceived Authority of Nurse Manager							
Budgeting authority	4.0 (0.8)	3.8 (0.5)	4.0 (1.3)	3.9 (0.9)	2.9 (0.7)	4.5 (0.7)	2.6 (0.9)
Patient care decision authority	3.8 (0.9)	3.4 (1.5)	2.9 (0.8)	3.8 (1.1)	4.0 (0.0)	4.1 (0.8)	2.8 (1.0)
Perceived Authority of Medical Director							
Budgeting authority	3.0 (0.9)	3.0 (0.5)	2.7 (0.5)	3.9 (1.1)	2.9 (0.9)	3.7 (0.9)	2.8 (0.7)
Patient care decision authority	3.1 (1.4)	4.4 (0.5)	4.1 (1.2)	4.4 (0.7)	4.3 (0.5)	4.6 (0.5)	3.7 (1.4)
Perceived Unit/Team Effectiveness							
Recruiting and retaining nurses	3.1 (1.0)	3.0 (1.0)	2.5 (1.2)	3.7 (1.0)	3.4 (0.9)	3.5 (1.1)	2.2 (0.6)
Recruiting and retaining physicians	3.1 (0.7)	3.1 (0.5)	2.9 (0.9)	3.3 (0.9)	2.6 (0.7)	3.1 (0.7)	2.1 (0.9)
Absolute technical quality of care	3.8 (0.5)	4.6 (0.5)	4.1 (0.9)	4.3 (0.7)	4.4 (0.5)	4.4 (0.5)	3.9 (0.6)
Meeting family needs	3.9 (0.4)	4.5 (0.6)	4.8 (0.5)	4.3 (0.9)	4.8 (0.5)	4.3 (0.8)	4.1 (0.7)
Job Satisfaction	4.5 (0.5)	4.3 (1.0)	3.5 (1.3)	3.8 (1.5)	4.5 (0.6)	4.4 (0.5)	4.1 (0.7)

Phase II A: Description of Provider Hemodynamic Monitoring Reliability/Validity Assessment and Hemodynamic Measurement and Intervention Processes

Description of actual hemodynamic practice was done by observation of CABGS nurse and CABGS assist personnel in the performance of their hemodynamic monitoring system reliability/validity checks, hemodynamic measurements and hemodynamic interventions. Observations of hemodynamic monitoring system reliability/validity assessments were performed with checklists for CABGS provider measurement of pulmonary arterial (PA) pressure, arterial line blood pressure, and manual and automatic cuff blood pressures; the checklists were developed by the investigator based on extensive literature review (reported previously) of hemodynamic monitoring requirements for obtaining accurate measurements.

The 42 item hemodynamic monitoring system reliability/validity assessment for pulmonary arterial monitoring (CHECKPA) had 24 scored items, with a potential for 24 points for the CABGS provider who did everything "by the book." The 15 item arterial line checklist (CHECKAR) contained 5 scored items, with a potential for 5 points for the CABGS provider. The blood pressure checklist (CHECKBP) was a combined manual and automatic 28 item checklist, with 11 items scored for manual blood pressure cuff assessments and 4 items scored for automatic blood pressure cuff assessments. There was no "scoring" of the hemodynamic measurements and interventions recorded in the database. Measurements and measurement-related activities were categorized by the reliability and validity aspect they addressed and frequencies of each category were calculated. Interventions were categorized into whether they were related to preload, afterload, contractility or heart rate control and classified as independent, dependent or collaborative interventions. Frequencies were hand-calculated.

Observations of hemodynamic measurements and hemodynamic interventions were recorded with a hemodynamic measurement and intervention checklist/database.

Error, reliability and sample descriptions of both hemodynamic reliability/validity assessments and hemodynamic measurement and interventions will be described jointly. Data analysis of reliability/validity assessment events and measurement and intervention events will be described separately due to their different units of analysis--the provider and the event respectively.

Type I Error: Observation of Provider Hemodynamic Monitoring Processes

Analysis of differences between case and control site hemodynamic reliability/validity assessment scores for the CHECKPA, CHECKAR, and CHECKBP were planned. The significance level for each of these analyses was set at .05. No analyses of differences between sites related to hemodynamic measurement and interventions were planned or carried out.

Power and Confidence: Observation of Provider Hemodynamic Monitoring Processes

Actual hemodynamic assessment and intervention practice has not been reported in the literature. Scores for 48 providers were recorded for both the CHECKAR and the CHECKPA checklists; scores for 38 providers were recorded for the CHECKBP checklist. Assuming that knowledge of hemodynamic assessment and actual practice proficiency are related, the CABGS nurse provider sample size, which was judged adequate for the description of hemodynamic knowledge, was also adequate for the assessment of actual hemodynamic practice for the total sample.

Assuming that knowledge and actual practice proficiency are related, a sample size of 30 per group would have been adequate to detect differences between CABGS nurse and assist providers in DOD medical centers with higher crude and risk-adjusted mortality and CABGS nurse and assist providers in DOD medical centers with lower crude and risk-adjusted mortality. However, there were only 19 CABGS provider CHECKAR and CHECKPA

checklist scores and 10 CHECKBP checklist scores for the higher crude and risk-adjusted mortality medical centers; there were 29 CHECKAR and CHECKPA checklist scores and 28 CHECKBP scores for the lower crude and risk-adjusted mortality medical centers. Due to these small sample sizes and the variability in the measurements performed--some medical centers performing only manual cuff pressures, only automatic cuff pressures or not performing cuff pressures at all (second post-operative shift) and some medical centers performing only pulmonary artery diastolic pressures, there was inadequate statistical power to determine differences between higher crude and risk-adjusted mortality and lower crude and risk-adjusted medical centers.

Reliability: Hemodynamic Monitoring Reliability/Validity Assessment Observation Instruments

Interrater reliability for the checklists was checked twice, during the pilot study site visit and the last site visit at Site 1. Interrater reliability for the pilot study assessment was 100% for the CHECKAR instrument; 100% for the CHECKBP instrument; and 90% for the CHECKPA instrument. Interrater reliability for the second assessment was 100% for the CHECKAR instrument; 100% for the CHECKBP instrument; and 90% for the CHECKPA instrument. No interrater reliability assessment of the hemodynamic measurement and intervention checklist/database was performed.

Sample: Observation of Provider Hemodynamic Monitoring Processes

The intended sample for the observation of hemodynamic monitoring practice was comprised of the hemodynamic monitoring events performed by the CABGS nurse and CABGS assist care providers during their unit's 2 week observation timeframe between 1 January and 30 June 1995. Personnel performing CABGS care during this timeframe included 104 nurse and 26 assist providers at the 6 Phase II-A, case and control sites. A total of 64

different CABGS care providers were observed performing 1,681 different hemodynamic monitoring events. Forty-eight different providers were observed performing arterial line and central pressure assessments; 38 different providers were observed performing manual or automatic cuff pressure assessments; and 60 different providers were observed performing hemodynamic-measurement interventions. Providers were observed either performing one, two or all of the hemodynamic reliability/validity assessments or performing hemodynamic-measurement interventions for 31 CABGS/CABGS valve replacement patients at five of the case and control sites. Table 4-30 presents the number of CABGS providers observed by the type of hemodynamic event observed; Table 4-31 presents the number of hemodynamic events observed by type. No observations were performed at Site # 5 since no providers met the inclusion criteria; there were no CABGS or CABGS/valve replacements patients in the unit during the study's two week observation timeframe. Numbers differed for each type of event described due to different members of the CABGS performing and/or intervening for the different measurements and to missing observations.

Table 4-30.

Number of CABGS Nurse and CABGS Assist Providers Observed By Type of Observed Event

	Arterial Line Pressure Assessment Event (Reliability/ Validity)	Cuff Blood Pressure Assessment Event (Reliability/ Validity)	Pulmonary Artery Pressure Assessment Event (Reliability/ Validity)	Hemodynamic Measurement - Intervention Event
Site # 1 n = 22	17 (77%)	8[a] (77%)	16[b] (72%)	17 (77%)
Site # 5[c] n = 12	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Site # 8 n = 16	7 (43%)	7 (43%)	7 (43%)	7 (43%)
Site # 9 n = 28	9[d] (32%)	9[d] (32%)	10 (36%)	10 (36%)
Site # 11 n = 28	13 (46%)	12[e] (46%)	12[f] (50%)	23 (82%)
Site # 12 n = 24	2 (8%)	2 (8%)	3[g] (13%)	3 (13%)
Total Number of Providers Observed For Event	48 (37%)	38 (37%)	48 (38%)	60 (46%)

a = Discrepancy related to second shift providers not performing cuff blood pressure assessments

b = Discrepancy related to anesthesiologist performance of pulmonary artery pressure reliability and validity assessment.

c = Lack of observations for site 5 relates to no post-operative CABGS within 2 week site observation timeframe.

d = Discrepancy related to loss of second shift arterial line and blood pressure cuff reliability and validity assessment.

e = Discrepancy related to non-performance of a cuff blood pressure assessment

f = Discrepancy related to lack of central line in patient during 4 hour observation timeframe

g = Discrepancy related to performance of pulmonary artery wedge pressure reliability/validity assessment by 2 different nurses within observation timeframe

Table 4-31

Number of Hemodynamic Events Observed By Type

	Arterial Line Pressure Assessment Event (Reliability/ Validity)	Cuff Blood Pressure Assessment Event (Reliability/ Validity)	Pulmonary Artery Pressure Assessment Event (Reliability/ Validity)	Hemodynamic Measurement - Intervention Event
Site # 1	19	19	18[a]	436
Site # 5[b]	0	0	0	0
Site # 8	8	8	8	276
Site # 9	9[c]	9[c]	13	326
Site # 11	16	16	18[d]	423
Site # 12	2	2	3[e]	50
Event Totals	54	54	62	1511

a = Discrepancy related to anesthesiologist performance of pulmonary artery pressure reliability and validity assessment.

b = Lack of observations for site 5 relates to no post-operative CABGS within 2 week site observation timeframe.

c = Discrepancy related to loss of second shift arterial line and blood pressure cuff reliability and validity assessment.

d = Discrepancy related to performance of pulmonary artery pressure reliability and validity assessment by 2 different nurses within the observation timeframe twice.

e = Discrepancy related to performance of pulmonary artery pressure reliability and validity assessment by 2 different nurses within the observation timeframe.

Data Analysis: Description of Provider Hemodynamic Monitoring Reliability/Validity Assessment Processes

CHECKPA, CHECKAR, CHECKBP total scores. Scores for CHECKPA are broken down by the type of measurement the provider obtained: pulmonary artery wedge pressure (24 points possible), pulmonary artery diastolic pressure (14 points possible), or central venous pressure (14 points possible). A "common elements" score was also calculated on reliability

criteria relevant to both pulmonary artery wedge and pulmonary artery diastolic pressures (14 points possible). CHECKBP scores are broken down by whether the provider obtained blood pressure by manual (11 points possible) or automatic (5 points possible) blood pressure cuff. CHECKAR had 4 points possible. Scores are not broken down by provider level due to the small number of observations for each measurement. Missing items were scored as zeros.

The mean CHECKPA score for the 24 CABGS nurse and CABGS assist personnel performing pulmonary artery wedge pressures was 17.1 with a standard deviation of 2.4; scores ranged from 11 to 20 out of a possible 24 points. Twenty one CABGS nurse and CABGS assist personnel performed pulmonary diastolic pressures only; the mean score obtained was 8.1 with a standard deviation of 1.9 out of a possible 14 points. Three nurses/assist personnel performed central venous pressures only---their patients had no pulmonary artery catheter in place. The mean CHECKPA score for central venous pressure assessment was 8 -- standard deviation 0, out of a possible 8 points. The mean of CABGS nurse and assist personnel common element score for pulmonary artery wedge, pulmonary artery diastolic and central venous pressure was 8.6 out of a possible 14 points (standard deviation = 2.0).

The mean score on the CHECKAR was 3.3 out of a potential 5 points (standard deviation 0.6). CHECKBP manual blood pressure assessment scores for CABGS nurse and assist personnel ranged from 7 to 11 points with a mean of 8.6 and a standard deviation of 1.3. CHECKBP automatic blood pressure assessment scores for CABGS nurse and assist personnel ranged from 2 to 4 points with a mean of 3.5 and a standard deviation of 0.8.

Scores summaries for the CHECKPA, CHECKAR and CHECKBP observation of hemodynamic reliability/validity assessments are presented in Tables 4-32, 4-33 and 4-34 respectively.

Description of CABGS Nurse and CABGS assist personnel hemodynamic reliability and validity assessments by observation criterion. Description of each of the hemodynamic reliability and validity assessment by percent who complied with each criterion element is more informative than examination of total scores.

Examination of the criteria for the performing reliable and valid central pressures as assessed by the components of the common element score reveals problem areas in the assessment of these pressures. Criteria not met include: distinct waveform (19%); zeroing (8%); leveling (11%); use of a carpenter's level during the leveling procedure (71%); use of the zeroing stopcock as the monitoring system reference point for leveling (15%); use of the phlebostatic axis as the patient leveling reference point (17%); marking the patient reference point used on the patient (88%); and performing dynamic response assessment (84%). Transducer calibration and assessment of hemodynamic monitoring system dynamic response characteristic on paper were never performed.

Criteria for obtaining reliable and valid measurements were also not met in the assessment of blood pressure, whether assessed directly or by manual or by automatic blood pressure cuff. Criteria not met in the performance of direct arterial blood pressure assessment include transducer calibration (100%); leveling (8%); and hemodynamic response assessment (69%). Manual cuff blood pressure assessment criteria not met include appropriate cuff size (28%); verification of systolic pressure with palpation prior to auscultation (77%); use of the stethoscope bell (54%); assessment/documentation of the muffling component of blood pressure measurement (54%). Lack of appropriate cuff size (24%) and placement (24%) were criteria not met in the performance of automatic cuff blood pressure assessment.

Description of hemodynamic reliability and validity assessment criteria compliance by CABGS nurse and assist personnel are described in Table 4-34 (central pressure), Table 4-35 (direct arterial pressure) and Table 4-36 (indirect arterial).

Description of CABGS nurse and CABGS assist personnel hemodynamic reliability and validity assessments by site. Examination of hemodynamic reliability and validity assessment scores by site besides revealing small differences between sites reveals the extent of practice variation in hemodynamic monitoring that existed within DOD during the study timeframe. Sites 1 and 12 always monitored their CABGS patient's pulmonary artery wedge pressures, while Sites 8 and 9 never monitored that parameter, though pulmonary artery catheters were in place. Site 11 monitored CABGS patient pulmonary artery pressures when the catheter was in place, but placed that catheter selectively, based on pre-operative severity of illness assessment. Site 1 assessed blood pressure by cuff pressure only on admission of the CABGS patient to the unit, and used only automatic cuffs in their blood pressure assessments. Sites 1, 8 and 9 did not take manual cuff pressures: Site 12 always did. Site 11 assessed cuff blood pressures using both automatic and manual cuff pressure assessment. Site hemodynamic reliability and validity assessment scores are contained in Table 4-37.

Analysis of provider hemodynamic reliability and validity assessment processes: DOD medical centers with higher mortality versus DOD medical centers with lower mortality. Analyses of differences in hemodynamic reliability and validity assessment processes between DOD CABGS units with higher and lower actual mortality and higher and lower risk-adjusted mortality will be presented with the analyses of differences in other CABGS care provider provider processes at the end of Chapter IV.

Table 4-32

CHECKPA Observation Score Summary for CABGS Nurse and CABGS Assist Providers (N = 48 Providers)

Measurement Assessed With CHECKPA	Observation Checklist Statistic	Values
Pulmonary Artery Wedge Pressure (n = 24 Providers)	Median	18
	Mean	17.1
	Standard Deviation	2.4
	Highest Score	20
	Lowest Score	11
	Highest Possible Score	24
Pulmonary Artery Diastolic Pressure (n = 21 Providers)	Median	9
	Mean	8.1
	Standard Deviation	1.9
	Highest Score	10
	Lowest Score	3
	Highest Possible Score	14
Central Venous Pressure (n = 3 Providers)	Median	8
	Mean	8
	Standard Deviation	0
	Highest Score	8
	Lowest Score	8
	Highest Possible Score	14
"Common Element" Score (n = 48 Providers)	Median	9
	Mean	8.6
	Standard Deviation	2.0
	Highest Score	12
	Lowest Score	3
	Highest Possible Score	13

Table 4-33

CHECKAR Observation Score Summary for CABGS Nurse and CABGS Assist Providers (N = 48 Providers)

CHECKAR	Observation Checklist Statistic	Values
Blood pressure by arterial line (n = 48 Providers)	Median	3
	Mean	3.3
	Standard Deviation	0.6
	Highest Score	4
	Lowest Score	2
	Highest Possible Score	5

Table 4-34

CHECKBP Observation Score Summary for CABGS Nurse and CABGS Assist Providers (N= 38 Providers)

Measurement Assessed With CHECKBP	Observation Checklist Statistic	Values
Manual cuff blood pressure (n = 13 Providers)	Median	8
	Mean	8.6
	Standard Deviation	1.3
	Highest Score	11
	Lowest Score	7
	Highest Possible Score	11
Automatic cuff blood pressure (n = 25 Providers)	Median	4
	Mean	3.5
	Standard Deviation	0.8
	Highest Score	4
	Lowest Score	2
	Highest Possible Score	4

Table 4-35

Description of Central Pressure Reliability/Validity Assessment By Criterion (N = 48 Providers)

CHECKPA Criterion	Criterion Met: n (%)
Common Elements of PAWP, PAD, and CVP (n = 48 Providers)	
RN assessed waveform	48 (100)
Rater's assessment: PA had distinct dicrotic notch	39 (81)[3]
RN performed monitor calibration	44 (91)
RN performed transducer calibration	0 (0)[1]
RN performed zeroing	44 (91)
RN performed leveling procedure	43 (89)
RN used carpenter's level during leveling	14 (29)
RN used zeroing stopcock as transducer leveling reference	41 (85)
RN used phlebostatic axis (PSA) as patient leveling reference	40 (83)
RN marked PSA or used PSA point already marked on patient	1 (2)
RN positioned patient in the supine position during measurement	43 (89)
RN positioned patient with HOB < 45°	46 (95)[2]
RN performed dynamic response assessment of system	8 (16)[2]
RN performed dynamic response assessment of system on paper	0 (0)[1]

Superscript numbers indicate missing observations for that criterion

Table 4-36

Description of Direct Arterial Blood Pressure Reliability/Validity Assessment By Criterion (N = 48 Providers)

CHECKAR Criterion	Criterion Met: n (%)
RN performed monitor calibration	48 (100)
RN performed transducer calibration	0 (0)
RN performed zeroing	48 (100)
RN performed leveling procedure	44 (92)
RN performed dynamic response assessment of system	14 (31)

Table 4-37

Description of Cuff Blood Pressure Reliability/Validity Assessment By Criterion (N= 38 Providers)

CHECKBP Criterion	Criterion Met: n (%)
Manual Cuff Blood Pressure Criterion (n = 13 Providers)	
Bladder width 40-50% of upper arm circumference	8 (62)
Bladder place snugly, centered over artery, arm without clothing	13 (100)
Bulb exhaust valve unobstructed	13 (100)
Cuff tubing without kinks or leaks	13 (100)
Mercury meniscus/aneroid manometer at RN eye-level	13 (100)
RN verified systolic pressure by palpation prior to auscultation	3 (23)
RN ensured patient's arm supported at heart level	13 (100)
RN used stethoscope bell	6 (46)
RN placed stethoscope bell lightly over brachial artery	11 (85)
RN used a 2-3 second rate of cuff deflation	13 (100)
RN assessed systolic, diastolic and muffling	6 (46)
Automatic Cuff Blood Pressure Criterion (n = 25 Providers)	
Bladder width 40-50% of upper arm circumference	19 (76)
Bladder place snugly, centered over artery, arm without clothing	19 (76)
Cuff tubing without kinks or leaks	25 (100)
RN ensured patient's arm supported at heart level	25 (100)

Table 4-38

Description of Hemodynamic Reliability/Validity Assessment Scores By Site: Sites at Which Greater Than 20% of Personnel Were Observed

Reliability/Validity Assessment Score	Site #1 M (SD) [n]	Site #8 M (SD) [n]	Site #9 M (SD) [n]	Site #11 M (SD) [n]	Site # 12 M (SD) [n]
CHECKPA: Pulmonary Artery Wedge Pressure	17.6 (2.6) [n = 16]	d	d	14.8 (2.6) [n =6]	17.0 (0.0) [n = 3]
CHECKPA: Pulmonary Artery Diastolic	a	9.1 (0.4) [n = 7]	7.5 (2.0) [n =10]	8.0 (2.7) [n = 4]	a
CHECKPA: Common Element Score	9.3 (2.6) [n = 16]	9.1 (0.4) [n = 7]	7.5 (2.0) [n =10]	7.8 (2.1) [n = 13][e]	8.7 (0.6) [n = 3]
CHECKAR: Direct Arterial Blood Pressure	3.4 (0.5) [n = 17]	3.6 (0.5) [n = 7]	2.7 (0.5) [n = 9]	3.4 (0.7) [n = 13]	3.5 (0.7) [n = 2]
CHECKBP: Manual Cuff Pressure Score	b	b	b	8.7 (1.3) [n = 11]	8.0 (1.4) [n = 2]
CHECKBP: Automatic Cuff Pressure Score	4 (0.0) [n = 8][c]	3.7 (0.5) [n = 7]	2.9 (0.9) [n = 9]	4.0 (0.0) [n = 1]	f

a = Site obtained and treated PAWP: reliability/validity assessment only done for PAWP
b = Site did not obtain manual cuff blood pressures
c = Site did not recheck automatic cuff pressure after initial pressure obtained on patient return from operating room
d = Site did not obtain PAWP measurement
e = Common element score included 3 CVP measurements: CABGS patients had no pulmonary artery catheter in place
f = Site did not obtain automatic cuff blood pressures

Data Analysis: Description of Hemodynamic Monitoring Measurement/Intervention Events

The hemodynamic measurement event of CABGS nurse leveling will be described by site, followed by discussion of CABGS nurse hemodynamic intervention events by site.

Hemodynamic measurement event: Leveling. CABGS nurses at the 5 DOD medical center case and control sites often did not re-level their patients hemodynamic systems after repositioning their patients. Percentages for repositioning without re-leveling are as follows: Site 1--50%, nurses did not re-level 9 of 18 patient repositionings witnessed; Site 8--71%, nurses re-leveled only 4 of the 14 patient repositionings witnessed; Site 9--72%, nurses did not re-level 13 of the 18 patient repositionings witnessed; Site 11--36%, nurses did not re-level 10 of the 28 patient repositionings witnessed; and Site 3--0%, nurses re-leveled with each of the 3 patient repositionings witnessed.

Hemodynamic intervention events: Manipulation of preload, afterload and contractility. Physician-directed CABGS nurse manipulation of preload, afterload and contractility differed by site. The majority of physician directed CABGS nurse interventions related to afterload reduction via titration of Nitroprusside at all case and control sites except Site 8 where the majority of interventions related to titration of Nitroglycerin. Manipulation of preload via Nitroglycerin and volume expanders (colloid, blood and crystalloid) were the next most performed interventions.

Degree of CABGS nurse independence in the performance of hemodynamic intervention events. Independence of CABGS nurse hemodynamic interventions ranged from 46% at Site 1 which has a cardiothoracic residency program to 71% at Site 8, a combined military/contract cardiothoracic program. Independence of nursing hemodynamic interventions is defined as CABGS nurse performance of an intervention under the direction of a physician via standing order or protocol without further physician direction or consultation. CABGS

nurse consultation with the physician before the performance of an intervention ranged from 4% at Site 8 to 34% at Site 9. Physician order of the preload, afterload or contractility modalities without consultation or notification occurred most frequently at Site 1 which is a cardiothoracic residency program site.

Table 4-39

Description of Hemodynamic Measurement-Intervention Events (N= 1511 Events)

Hemodynamic Measurement-Intervention Event	Site # 1 [n = 436 events in 10 patients] n (n performed independently* by RN)	Site # 8 [n = 242 events in 5 patients] n (n performed independently* by RN)	Site # 9 [n = 326 events in 7 patients] n (n performed independently* by RN)	Site # 11 [n = 423 events in 8 patients] n (n performed independently* by RN)	Site # 12 [n = 50 events in 1 patients] n (n performed independently* by RN)
Preload reduction					
Furosemide	0	2 (1)[1]	1-Drip (0)[0]	0	1 (1)[0]
Bumetanide	0	0	0	0	0
Nitroglycerin	17 (1)[4]	60 (51)[3]	13 (2)[1]	17 (4)[0]	5 (3)[0]
Preload augmentation					
Blood products:					
Cellsaver	2	0	0	0	1
Autotransfusion	0	5-Continuous	6	0	0
Packed red blood cells	7	0	0	9	0
Fresh frozen plasma	6	0	0	11	0
Platelets	3	0	0	3	0
Other volume expanders:					
Colloid	33 (6)[1]	19 (11)[4]	11 (0)[4]	16 (0)[1]	4 (1)[2]
Crystalloid	1 (1)[0]	0	1 (0)[1]	7 (1)[0]	1 (1)[0]

Table 4-39--continued

Afterload reduction					
Nitroprussi de	92 (78)[8]	14 (13)[1]	96 (87)[1]	154(123)[10]	11 (7)[0]
Afterload augmentation					
Epinephrine	11 (1)[4]	3 (0)[2]	0	0	0
Norepinephrine	2 (1)[0]	12 (9)[0]	0	0	0
Neosynephrine	0	0	0	0	0
Contractility augmentation					
Dobutamine	11 (4)[1]	12 (4)[0]	4 (0)[1]	8 (0)[4]	0
Dopamine	13 (4)[1]	2 (1)[0]	10 (1)[2]	7 (1)[1]	0
Amrinone	4 (0)[2]	0	0	4 (0)[3]	0
Control of heart rate/dysrythmias					
Esmolol	0	0	0	19 (11)[3]	0
Lidocaine	11 (2)[2]	1 (0)[0]	3-Bolus-(0)[2]	0	0
Procainamide	0	0	0	4 (0)[0]	0
Bretylium	1 (0)[0]	0	0	0	0
Pacemaker	18 (1)[6]	11 (7)[0]	2 (1)[1]	13 (1)[10]	1 (0)[0]
Total non-blood-product-related interventions described	214 (99)[29]	137 (97)[11]	141 (91)[13]	249 (141)[21]	23 (13)[2]

* Independently is defined as under the direction of a physician via standing order or protocol without further physician direction or consultation

Superscript numbers indicate number of intervention classifications missing for that intervention

Table 4-40

Dependence, Independence, Collaboration of Hemodynamic Intervention Events (N= 1511 Events)

Hemodynamic Measurement-Intervention Event	Site # 1 [n = 436 events in 10 patients]	Site # 8 [n = 242 events in 5 patients]	Site # 9 [n = 326 events in 7 patients]	Site # 11 [n = 423 events in 8 patients]	Site # 12 [n = 50 events in 1 patients]
	n (%)	n (%)	n (%)	n (%)	n (%)
RN performed intervention without MD consultation or notification	99 (46)	9 (71)	91 (64)	141 (57)	13 (57)
RN performed intervention after MD consultation	29 (14)	6 (4)	34 (24)	23 (9)	8 (35)
MD ordered without RN notification or consultation	57 (27)	18 (13)	3 (2)	47 (19)	0 (0)
RN performed intervention after consultation with another RN: no MD notification or consultation	0 (0)	4 (3)	0 (0)	0 (0)	0 (0)
RN performed intervention simultaneously with MD notification	0 (0)	1 (.7)	0 (0)	2 (.1)	0 (0)
Accidental intervention / change in therapy	0 (0)	0 (0)	0 (0)	4 (2)	0 (0)
MD performed intervention	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Description of event missing	29 (14)	11 (8)	13 (9)	32 (13)	2 (9)
Total number non-blood product related events	214	137	141	249	23

Description of the CABGS Clinical Care Processes: Phase IIC Chart Audit

Type I and Type II Error: Chart Audit Data Collection

Fourteen analyses of differences between the CABGS care provider processes of high and low crude and actual versus expected mortality medical centers were planned and performed. CABGS care provider processes analyzed were: hospital length of stay; post-CABGS length of stay; length of intensive care unit stay; length of time patient on bypass; length of time aorta cross-clamped; patient temperature on return from the operating room; length of time patient on vasoactive drips; length of time patient on oxygen therapy; length of time patient had pacer wires in place; and length of time the patient was intubated with the endotracheal tube, pulmonary artery catheter, arterial line, foley catheter and mediastinal tube(s). The α criterion was set at .0036 to evaluate the significance of each of these differences, bringing the family-wise error rate to .05. Sample sizes for each site were such that statistical power was not a problem for this phase of the study.

Reliability of the Chart Audit Instrument

Percentage agreement for the purposive sample of 5% (approximate) of the charts reviewed at each site for inter-rater reliability assessment was calculated by variable type--demographic and operative, pre-operative medication and severity of illness; care process, and outcome variables (Table 4-41). Percentage agreement for each variable type differed by site. Percentage agreement was less than 80% in only one instance--the audit of severity of illness variables at Site 11. Site 11 had the greatest number of charts to review in the three week period (136); the speed with which the chart audits had to be done to accomplish the chart audit at this site may have impacted on chart audit accuracy at this site.

Table 4-41

Percentage Agreement On Chart Audit Variable By Type

	Number of Charts Sampled	Demographic and Operating Room Variables % Agreement N = 19	Severity of Illness Variables % Agreement N = 39	Care Process and Outcome Variables % Agreement N = 49
Site #1	3	96.5%	98.3%	90.5%
Site #5	2	100%	94.9%	100%
Site #8	4	94.7%	87.2%	77.6%
Site #9	4	89.5%	92.3%	91.8%
Site #11	10	84.2%	74.4%	81.6%
Site #12	2	89.5%	82.1%	85.7%

Description of the Sample.

Patient records sampled in the chart audit. Due to discrepancies between the cases listed in the service database (October, 1994) and the facility log at Site 8, service database register number listings were supplemented with register numbers of CABGS cases from facility logs at all sites except Site 9 and 12--Site # 9 and site # 12 had already had their site visits completed). In all, 424 patient medical records were located out of the 433 medical records known to exist at the time of the chart audit. Table 4-42 is a listing of the actual number of cases listed in the service database, the number of cases in the log that were not in the database, the number of cases in the databases that were not in the log, and the number of cases/records located for each category. When compared to a June, 1995 RCMAS listing of CABGS cases, the total number of medical records in the case control subset was found to be

450. Site 12 had the largest number of missing records--13 (25%). Site 5 was the only site where all medical records for the timeframe were obtained.

Table 4-42

Number of Patient Records Possible and Number of Records Located

	Site # 1	Site # 5	Site # 8	Site #9	Site #11	Site # 12
Number of Cases: Service Database Listing October, 1994	61	21	67	83	133	40
Number of Cases: Medical Center Log	66	27	77	N/A	134	N/A
Number of Cases in Service Database Not in Log	1	1	0	N/A	5	N/A
Number of Cases in Log Not in Database	5	8	10	N/A	6	N/A
Total Number of Possible Cases	66	28	77	83	139	40
Total Number of Cases Found	65	27	74	82	136	40
Number of Cases Listed in RCMAS Database June, 1995	69	27	78	84	139	53

Demographics of the Total Sample of Case and Control Site Patients: Chart Audit Data.

The majority of chart audit patients were male (80%) and Caucasian (85%). The average age of the chart audit patient was 62.1. These demographics are similar to those

obtained from analysis of the discharge abstract demographic data for the total CABGS sample. Chart audit sample demographic data is contained in Table 4-43.

Severity of Illness of the Total Sample of Case and Control Site Patients: Chart Audit Data

Cursory comparison of severity of illness data obtained on chart audit (N= 424) and that obtained from the discharge data analysis for the case and control sub-sample (n = 450) reveals some notable differences. Sixty four transfer admissions were noted in the chart audit sample, while the discharge abstract sample for the same sites had only 23 transfers. Cerebrovascular disease was noted in 70 patients in the chart audit sample while 0 patients were noted to have cerebrovascular disease in the discharge abstract data case and control sub-sample. Other notable differences between the number of patients with severity of illness variables documented in the chart audit sample versus documented in the discharge abstract subset of case and control sites include hypercholesterolemia (252 versus 121); history of myocardial infarction (174 (recent and history) versus 90); obesity (249 versus 9); and repeat CABGS (47 versus 30). The greater incidence of severity of illness variables found in the case and control patient sample calls into question the reliability and validity of the discharge abstract data. More detailed analysis of the extent of differences between chart audit and discharge abstract severity of illness variables is beyond the scope of this investigation. Description of patient severity of illness in the chart audit case and control subset of patients is described in Table 4-44.

Outcomes of the Total Sample Of Case and Control Site Patients: Chart audit data

Outcome rates differed between the case and control site chart audit sample when compared to the outcome rates noted in the discharge abstract for those same sites. One less death was noted at Site 12; transfer rates were also discrepant with 11 transfers noted for sites

in the chart audit data while only 3 were noted in the discharge abstract for the case and control sites. Outcome data for the chart audit sample is presented in Table 4-45.

CABGS Care Provider Processes of the Total Sample of Case and Control Site Patients: Chart Audit Data

CABGS patient care intra-operative processes described included those known to impact on post-operative patient care: these include use of the internal mammary artery graft, the time patient was on cardiopulmonary bypass, the time the patient's aorta was cross-clamped, and the temperature the patient returned to the intensive care unit (ICU) from the operating room. Internal mammary grafts were used in 67% of CABGS patients. The mean cardiopulmonary bypass time was 110 minutes, mean aortic cross-clamp time was 60.6 minutes and mean patient temperature on admit to the ICU was 35.6 degrees Centigrade.

Post-operatively, 44% of patients received non-autologous blood transfusions: autotransfusion was utilized in 26% of the cases reviewed. Volume expanders were utilized in 70% of CABGS patients. Pulmonary artery catheters were used to monitor hemodynamics in 81% of patients. Nitroglycerin (84%), Nitroprusside (63%), and Dopamine (44%) were the most popular vasoactive drips used in the post-operative period. Lidocaine, used in 17% of CABGS patients, was the most utilized anti-dysrhythmic medication. Patients remained intubated post-operatively for an average of 21.6 hours. Vasoactive drips were used to treat patient hemodynamics for an average of 31.7 hours. On average patients' pulmonary artery catheters and mediastinal tubes were discontinued on post-operative day 2; arterial lines and foley catheters were discontinued on post-operative day 3 and oxygen and pacemaker wires were discontinued on post-operative day 5. Mean post-CABGS intensive care, post-procedure and total hospital lengths of stay were 67.6 hours, 9.2 days and 13.4 days, respectively.

Post-operative processes for the total chart audit sample are described in Table 4-46.

CABGS Care Provider Processes of Case and Control Site Patients, By Site: Chart Audit Data

Post-operative care processes differed markedly by site. Use of non-autologous blood transfusion ranged from 19% (Site 8) to 70% (Site 5). Autotransfusion was used in 0% of patient at Site 11, while Site 8 utilized autotransfusion in 97% of their CABGS patients. Volume expander usage in post-operative CABGS management ranged from 48% (Site 12) to 99% (Site 8). Pulmonary artery catheters were used to monitor over 90% of post-operative CABGS at all sites except Site 11, where pulmonary artery catheter usage was only 47%. Use of mechanical circulatory support for post-operative patient management ranged from 4% (Site 5) to 29% (Site 1). Use of vasoactive medications also differed markedly by site. The most marked discrepancies were in the use of Nitroglycerin and Nitroprusside; Nitroglycerin use ranged from 33% (Site 12) to 99% (Site 9) while Nitroprusside use ranged from 28% (Site 12) to 90% (Site 9).

Bypass time ranged from 94 minutes (Site 11) to 150 minutes (Site 1); cross-clamp time ranged from 47 minutes (Site 9) to 76 minutes (Site 1). Mean time to patient extubation ranged from 15 hours (Site 11) to 43 hours (Site 5). Patient vasoactive drips were titrated off earliest at Site 11 (21 hours), while patient remained on vasoactive intravenous medications the longest at Site 1 (54 hours). Length of intensive care unit stay ranged from 55 hours (Site 11) to 172 hours (Site 5). Post-procedure length of stay ranged from 7 days (Site 8) to 17 days (Site 5). Total hospital length of stay ranged from 10 days (Site 8) to 26 days (Site 5). Pulmonary artery catheters were discontinued on post-operative day 1 at all sites except Site 5, where they were discontinued on day 2. Arterial lines (day 4), foley catheters (day 9), pacing wires (day 6) and oxygen (day 10) were all discontinued latest at Site 5. Site 11 discontinued

arterial lines (day 1), mediastinal tubes (day 1), foley catheters (day 2) and pacer wires (day 4) earliest.

CABGS intra-operative and post-operative process descriptions by site are contained in Table 4-47.

Differences Between CABGS Care Provider Processes at High and Low Crude Mortality and High and Low Risk-Adjusted Mortality DOD Medical Centers: Chart Audit Data

Differences between CABGS care provider processes at high and low crude mortality and high and low risk-adjusted mortality DOD medical centers will be discussed with all such differences at the conclusion of Chapter IV.

Table 4-43

Demographic Characteristics of the 1 January Through 30 June 1994 CABGS Cases: Chart Audit Data (N = 424)

Variable	n (%)
Sex	
Female	85 (20.0)
Male	339 (80.0)
Race	
Caucasian	361 (85.1)
Black	24 (5.7)
Hispanic	17 (4.0)
Oriental/Asian	9 (2.1)
Filipino	9 (2.1)
Pacific Islands	2 (0.5)
Pakistani/East Indian	1 (0.2)
Missing	1 (0.2)
Source of Admission	
Direct From ER	117 (27.6)
Direct From Other Than ER	227 (53.5)
Transfer	55 (13.0)
Air Evac: Transfer	9 (2.1)
Air Evac: Non-Transfer/Referral	12 (2.8)
Missing	4 (0.9)
Concurrent Procedure: Operative Report	
None	361 (85.1)
Aortic Valve Replacement	11 (2.6)
Mitral Valve Replacement	9 (2.1)
Aneurysmectomy	2 (0.5)
Carotid Endarterectomy	3 (0.7)
Coronary Endarterectomy	5 (1.2)
Aortic Dissection Repair	3 (0.7)
IABP Insertion	17 (4.0)
Other	11 (2.6)
Missing	2 (0.5)
	M (SD)
Age (years)	62.1 (9.6)

Table 4-44

Frequency of Severity of Illness Variables For 1 January through 30 June 1994 DOD CABGS Cases: Chart Audit Data (N = 424)

Variable	n (%)	Missing Observations n (%)
Admission, Emergency	117 (27.6)	4 (0.9)
Admission, Transfer	64 (15.1)	4 (0.9)
Angina, Unstable	267 (63.0)	1 (0.2)
Cardiogenic Shock	21 (5.0)	4 (0.9)
Cardiomegaly	66 (15.6)	55 (13.0)
Cerebrovascular Disease	70 (16.5)	2 (0.5)
History of Cerebrovascular Accident	25 (5.9)	2 (0.5)
Congestive Heart Failure	73 (17.2)	2 (0.5)
COPD	43 (10.1)	1 (0.2)
Chronic Liver Failure	1 (0.2)	1 (0.2)
Chronic Renal Failure	1 (0.2)	1 (0.2)
Chest X-ray, Infiltrates	25 (5.9)	85 (20.1)
Chest X-ray, Congestive Heart Failure	47 (11.1)	90 (21.2)
Diabetes Mellitus	124 (29.3)	1 (0.2)
Diabetic On Insulin Therapy	38 (9.0)	–
Emergency Operation	109 (25.7)	1 (0.2)
Hypercholesterolemia	252 (59.4)	2 (0.5)
Hypertension	308 (72.6)	1 (0.2)
Myocardial Infarction, Acute (< 6 weeks)	97 (2.9)	2 (0.5)
Myocardial Infarction, History of (> 6 months)	147 (34.7)	1 (0.2)
Myocardial Infraction, Recent (< 6 months)	27 (6.4)	1 (0.2)
Obesity	249 (58.7)	-
PTCA, Prior to CABGS (This or Past Admit)	84 (19.8)	1 (0.2)
Pre-operative Antiplatelet Use	275 (64.9)	1 (0.2)
Pre-Operative Steroid Use	8 (1.9)	1 (0.2)
Peripheral Vascular Disease	82 (19.3)	2 (0.5)
Pre-operative IABP	45 (10.6)	1 (0.2)
Previous Heart Surgery	48 (11.3)	1 (0.2)
Previous Vascular Surgery	36 (8.5)	1 (0.2)

Table 4-44--continued

Rales on Admit History	63 (14.9)	2 (0.5)
Redo CABGS	47 (11.1)	1 (0.2)
Sex, Female	85 (20.1)	0 (0.0)
Valve Disease, Aortic	29 (6.8)	3 (0.7)
Valve Disease, Mitral	92 (21.7)	2 (0.5)
Ventricular Aneurysm	8 (1.9)	4 (0.9)
Race		
Caucasian	361 (85.1)	1 (0.2)
Black	24 (5.7)	
Hispanic	17 (4.0)	
Oriental/Asian	9 (2.1)	
Filipino	9 (2.1)	
Pacific Islands	2 (0.5)	
Pakistani/East Indian	1 (0.2)	

	M (SD)	Missing Observations n (%)
Age (years)	62.1 (9.6)	1 (0.2)
Clinical Severity Score	3.4 (3.6)	97 (22.9)
Extent of coronary artery disease (number of diseased vessels)	2.7 (0.6)	4 (0.9)
Height (inches)	68.2 (14.5)	5 (1.2)
Left main, percent blockage	20.2 (31.2)	3 (0.7)
Left ventricular ejection fraction (%)	54.5 (14.4)	24 (5.7)
Number of medications	4.3 (2.5)	-
Number of cardiac medications	2.5 (1.3)	-
Pre-operative hematocrit	39.8 (4.9)	4 (0.9)
Pre-operative blood urea nitrogen	17 (5.8)	5 (1.2)
Pre-operative creatinine	1.2 (0.5)	5 (1.2)
Pre-operative heart rate	69.8 (14.6)	2 (0.5)
Pre-operative systolic blood pressure	132 (19.3)	2 (0.5)
Pre-operative diastolic blood pressure	71.3 (11.3)	2 (0.5)
Pre-operative weight (kilograms)	83.6 (16.1)	3 (0.7)

- = Transformed data had missing values changed to 0s.

Table 4-45

1 January through 30 June 1994 DOD CABGS Processes: Chart Audit Data (N = 424)

Process	n (%)	Missing Observations n (%)
Use of Internal Mammary Artery		
Yes, Single	280 (66.0)	1 (0.2)
Yes, Double	6 (1.4)	
Use of Autotransfusion Post-Operatively	112 (26.4)	7 (1.7)
Use of Blood Products Intra- and Post-Operatively		
Packed Red Blood Cells	187 (44.1)	7 (1.7)
Fresh Frozen Plasma	87 (20.5)	6 (1.4)
Platelets	110 (25.9)	6 (1.4)
Other	20 (4.7)	7 (1.7)
Use of Volume Expanders	295 (69.5)	14 (3.3)
Pulmonary Artery Catheter Placed Peri-Operatively	343 (81.0)	11 (2.6)
Patient On Mechanical Circulatory Support Post-operatively	61 (14.4)	8 (1.9)
Pacer Utilized Post-operatively	187 (44.1)	86 (20.3)[b]
Use of Vasoactive Drips		
Dobutamine	87 (20.8)	6 (1.4)
Dopamine	182 (43.7)	7 (1.7)
Esmolol	10 (2.4)	7 (1.7)
Epinephrine	32 (7.7)	7 (1.7)
Amrinone	31 (7.4)	7 (1.7)
Norepinephrine	53 (12.7)	7 (1.7)
Neosynephrine	115 (27.6)	7 (1.7)
Sodium Nitroprusside	264 (63.3)	7 (1.7)
Nitroglycerin	350 (83.9)	7 (1.7)
Use of Anti-dysrhythmics		
Lidocaine	69 (16.6)	7 (1.7)
Procainamide	20 (4.8)	
Lidocaine and Procainamide	12 (2.9)	
Lidocaine and Bretylium	3 (0.7)	

Process/Outcome	M (SD)	Missing Observations n (%)
Bypass time (minutes)	110.2 (47.9)	3 (0.7)
Cross clamp time (minutes)	60.6 (31.9)	5 (1.2)
Patient temperature on admit to ICU (degrees Centigrade)	35.6 (0 7)	12 (2.8)
Length of time intubated (hours)	21.6 (31.6)	11 (2.6)
Length of time on vasoactive drips (hours)	31.7 (35.0)	23 (5.4)
Length of intensive care unit stay (hours)	67.6 (108.8)	21(5.0)
Hospital length of stay (date of discharge - date of admit)	13.4 (10.8)	2 (0.5)
Post-CABGS length of stay (date of discharge - date of surgery)	9.2 (9.6)	3 (0.7)
Length of time pulmonary artery catheter in place (days) (of 343 patients who had device in place)	1.4 (1.2)	14 (3.3)
Length of time arterial line in place (days)	2.4 (2.5)	18 (4.2)
Length of time mediastinal tubes in place (days)	1.7 (0.8)	14 (3.3)
Length of time foley catheter in place (days)	2.9 (5.2)	23 (5.4)
Length of time pacing wires in place (days)	5.0 (2.4)	27 (6.4)
Length of time patient on oxygen (days)	5.5 (4.8)	37 (8.7)

a = Missing observations related either to poor documentation in chart or chart auditor error.

b = Missing observation for pacer use category related to chart audit data collection form error at Site 8.

Table 4-46

1 January through 30 June 1994 DOD CABGS Outcomes: Chart Audit Data (N = 424)

Outcome	n %	Missing Observations n (%)
Discharge Status		
Home	396 (93.4)	1 (0.2)
Death	16 (3.8)	
Transfer to Other Health Care Institution	11 (2.6)	
Process/Outcome	**M (SD)**	
Hospital Length of Stay	13.4 (10.8)	2 (0.5)
Post-CABGS Length of Stay	9.2 (9.6)	3 (0.7)

Table 4-47

Description of Processes of the 1 January Through 30 June 1994 CABGS Cases By Case and Control Site: Chart Audit Data (N = 424)

Variable	Site 1* n % N=65	Site 5 n % N=27	Site 8 n % N=74	Site 9 n % N=82	Site 11 n % N=136	Site 12* n % N=40
Use of Internal Mammary Artery						
Yes, Single	39 (60)[0]	21 (78)[1]	59 (80)[0]	49 (60)[0]	77 (57)[0]	35 (88)[0]
Yes, Double	0	0	1 (1)	1 (1)[0]	4 (3)	0
Use of Autotransfusion Post-Operatively	22 (34)[3]	1 (4)[1]	72 (97)[0]	11 (13)[1]	0[1]	6 (15)[0]
Use of Blood Products Intra- and Post-Operatively						
Packed Red Blood Cells	41 (63)[3]	19 (70)[1]	14 (19)[0]	30 (40)[0]	61 (45)[2]	19 (48)[1]
Fresh Frozen Plasma	21 (32)[3]	9 (33)[1]	6 (8.1)[0]	4 (5)[0]	34 (25)[1]	13 (33)[1]
Platelets	26 (40)[3]	9 (33)[1]	13 (18)[0]	12 (15)[0]	42 (31)[1]	8 (20)[1]
Other	7 (11)[3]	0[1]	3 (4)[0]	1 (1)[0]	8 (6)[2]	1 (3)[1]
Use of Volume Expanders	36 (55)[5]	24 (89)[1]	73 (99)[0]	77 (94)[4]	66 (49)[3]	19 (48)[1]
Pulmonary Artery Catheter Placed Peri-Operatively	59 (91)[6]	26 (96)[1]	73 (99)[0]	82 (100)[0]	64 (47)[3]	39 (98)[1]
Patient On Mechanical Circulatory Support Post-operatively	19 (29)[3]	1 (4)[1]	5 (7)[0]	14 (17)[0]	20 (15)[3]	3 (8)[1]

Table 4-47--continued

Pacer Used Post-operatively	19 (29)[3]	10 (37)[1]	53 (72)[2]	8 (10)[73]	83 (61)[6]	14 (35)[1]
Use of Vasoactive Drips						
Dobutamine	22 (34)[3]	3 (11)[1]	1 (1)[0]	29 (35)[0]	22 (16)[2]	10 (25)[0]
Dopamine	42 (65)[3]	12 (44)[1]	30 (41)[0]	47 (57)[0]	27 (20)[2]	24 (60)[1]
Esmolol	3 (5)[3]	7 (26)[1]	0[0]	0[0]	0[2]	0[1]
Epinephrine	9 (14)[3]	3 (11)[1]	1 (1)[0]	4 (5)[0]	6 (4)[2]	9 (23)[1]
Amrinone	7 (11)[3]	4 (15)[1]	0[0]	10 (12)[0]	7 (5)[2]	3 (8)[1]
Norepinephrine	6 (9)[3]	2 (7)[1]	36 (49)[0]	3 (4)[0]	6 (4)[2]	0[1]
Neosynephrine	12 (18)[3]	5 (19)[1]	0[0]	10 (12)[0]	77 (57)[2]	11 (28)[1]
Nitroprussi de	46 (71)[3]	13 (48)[1]	29 (39)[0]	74 (90)[0]	91 (67)[2]	11 (28)[1]
Nitroglycerin	57 (88)[3]	24 (89)[1]	69 (92)[0]	81 (99)[0]	107 (79)[2]	13 (33)[1]
Use of Anti-dysrhythmics						
Lidocaine	18 (28)[3]	1 (4)[1]	1 (1)[0]	6 (7)[0]	86 (63)[2]	9 (23)[1]
Procainamide	5 (8)	5 (19)	0	3 (4)	6 (4)	1 (3)
Lidocaine and Procainamide	1 (2)	1 (4)	0	1 (1)	7 (5)	1 (3)
Lidocaine and Bretylium	1 (2)	1 (4)	0	1 (1)	1 (1)	0

Table 4-45--continued

	M(SD)	M (SD)	M(SD)	M(SD)	M(SD)	M(SD)
Bypass time (minutes)	150 (54)[1]	124 (38)[1]	105 (38)[0]	99 (44)[1]	94 (45)[0]	124 (34)[0]
Cross clamp time (minutes)	76 (28)[2]	62 (23)[1]	50 (27)[0]	47 (24)[2]	56 (32)[0]	97 (28)[0]
Patient temperature on admit to ICU (degrees Centigrade)	36.0 (.9)[5]	36.0 (.6)[1]	35.7 (.7)[0]	35.8 (.8)[1]	35.4 (.7)[4]	35.3 (.6)[1]
Length of time intubated (hours)	25 (26)[6]	43 (62)[2]	20 (16)[2]	25 (52)[4]	15 (9)[6]	22 (17)[1]
Length of time on vasoactive drips (hours)	54 (42)[7]	50 (46)[3]	22 (16)[1]	36 (51)[6]	21 (15)[4]	32 (32)[2]
Length of intensive care unit stay (hours)	76 (123)[7]	172(293)[4]	60 (61)[2]	63 (68)[3]	55 (90)[4]	60 (36)[1]
Hospital length of stay (date of discharge - date of admit)	15 (10)[0]	26 (21)[1]	10 (5)[0]	11 (8)[0]	13 (11)[1]	14 (8)[0]
Post-CABGS length of stay (date of discharge - date of surgery)	10 (8)[1]	17 (20)[1]	7 (4)[0]	8 (8)[0]	8 (10)[1]	11 (7)[0]
Length of time pulmonary artery catheter in place (days) (of 343 patients who had device in place)	1.4 (1.0)[6]	2.3 (2.2)[1]	1.2 (0.7)[1]	1.6 (1.3)[3]	1.2 (0.5)[3]	1.6 (1.3)[1]
Length of time arterial line in place (days)	2.8 (3.3)[7]	4.8 (7.0)[2]	2.3 (1.2)[0]	2.3 (1.8)[3]	1.9 (0.9)[5]	2.3 (1.5)[1]
Length of time mediastinal tubes in place (days)	2.1 (0.9)[7]	2.0 (0.7)[1]	1.9 (0.8)[0]	1.8(0.9)[3]	1.3 (0.5)[2]	1.6 (0.7)[1]
Length of time foley catheter in place (days)	3.4 (5.2)[7]	9.1 (18)[3]	2.3(0.8)[1]	2.6 (2.4)[4]	2.2 (1.8)[7]	2.9 (2.0)[1]
Length of time pacing wires in place (days)	6.4 (2.9)[10]	6.8 (4.5)[2]	4.4 (0.9)[0]	5.6 (3.3)[5]	4.2 (1.0)[6]	4.9 (1.3)[4]
Length of time patient on oxygen (days)	5 (5)[10]	10 (14)[5]	4.6 (3.5)[1]	5.5 (3.1)[3]	4.9 (2.2)[16]	6.1 (4.9)[2]

Number of missing observations associated with that parameter indicated in superscript
* = Case (high mortality) site

Analysis of Differences Between DOD Medical Centers With Higher Versus Lower Crude and Risk-Adjusted Mortality

Analysis of Differences Between Providers: High and Low Crude Mortality Medical Center Providers

Differences between CABGS nurse provider hemodynamic knowledge, CABGS nurse collaboration process assessment, and CABGS nurse and CABGS assist personnel hemodynamic practices at high and low crude mortality DOD medical centers were evaluated using independent t- tests. CABGS provider post-operative care process differences at high and low crude mortality DOD medical centers were also evaluated using independent t-tests. A high crude mortality medical center was defined as having a mortality of greater than or equal to 4.7% for CABGS identified by ICD-9-CM procedure codes for the 1 January through 30 June 1994 timeframe (RCMAS-OSE, June 1995): Sites 1, 3, 6 and 12 met this criteria. A low crude mortality medical center was defined as having a mortality of less than or equal to 2.4% for CABGS identified by ICD-9-CM procedure codes for the 1 January through 30 June 1994 timeframe (RCMAS-OSE, June 1995): Sites 2, 4, 7, 8, 10, and 11 met this criteria.

Differences in CABGS Nurse Provider Knowledge

CABGS nurses at sites with lower crude mortality were hypothesized to have higher BPDQ and PACKAT scores than the CABGS nurses at the higher crude mortality sites, therefore a t statistic with a one-tailed p value less than .025 (.05/2) would demonstrate a significant difference. No difference between BPDQ scores of CABGS nurses working at high and low crude mortality DOD medical centers was noted by t-test; there was inadequate statistical power to determine any difference. A difference between PACKAT scores of

CABGS nurses working at high crude mortality (≥ 4.7%) and CABGS nurses working at low crude mortality (≤ 2.4%) DOD medical centers was demonstrated by independent t-test (α = .025, one-tailed). Results of the evaluation of differences between BPDQ and PACKAT scores for CABGS nurse providers working at high and low crude mortality DOD medical centers are described in Table 4-48.

Table 4-48

Comparison of PACKAT and BPDQ Scores For CABGS Nurse Providers of DOD CABGS Units With Higher Crude Mortality [a] and DOD CABGS Units With Lower Crude Mortality [b]

Score	n	M (SD)	t	df	p
BPDQ					
High mortality (≥ 4.7%)[a]	18	18.7 (2.2)	-0.59	33	.294[c]
Low mortality (≤ 2.4%)[b]	22	19.5 (5.0)			
PACKAT					
High mortality (≥ 4.7%)	18	30.2 (6.6)	-2.41	33	.013[d]
Low mortality (≤ 2.4%)	22	36.0 (8.4)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10 and 11
c = p - value is one tailed and based on separate variances
d = p - value is one tailed and based on pooled variances

Differences in CABGS Nurse Provider Organizational Assessment

Differences between collaboration-related Nurse Questionnaire sub-scale scores of CABGS nurse providers at high crude mortality and low crude mortality DOD medical centers were evaluated using independent t- tests. The collaboration-related sub-scales were the between-group communication openness, accuracy, problem-solving and conflict avoiding sub-scales of the Nurse Questionnaire. CABGS nurse at sites with higher crude mortality were hypothesized to have lower collaboration-related sub-scale scores than CABGS nurses at the

lower crude mortality sites, therefore a t statistic with a one-tailed p value less than .0125 (.05/4) would demonstrate a significant difference. No difference between any collaboration-related sub-scale score of CABGS nurses working at high and low crude mortality DOD medical centers was noted by t-test (Table 4-49); there was inadequate power to determine any difference.

Table 4-49

Comparison of Nurse Physician Questionnaire Collaboration-Related Sub-scale Scores For CABGS Nurse Providers of DOD CABGS Units With Higher Crude Mortality[a] and DOD CABGS Units With Lower Crude Mortality[b]

Between-Group Sub-scale	n	M (SD)	t	df	p[c]
Communication openness					
High mortality (≥ 4.7%)[a]	18	16.1 (2.1)	-1.30	38	.101
Low mortality (≤ 2.4%)[b]	22	17.0 (2.0)			
Communication accuracy					
High mortality (≥ 4.7%)[a]	18	8.9 (2.4)	-0.73	38	.239
Low mortality (≤ 2.4%)[b]	22	9.5 (2.9)			
Problem-solving					
High mortality (≥ 4.7%)[a]	18	12.1 (3.1)	-1.52	37	.065
Low mortality (≤ 2.4%)[b]	22	13.5 (2.4)			
Conflict-avoiding					
High mortality (≥ 4.7%)[a]	18	11.3 (2.3)	-0.71	38	.234
Low mortality (≤ 2.4%)[b]	22	11.7 (1.6)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10 and 11
c = p - values are one-tailed and based on pooled variances.

Differences in CABGS Nurse and CABGS Assist Hemodynamic Measurement Reliability /Validity Assessment Processes

Differences between hemodynamic measurement reliability/validity assessment processes of CABGS nurse and CABGS assist personnel at DOD medical center with high and low crude mortality were evaluated using independent t-tests. Differences between CABGS nurse and CABGS assist personnel total scores on the Arterial Blood Pressure Checklist and the Manual/Automatic Cuff Pressure Checklist, and the common element score of the Pulmonary Artery Pressure Checklist at medical centers with higher and lower crude mortality were analyzed. Hemodynamic reliability/validity assessment checklist scores were hypothesized to be higher for CABGS nurse and CABGS assist personnel at DOD medical centers with lower crude mortality. There were no significant differences noted between CABGS nurse and CABGS assist personnel hemodynamic measurement reliability/validity assessment scores at high and low crude mortality medical centers (α = .0125 (.05/4) (Table 4-50). There was inadequate power to determine a difference if it existed.

Table 4-50

Comparison of DQD CABGS Units With Higher Crude Mortality[a] and DQD CABGS Units With Lower Crude Mortality[b]: Hemodynamic Measurement Reliability/Validity Assessment Scores of CABGS Nurses and Assist Personnel

Between-Group Sub-scale	n	M (SD)	t	df	p
Pulmonary Artery Checklist Common Element Score					
High mortality (≥ 4.7%)[a]	19	9.2 (2.4)	1.01	28	.161[c]
Low mortality (≤ 2.4%)[b]	20	8.6 (1.3)			
Arterial Blood Pressure Checklist Score					
High mortality (≥ 4.7%)[a]	19	3.4 (0.5)	- 0.46	37	.324[d]
Low mortality (≤ 2.4%)[b]	20	3.4 (0.6)			
Manual Blood Pressure Checklist Score					
High mortality (≥ 4.7%)[a]	8	4.0 (0.0)	1.53	7	.171[c]
Low mortality (≤ 2.4%)[b]	8	3.8 (0.5)			
Automatic Blood Pressure Checklist Score					
High mortality (≥ 4.7%)[a]	2	8.0 (1.4)	-0.70	11	.499[d]
Low mortality (≤ 2.4%)[b]	11	8.7 (1.4)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10 and 11
c = p - values is one-tailed and based on separate variances
d = p - values is one-tailed and based on pooled variances

Differences in CABGS Care Provider Processes

Differences between process times at high crude mortality and low crude mortality medical centers were evaluated using independent t-tests. Care processes analyzed for differences were: the intra-operative provider processes of cardiopulmonary bypass and aortic cross-clamp time (because of their known impact on post-operative outcome); the post-operative provider processes of intensive care, post-procedure and hospital lengths of stay; and the post-operative provider processes of length of time patient utilized the following therapeutic devices or therapies--endotracheal tube, pulmonary artery catheter, arterial line, mediastinal tube, pacer wires, foley catheter, and oxygen. CABGS processes at high crude mortality medical center were hypothesized to be of greater length (slower) than CABGS care provider processes at low crude mortality medical centers. Low crude mortality DOD medical centers had significantly ($p < .003$ (.05/13) shorter CABGS care process times for the following; cardiopulmonary bypass ($p = .000$); aortic cross-clamp ($p = .000$); endotracheal intubation ($p = .000$); vasoactive drips ($p = .000$); mediastinal tube(s) ($p = .001$); and pacer wires ($p = .000$). Results of the CABGS care process analyses are described in Table 4-51 (intra-operative processes), Table 4-52 (post-operative length of stay processes), and Table 4-53 (post-operative therapeutic device/therapy processes).

Table 4-51

Comparison of CABGS Providers Intra-Operative Processes of DOD CABGS Units With Higher Crude Mortality[a] and DOD CABGS Units With Lower Crude Mortality[b]

Between-Group Sub-scale	n	M (SD)	t	df	p[c]
Cardiopulmonary Bypass Time					
High mortality (≥ 4.7%)[a]	104	140.1 (49.1)	7.41	312	.000
Low mortality (≤ 2.4%)[b]	210	98.19 (42.9)			
Aortic Cross-Clamp Time					
High mortality (≥ 4.7%)[a]	103	84.2 (29.8)	8.32	311	.000
Low mortality (≤ 2.4%)[b]	210	54.1 (30.5)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10 and 11
c = p - values are one-tailed and based on pooled variances.

Table 4-52

Comparison of CABGS Providers Post-Operative Processes of DOD CABGS Units With Higher Crude Mortality[a] and DOD CABGS Units With Lower Crude Mortality[b]: Length of Stay (LOS) Processes

Between-Group Sub-scale	n	M (SD)	t	df	p
Intensive Care LOS					
High mortality (≥ 4.7%)[a]	97	69.8 (97.7)	1.15	160	.125[c]
Low mortality (≤ 2.4%)[b]	204	56.7 (80.6)			
Post-CABGS Procedure LOS					
High mortality (≥ 4.7%)[a]	104	10.4 (7.8)	2.44	311	.008[d]
Low mortality (≤ 2.4%)[b]	209	8.0 (8.6)			
Hospital LOS					
High mortality (≥ 4.7%)[a]	105	14.7 (9.4)	2.48	312	.007[d]
Low mortality (≤ 2.4%)[b]	209	11.9 (9.5)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10, and 11
c = p - value is one-tailed and based on separate variances
d = p - value is one-tailed and based on pooled variances

Table 4-53

Comparison of CABGS Providers Post-Operative Processes of DOD CABGS Units With Higher Crude Mortality[a] and DOD CABGS Units With Lower Crude Mortality[b]: Processes Related to Length of Time Therapeutic Device/Therapy Utilized

Between-Group Sub-scale	n	M (SD)	t	df	p
Endotracheal Tube					
High mortality (≥ 4.7%)[a]	98	23.8 (22.9)	3.00	124	.002[c]
Low mortality (≤ 2.4%)[b]	202	16.4 (12.1)			
Pulmonary Catheter					
High mortality (≥ 4.7%)[a]	98	1.5 (1.1)	2.52	140	.006[c]
Low mortality (≤ 2.4%)[b]	138	1.2 (0.6)			
Arterial Line					
High mortality (≥ 4.7%)[a]	97	2.6 (2.7)	2.18	110	.016[c]
Low mortality (≤ 2.4%)[b]	205	2.0 (1.0)			
Vasoactive Drips					
High mortality (≥ 4.7%)[a]	96	45.2 (40.1)	5.59	108	.000[c]
Low mortality (≤ 2.4%)[b]	205	21.6 (15.2)			
Mediastinal Tubes					
High mortality (≥ 4.7%)[a]	97	1.9 (0.9)	3.58	303	.000[d]
Low mortality (≤ 2.4%)[b]	208	1.5 (0.7)			
Pacer Wires					
High mortality (≥ 4.7%)[a]	91	5.8 (2.5)	5.73	102	.000[c]
Low mortality (≤ 2.4%)[b]	204	4.2 (1.0)			
Foley Catheter					
High mortality (≥ 4.7%)[a]	97	3.2 (4.3)	2.21	108	.015[c]
Low mortality (≤ 2.4%)[b]	202	2.2 (1.5)			
Oxygen					
High mortality (≥ 4.7%)[a]	93	5.7 (4.8)	1.71	122	.045[C]
Low mortality (≤ 2.4%)[b]	193	4.8 (2.8)			

a = Sites meeting the ≥ 4.7% mortality criteria are Sites 1, 3, 6 and 12
b = Sites meeting the ≤ 2.4% mortality criteria are Sites 2, 4, 7, 8, 10 and 11
c = p - values is one-tailed and based on separate variances
d = p - values is one-tailed and based on pooled variances.

Analysis of Differences Between Providers:

High and Low Risk-Adjusted Mortality Medical Center Providers

Differences between CABGS nurse provider hemodynamic knowledge, CABGS nurse collaboration process assessment, and CABGS nurse and CABGS assist hemodynamic practices at higher and lower actual versus expected or risk-adjusted mortality DOD medical centers were evaluated using independent t- tests. CABGS provider post-operative care process differences at higher and lower risk-adjusted mortality DOD medical centers were also evaluated using independent t-tests. A higher risk-adjusted mortality medical center was defined as having a risk-adjusted mortality of greater than or equal to .115 for CABGS identified by ICD-9-CM procedure codes for the 1 January through 30 June 1994 timeframe (RCMAS-OSE, June 1995): Sites 1, 3, 5, 6 and 12 met this criteria. A lower risk-adjusted mortality medical center was defined as having a mortality of less than or equal to .086 for CABGS identified by ICD-9-CM procedure codes for the 1 January through 30 June 1994 timeframe (RCMAS-OSE, June 1995): Sites 2, 4, 7, 8, 9, 10, and 11 met this criteria.

Differences in CABGS Nurse Provider Knowledge

CABGS nurses at sites with lower risk-adjusted mortality were hypothesized to have higher BPDQ and PACKAT scores than CABGS nurses at the higher risk-adjusted mortality sites, therefore a t statistic with a one-tailed p value less than .025 (.05/2) would demonstrate a significant difference. No difference between BPDQ scores of CABGS nurses working at higher and lower risk-adjusted mortality DOD medical centers was noted by t-test; there was inadequate power to determine any difference. A difference between PACKAT scores of CABGS nurses working at higher risk-adjusted mortality and CABGS nurses working at low risk-adjusted mortality DOD medical centers was demonstrated by independent t-test (α =

.025, one-tailed). Results of the evaluation of differences between BPDQ and PACKAT scores for CABGS nurse providers working at high and low risk-adjusted mortality DOD medical centers are described in Table 4-54.

Table 4-54

Comparison of PACKAT and BPDQ Scores For CABGS Nurse Providers of DOD CABGS Units With Higher Risk-Adjusted Mortality [a] and DOD CABGS Units With Lower Risk-Adjusted Mortality [b]

Score	n	M (SD)	t	df	p[c]
BPDQ					
High mortality (≥ .115)[a]	19	18.2 (3.1)	-0.38	50	.366
Low mortality (≤ .086)[b]	33	18.6 (4.4)			
PACKAT					
High mortality (≥ .115)	19	30.1 (6.4)	-2.71	50	.004
Low mortality (≤ .086)	33	36.0 (8.2)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9, 10, and 11
c = p - value is one tailed and based on separate variances

Differences in CABGS Nurse Provider Organizational Assessment

Differences between collaboration-related Nurse Questionnaire sub-scale scores of CABGS nurse providers at higher mortality and lower risk-adjusted mortality DOD medical centers were evaluated using independent t- tests. The collaboration-related sub-scales were the between-group communication openness, accuracy, problem-solving and conflict avoiding sub-scales of the Nurse Questionnaire. CABGS nurses at sites with higher risk-adjusted mortality were hypothesized to have lower collaboration-related sub-scale scores than the CABGS nurses at the site with lower risk-adjusted mortality, therefore a t statistic with a one-tailed p value less than .0125 (.05/4) would demonstrate a significant difference. No

difference between any collaboration-related sub-scale score of CABGS nurses working at higher and lower risk-adjusted mortality DOD medical centers was noted by t-test (Table 4-55); there was inadequate power to determine any difference.

Table 4-55

Comparison of Nurse Physician Questionnaire Collaboration-Related Sub-scale Scores For CABGS Nurse Providers of DOD CABGS Units With Higher Risk-Adjusted Mortality[a] and DOD CABGS Units With Lower Risk-Adjusted Mortality[b]

Between-Group Sub-scale	n	M (SD)	t	df	p[c]
Communication openness					
High mortality (≥ .115)[a]	19	16.3 (2.2)	-1.14	51	.131
Low mortality (≤ .086)[b]	34	17.1 (2.3)			
Communication accuracy					
High mortality (≥ .115)[a]	19	8.9 (2.4)	-1.08	51	.143
Low mortality (≤ .086)[b]	34	9.7 (2.6)			
Problem-solving					
High mortality (≥ .115)[a]	19	11.9 (3.1)	-1.83	50	.037
Low mortality (≤ .086)[b]	33	13.4 (2.5)			
Conflict-avoiding					
High mortality (≥ .115)[a]	19	11.1 (2.4)	-0.94	51	.177
Low mortality (≤ .086)[b]	34	11.6 (1.6)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9, 10 and 11
c = p - values are one-tailed and based on pooled variances.

Differences in CABGS Nurse and CABGS Assist Hemodynamic Measurement Reliability /Validity Assessment Processes

Differences between hemodynamic measurement reliability/validity assessment processes of CABGS nurse and CABGS assist personnel at medical centers with higher and lower risk-adjusted mortality were evaluated using independent t-tests. Differences of CABGS nurse and CABGS assist personnel total scores on the Arterial Blood Pressure Checklist and the Manual/Automatic Cuff Pressure Checklist, and the common element score of the Pulmonary Artery Pressure Checklist at medical center with higher and lower risk-adjusted mortality were analyzed. Hemodynamic reliability/validity assessment checklist scores were hypothesized to be higher for CABGS nurse and CABGS assist personnel at DOD medical centers with lower risk-adjusted mortality. One significant difference was found, however that difference was in the opposite direction from that hypothesized; CABGS nurse and CABGS assist personnel at DOD medical centers with higher risk-adjusted mortality had higher Arterial Blood Pressure scores than CABGS nurse and assist personnel at DOD medical centers with lower risk-adjusted mortality. No other significant differences were noted between CABGS nurse and CABGS assist personnel hemodynamic measurement reliability/validity assessment scores at higher and lower risk-adjusted mortality medical centers (α = .0125 (.05/4) (Table 4-56). There was inadequate power to determine a difference if it existed.

Table 4-56

Comparison of DOD CABGS Units With Higher Risk-Adjusted Mortality[a] and DOD CABGS Units With Lower Risk-Adjusted Mortality[b]: Hemodynamic Measurement Reliability/Validity Assessment Scores of the CABGS Nurses and Assist Personnel

Between-Group Sub-scale	n	M (SD)	t	df	p
Pulmonary Artery Checklist Common Element Score					
High mortality (≥ .115)[a]	19	9.2 (2.4)	1.74	46	.044[c]
Low mortality (≤ .086)[b]	30	8.2 (1.6)			
Arterial Blood Pressure Checklist Score					
High mortality (≥ .115)[a]	19	3.4 (0.5)	0.90	46	.187[c]
Low mortality (≤ .086)[b]	29	3.2 (0.7)			
Manual Blood Pressure Checklist Score					
High mortality (≥ .115)[a]	2	8.0 (1.4)	-0.70	11	.250[c]
Low mortality (≤ .086)[b]	11	8.7 (1.3)			
Automatic Blood Pressure Checklist Score					
High mortality (≥ .115)[a]	8	4.0 (0.0)	3.43	16	.002[d]
Low mortality (≤ .086)[b]	17	3.3 (0.8)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9, 10 and 11
c = p - value is one-tailed and based on pooled variances
d = p - value is one-tailed and based on separate variances

Differences in CABGS Care Provider Processes

Differences between process times at higher risk-adjusted mortality and low risk-adjusted mortality medical centers were evaluated using independent t-tests. Care processes analyzed for differences were: the intra-operative provider processes of cardiopulmonary bypass and aortic cross-clamp time (because of their known impact on post-operative outcome); the post-operative provider processes of intensive care, post-procedure and hospital lengths of stay; and the post-operative provider processes of length of time patient utilized the following therapeutic devices or therapies--endotracheal tube, pulmonary artery catheter, arterial line, mediastinal tube, pacer wires, foley catheter, and oxygen. CABGS processes at the higher risk-adjusted mortality medical center were hypothesized to be of greater length (slower) than CABGS care provider processes at the lower risk-adjusted mortality medical centers. Lower risk-adjusted mortality DOD medical centers had significantly ($p < .003$ (.05/13) shorter CABGS care process times for the following; cardiopulmonary bypass ($p = .000$); aortic cross-clamp ($p = .000$); hospital stay ($p = .001$); post-procedure stay ($p = .001$) vasoactive drips ($p = .000$); mediastinal tube(s) ($p= .000$); and pacer wires ($p = .000$). Results of the CABGS care process analyses are described in Table 4-57 (intra-operative processes), Table 4-58 (post-operative length of stay processes), and Table 4-59 (post-operative therapeutic device /therapy processes).

Table 4-57

Comparison of CABGS Providers Intra-Operative Processes of DOD CABGS Units With Higher Risk-Adjusted Mortality[a] and DOD CABGS Units With Lower Risk-Adjusted Mortality[b]

Between-Group Sub-scale	n	M (SD)	t	df	p[c]
Cardiopulmonary Bypass Time					
High mortality (≥ .115)[a]	130	136.8 (47.5)	8.18	419	.000
Low mortality (≤ .086)[b]	291	98.4 (43.1)			
Aortic Cross-Clamp Time					
High mortality (≥ .115)[a]	129	79.6 (30.0.)	8.88	417	.000
Low mortality (≤ .086)[b]	290	52.1 (29.0)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9, 10, and 11
c = p - values are one-tailed and based on pooled variances.

Table 4-58

Comparison of CABGS Providers Post-Operative Processes of DOD CABGS Units With Higher Risk-Adjusted Mortality[a] and DOD CABGS Units With Lower Risk-Adjusted Mortality[b]: Length of Stay (LOS) Processes

Between-Group Sub-scale	n	M (SD)	t	df	p[c]
Intensive Care LOS					
High mortality (≥ .115)[a]	120	89.4 (158.7)	2.04	144	.021
Low mortality (≤ .086)[b]	283	58.4 (77.3)			
Post-CABGS Procedure LOS					
High mortality (≥ .115)[a]	130	11.8 (11.6)	3.31	192	.001
Low mortality (≤ .086)[b]	291	8.0 (8.4)			
Hospital LOS					
High mortality (≥ .115)[a]	131	16.9 (13.2)	4.01	188	.000
Low mortality (≤ .086)[b]	291	11.8 (9.1)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9, 10, and 11
c = p - value is one-tailed and based on separate variances

Table 4-59

Comparison of CABGS Providers Post-Operative Processes of DOD CABGS Units With Higher Risk-Adjusted Mortality[a] and DOD CABGS Units With Lower Risk-Adjusted Mortality[b]: Processes Related to Length of Time Therapeutic Device/Therapy Utilized

Between-Group Sub-scale	n	M (SD)	t	df	p
Endotracheal Tube					
High mortality (≥ 115)[a]	123	27.8 (35.2)	2.46	200	.007[c]
Low mortality (≤ .086)[b]	280	18.8 (29.5)			
Pulmonary Catheter					
High mortality (≥ .115)[a]	124	1.7 (1.4)	2.42	184	.008[c]
Low mortality (≤ .086)[b]	217	1.3 (0.9)			
Arterial Line					
High mortality (≥ .115)[a]	122	3.1 (4.0)	2.63	132	.005[c]
Low mortality (≤ .086)[b]	284	2.1 (1.3)			
Vasoactive Drips					
High mortality (≥ .115)[a]	120	46.1 (41.1)	4.93	176	.000[c]
Low mortality (≤ .086)[b]	281	25.6 (30.1)			
Mediastinal Tubes					
High mortality (≥ .115)[a]	123	1.9 (0.8)	3.16	408	.001[d]
Low mortality (≤ .086)[b]	287	1.6 (0.8)			
Pacer Wires					
High mortality (≥ .115)[a]	116	6.0 (3.1)	4.56	156	.000[c]
Low mortality (≤ .086)[b]	281	4.6 (2.0)			
Foley Catheter					
High mortality (≥ .115)[a]	121	4.4 (8.9)	2.51	124	.007[c]
Low mortality (≤ .086)[b]	280	2.3 (1.8)			
Oxygen					
High mortality (≥ .115)[a]	115	6.7 (7.5)	2.31	128	.011[c]
Low mortality (≤ .086)[b]	272	5.0 (2.8)			

a = Sites meeting the ≥ .115 mortality criteria are Sites 1, 3, 5, 6 and 12
b = Sites meeting the ≤ .086 mortality criteria are Sites 2, 4, 7, 8, 9 10 and 11
c = p - values is one-tailed and based on separate variances
d = p - values is one-tailed and based on pooled variances.

CHAPTER V

DISCUSSION

The discussion will encompass the study's findings, significance and implications, limitations, and directions for future research as they relate to: 1) risk-adjustment of DOD CABGS mortality to include the relationship of risk-adjusted and crude mortality rates; 2) hemodynamic knowledge and practice of DOD CABGS providers, including differences between hemodynamic knowledge and practice between DOD medical centers with higher and lower crude and risk-adjusted CABGS mortality; and 3) differences between CABGS provider collaboration and critical path processes between DOD medical centers with higher and lower crude and risk-adjusted CABGS mortality. Limitations of the study will be described using the Cook and Campbell (1979) framework for the examination of statistical conclusion, internal, construct and external validity of research findings as applicable.

Risk-adjustment of DOD CABGS Mortality

Findings

It was possible to risk-adjust DOD CABGS mortality using discharge abstract using logistic regression. The variables contained in the discharge abstract CABGS mortality model --based on variables which were significantly ($p < .25$) associated with CABGS mortality on bivariate analysis, included acute myocardial infarction ($p = .000$, Odds Ratio = 5.88); age ($p = .050$, Odds Ratio = 1.04); repeat CABGS ($p = .043$, Odds Ratio = 3.90); female sex ($p =$

.044, Odds Ratio = .40); diabetes mellitus (p = .066, Odds Ratio = .15); hypertension (p = .052, Odds Ratio = .42). The model was statistically significant (Log-Likelihood = -99.770, p = .000) and had good calibration and discrimination (Hosmer-Lemeshow goodness-of-fit = .730, area under the Receiver Operating Curve = .813). Removal of the two variables in the model which were not statistically significant (diabetes mellitus and hypertension) resulted in severe degradation of the model as measured by model calibration and discrimination indices.

Medical center risk-adjusted mortality rates calculated using the developed model indicated that all DOD medical centers had lower than predicted CABGS mortality rates. DOD medical center crude and risk-adjusted mortality rates were highly correlated (Spearman's *rho* = .93).

Mortality of CABGS had been previously modelled with administrative data in civilian patients undergoing the procedure in New York state by Hannan, et al. (1992) and in California by Luft and Romano (1993). This was the first administrative risk-adjustment of mortality in DOD.

Individual variables in the model appear appropriate. Emergent CABGS, often the greatest predictor of poor outcome in CABGS (Blumberg, personal communication, August 1995; Edwards, et al., 1994; Grover, et al., 1990; Hammermeister, et al., 1990; Hannan, et al., 1990; Hannan, et al., 1991; Higgins, et al., 1992; Luft & Romano, 1993; O'Connor, et al., 1992; Parsonnet, et al., 1989; Showstack, et al., 1987; Wright, et al., 1987) was not in the model. This was due to the inability to determine if the CABGS was an emergency procedure from the discharge abstract since there are no dates of procedures noted in DOD discharge abstract data. Emergency admission does not necessarily relate to emergency CABGS. Acute myocardial infarction could be the proxy for emergent CABGS in this data (Blumberg, personal communication, August, 1995). Acute myocardial infarction has also been found to

be significantly associated with CABGS mortality in other risk-adjusted models of mortality (Edwards, et al., 1994; Hannan, et al., 1990). Age and redo CABGS also appear appropriate and have appeared in other risk-adjusted models of CABGS mortality.

The odds ratios for the variables of female sex, diabetes mellitus, and hypertension indicate that these variables decrease the risk of CABGS mortality, i. e., are protective of the patient. Female sex has usually been demonstrated to be associated with increased CABGS mortality (Edwards, et al., 1994; Hammermeister, et al., 1994; Hannan, et al., 1990; Hannan, et al., 1991; Hannan, et al., 1994; Hartz, et al., 1990; Iyer, et al., 1993; Luft & Romano, 1993; O'Connor, et al., 1992; Parsonnet, et al., 1989), though one other study found males to have increased risk of CABGS mortality (Geraci, et al., 1993). The increased risk of CABGS mortality noted for females has been postulated to be less gender-related and more body-size related. Lower weight has been found to be associated with CABGS mortality (Higgins, et al., 1992).

The counter-intuitive findings of significant co-morbidities decreasing rather than increasing the risk of CABGS mortality have been demonstrated in other administratively-based risk-adjusted outcome studies (Iezzoni, 1994; Jencks, William, & Kay, 1988). However, of the two discharge abstract based models of CABGS mortality, Luft and Romano (1993) found both hypertension and diabetes and Hannan, et al., (1991) found diabetes to be predictive of CABGS mortality. Hypotheses for co-morbidities appearing to decrease the risk of death relate to: the limited number of spaces for coding diagnoses in the discharge abstract-sicker patients' coding spaces are coded with the complications of their hospitalization, rather than co-morbidities; the regularity of health care contacts of patients with co-morbidities so that acute changes in their conditions are detected before they become more severe; and physiologic explanations--i.e. patients with the co-morbidity of hypertension have an improved

outcome after an acute myocardial infarction related due to the beta blocking medication they are chronically taking (Iezzoni, 1994).

There are only eight spaces for the coding of diagnoses in DOD discharge abstract data. Discharge abstract diagnosis coding spaces of patients who died may be being utilized for the coding of the complications they experienced--leaving no spaces for the coding of their co-morbidities. Patients who have no complications have their co-morbidities coded since they have had no complications. Luft and Romano (1993) performed their risk-adjustment of CABGS mortality using California discharge abstract data; California had 25 spaces for the coding of diagnoses during that study's timeframe. There were 5 spaces for the coding of diagnoses at the time of Hannan, et al.'s (1992) administrative risk-adjustment of CABGS mortality.

The high correlation of risk-adjusted mortality with crude mortality has been described before. Hartz, Kuhn, Kayser et al., (1992) and Hannan, et al., (1992) described correlations of risk-adjusted with crude mortality of .74, while others have described crude and risk-adjusted mortality correlations of .92 (O'Connor, et al, 1991) and .95 (Hartz, Kuhn, Green, et al., 1992).

Limitations

The limitations of the study relating to the discharge abstract-based risk-adjustment of CABGS mortality relate to threats to statistical conclusion, construct validity and external validity. The threats to statistical conclusion validity, which is concerned with whether two variables co-vary or are related, include low statistical power and reliability of measures. The threat to construct validity, which is concerned with the nature of causes and effects in the relationship between two variables, is mono-method bias. The threats to external validity,

which is concerned with the generalizability of findings across settings, persons and times, relate to interactions between setting and treatment and history and treatment.

Although a predictive model of CABGS mortality was formulated, the model built may be unstable due to small sample size. Sample size for an outcome with an incidence of 3 to 5% is and 7 to 15 predictor variables is estimated to be 2,000 (Daley, 1994). Event to variable ratios of 10 to 1 are described as the "rule of thumb" for the development of stable models (Daley, 1994; Marshall, Grover, Henderson, & Hammermeister, 1994); the model developed in this study had a 4 to 1 event to variable ratio. The ability to develop a model of CABGS mortality from such a small sample may have been a result of the homogeneous nature of this population of DOD CABGS patients--male, Caucasian.

Besides potential model instability, the small sample size (842) also precluded the model's cross-validation. Risk-adjusted models of outcome are usually built from a random sample of one half of the data collected (development sample) and then validated on the remaining half of the data (validation sample). Indices of model calibration and discrimination are generally higher in the development sample. The indices of model of calibration and discrimination described for the model of CABGS mortality developed in this study must therefore be interpreted in light of the fact that they describe a development sample; they are probably inflated relative to what they would have been in any validation sample.

The model was developed from data that has been demonstrated in the past to be unreliable. DOD discharge abstract data was demonstrated to have a 15.6% rate of coding differences between medical center abstractors and independent abstractors (Forensic Medical Advisory Services, 1993). This rate of coding error is similar to that seen in the civilian sector (Hsia, Ahern, Ritchie, Moscoe, & Drushat, 1992). Differences between rates of diagnoses coded in the discharge abstract and in the sub-sample of patients whose charts were audited

also revealed discrepancies calling into question the reliability of the discharge abstract data. Differences were noted in the rates of obesity, hypercholesterolemia and cerebrovascular disease obtained from the discharge abstract data and from the chart audit data for the case and control facilities.

The validity of the discharge abstract data on which the risk-adjusted model of DOD CABGS mortality is based is also called into question. The discharge abstract data did not represent all CABGS procedures performed in DOD during the study timeframe as evidenced by the differences between discharge abstract and facility log register number listings of CABGS patients.

Mono-method bias, described by Cook and Campbell (1979) is one threat to construct validity. The counter-intuitive findings that diabetes mellitus and hypertension decrease a CABGS patient's risk of mortality as described might be due to mono-method bias- a result of the discharge abstract coding method of data collection. Diabetes and hypertension may not be protective of CABGS mortality, but the coding of diabetes and hypertension may be protective of CABGS mortality.

The threats to external validity--the extent to which findings can be generalized across settings, persons and times, include interaction of setting and treatment and interaction of history and treatment. The study was a study of DOD CABGS mortality and as such is not generalizable to civilian CABGS mortality. The study of DOD CABGS mortality was conducted in the January through June 1994 timeframe. Due to the ever-changing nature of cardio-thoracic surgery and changes in health care delivery within the Department of Defense due to the inception of managed care, the results are not generalizable to other timeframes.

Significance and Implications

The significance of the findings relates to the use of discharge abstract data to risk-adjust outcomes in the Department of Defense. Discharge abstract based risk-adjusted of CABGS mortality was possible. However, reliability and validity problems of the discharge abstract on which the risk-adjustment was based were identified.

Implications for administration include the need for improvement of DOD discharge abstract data reliability and validity if discharge abstract data is to be utilized for quality of care screening purposes. Increases in the numbers of coding spaces for diagnoses and the addition of procedure dates and a means to distinguish complications from co-morbidities might also improve the usability of DOD discharge abstract data for risk-adjustment. The high correlation of risk-adjusted and crude mortality rates indicates that risk-adjustment might be an expensive and unnecessary method of looking for quality of care outliers. If risk-adjusted and crude mortality rates are so highly correlated, it might be more cost-effective to use crude mortality as a quality of care screen.

Implications for education and practice include the need for health care provider education in the interpretation of risk-adjusted outcome rates and their usefulness in benchmarking their outcomes against other providers.

Directions for Future Research

This discharge abstract based risk-adjustment of DOD CABGS mortality should be compared to a clinically based risk-adjustment of DOD CABGS mortality for the same sample and the models compared. The discharge abstract risk-adjustment of CABGS mortality should

be replicated in a larger sample. Risk-adjustment of DOD CABGS mortality using the same sample should be accomplished directly from the discharge abstract so that the limitation of eight coding spaces would not be a factor and the two models (discharge abstract database and direct discharge abstract) compared.

Risk-adjustment of mortality in timeframes relevant to DOD providers might not be feasible due to low rates of mortality in other diagnoses or procedures. Risk-adjustment of CABGS morbidity, which has been described as potentially more useful since complications occur more frequently than mortality and are often more expensive (Clark, Edwards, & Schwartz, 1994), cannot be done at the present time with DOD administrative data since there is no differentiation between co-morbidities and complications in DOD discharge abstract data. The risk-adjustment of morbidity--if and when co-morbidities and complications become distinguishable in DOD discharge abstract data--might be potentially more useful, and should be explored.

Hemodynamic Knowledge and Practice of DOD CABGS Providers

Findings

DOD CABGS Provider Hemodynamic Knowledge

DOD CABGS nurse and assist provider knowledge of blood pressure measurement was assess using the BPDQ (Sollek, 1988). DOD CABGS nurse and assist provider knowledge of pulmonary artery catheter measurement was assessed using the PACKAT (Dolter, 1987). Fifty five of 218 DOD CABGS nurses and assist providers responded to the BPDQ and PACKAT; a response rate of 25%. DOD CABGS physician knowledge of pulmonary artery

catheter measurement and measurement treatment was assessed using the PACSG (Iberti, et al., 1990). Twelve of 47 DOD CABGS physicians responded; a response rate of 25%.

DOD CABGS nurse and assist provider knowledge as assessed by the PACKAT (M = 33.8, S.D. = 8.1) appeared improved over that described in the previous administration of that test (M = 30.6, S.D. = 6.9). The PACKAT had been previously administered to a random sample of 500 AACN members who had designated a cardiovascular specialty by mail-out questionnaire; 20% of that sample responded (Dolter, 1987). Areas where DOD CABGS nurses had less than a mean of 50% correct included square wave/dynamic response assessment of the pulmonary artery (PA) system (47.9%), artifactual influences on PA measurement (45.5%) and lung zonal influences on PA measurement (32%). This was similar, though improved compared to the previous administration of the questionnaire where AACN nurses had mean percentage correct less than 50 in the areas of hemodynamic principle (49%); balloon inflation (48%); artifactual influences (40%); square wave (28%); and lung zonal influences (27%).

There appeared to be little difference between DOD CABGS nurse (M = 33.8, S.D. = 8.1) and DOD CABGS assist personnel (M = 32.7, S.D. = 9.3) related to pulmonary artery catheter knowledge when their knowledge as assessed by the PACKAT was examined separately; this difference was not examined statistically due to insufficient statistical power..

DOD CABGS physician provider knowledge as by the PACSG (M = 25.8, S.D. = 2.8) appeared improved over that described in the previous administration of that test (M = 20.7, S.D. = 5.4). The PACSG had been previously administered to a convenience sample of 496 interns, residents and staff physicians at 13 medical centers in the United States and Canada (Iberti, et al., 1990).

DOD CABGS provider knowledge of pulmonary artery catheter measurements, although somewhat better than that of their civilian counterparts, still appears deficient. DOD CABGS nurse and assist personnel mean percent correct on the PACKAT (Dolter, 1987) was 55%; DOD physician mean percent correct on the PACSG was 83% (Iberti, et al., 1990). DOD CABGS nurse and assist knowledge of manual cuff blood pressure assessment also appears deficient; mean percent correct on the BPDQ (Sollek, 1988) was 54%.

DOD CABGS Provider Hemodynamic Practice

Description of DOD CABGS nurse and CABGS assist provider hemodynamic practice was via criterion referenced observation checklists developed by the investigator for the purpose of observing provider pulmonary artery (CHECKPA), direct arterial blood pressure (CHECKAR) and indirect--manual and automatic, blood pressure (CHECKBP) reliability and validity assessments.

Reliability and validity criteria which were adhered to by less than 50% of the CABGS providers observed performing their pulmonary artery pressure measurements include: RN performance of transducer calibration (0%); RN identification of the patient's phlebostatic axis (PSA) by marking the PSA on the patient's chest wall (2%); and RN performance of dynamic response assessment (16%). Transducer calibration against a mercury manometer is important in assuring that the pressures indicated by the pulmonary artery catheter-transducer-monitor system are valid. Assurance of transducer calibration is especially important in assessing measurements of the low pressure central venous and pulmonary arterial systems. RN identification of the PSA by marking that point on the patient's chest wall is important in ensuring that pulmonary arterial measurements are consistent among nurses. This insures that patients are not treated for measurement inconsistencies among nurses, but rather are treated for actual changes in their hemodynamic status. Assurance of adequate pulmonary arterial

system dynamic response ensures that measurements obtained are measurements of pulmonary artery wedge pressure (PAWP) and not pressure measurements of air bubbles, blood clots or other occlusions within the pulmonary artery catheter monitoring system.

Reliability and validity criteria which were met by less than 50% of the CABGS providers observed performing direct arterial blood pressure measurements include: RN performance of transducer calibration (0%) and RN performance of dynamic response assessment (31%). The implications of transducer calibration and performance of dynamic response, described for pulmonary arterial catheters, also apply to the assessment of direct arterial pressure.

Reliability and validity criteria which were adhered to by less than 50% of the CABGS providers obtaining manual cuff pressure measurements include: RN verification of systolic pressure by palpation prior to auscultation (23%); RN use of the stethoscope bell (46%); and RN assessment of systolic, diastolic and muffling (46%). Also of note, only 62% of manual cuff pressure assessments and 76% of automatic cuff pressure assessments were obtained with cuffs of the correct size. Non-palpation of systolic pressure prior to auscultation may cause underestimation of a patient's systolic pressure. RN use of the stethoscope diaphragm may lead to inability to detect blood pressure measurements accurately. Non-identification of systolic, diastolic and muffling can lead to underestimation of a patient's systolic and overestimation of a patient's diastolic pressure.

Use of an inappropriately sized blood pressure cuff is extremely dangerous; it will cause inaccurate assessment of a patient's blood pressure leading to inaccurate diagnosis of a patient's condition and thus inappropriate intervention. If a patient's blood pressure is assessed with a cuff that is too small, his/her blood pressure will be overestimated, the patient will be inappropriately diagnosed with hypertension and potentially treated with anti-hypertensive

medication he/she doesn't need. If a patient's blood pressure is assessed with a cuff that is to large, his/her blood pressure will be underestimated, the patient will be inappropriately diagnosed with hypotension and potentially treated with vasopressors he/she doesn't need.

Variation in Hemodynamic Practices Between DOD Medical Centers

There was a great amount of variation in hemodynamic measurement practice between DOD medical centers. Two DOD medical centers (Sites 8 and 9) never obtained pulmonary artery wedge pressures (PAWP) preferring to measure and treat the pulmonary artery diastolic pressure (PAD), while 2 other DOD medical centers (Sites 1 and 12) always measured and treated the PAWP. Another DOD medical center (Site 11) measured and treated the PAWP in some patients, preferring to measure and treat the PAD in other patients. Site 11 also only placed pulmonary artery catheters in their higher risk patients, utilizing central venous catheters to monitor the hemodynamic status of their lower risk patients. All other sites where the hemodynamic observation was performed placed pulmonary artery catheters in all their patients.

The Relationship of DOD CABGS Provider Hemodynamic Knowledge and Practice

The relationship between DOD CABGS provider knowledge and practice was not able to be described for two reasons: 1) variability in hemodynamic measurement practice as described above; and 2) providers whose hemodynamic practice was observed were often not the providers who responded to the hemodynamic knowledge questionnaire.

Differences Between CABGS Provider Hemodynamic Knowledge and Practice at DOD Medical Centers With Higher and Lower Crude and Risk-Adjusted CABGS Mortality

Differences in CABGS nurse provider hemodynamic knowledge and hemodynamic measurement practices between DOD medical centers with higher and lower crude and risk-

adjusted mortality were examined using t-tests. CABGS nurses providing care at DOD medical centers with lower crude and risk-adjusted mortality were hypothesized to have greater hemodynamic knowledge than CABGS nurses providing care at DOD medical centers with higher crude and risk-adjusted mortality.

There were no significant differences in knowledge of blood pressure measurement as assessed by the BPDQ (Sollek, 1988) between CABGS nurses providing care at DOD medical centers with lower crude or risk-adjusted CABGS mortality and CABGS nurses providing care at DOD medical centers with higher crude (t = -.59, p = .294) or risk-adjusted (t = -. 38, p = .366) CABGS mortality. There were significant ($p \leq .025$, one-tailed) differences in knowledge of pulmonary artery measurement as assessed by the PACKAT (Dolter, 1987) between CABGS nurses providing care at DOD medical centers with lower crude or risk-adjusted CABGS mortality and CABGS nurses providing care at DOD medical centers with higher crude (t = -2.41, p = .013) or risk-adjusted (t = -2.71, p = .004) CABGS mortality.

There were no significant ($p \leq .0125$, one-tailed) differences in hemodynamic practices as assessed by the CHECKPA, CHECKAR, or CHECKBP observation instruments (Dolter, 1994) between CABGS nurses providing care at DOD medical centers with lower crude or risk-adjusted CABGS mortality and CABGS nurses providing care at DOD medical centers with higher crude or risk-adjusted CABGS mortality.

Limitations

The limitations of the study relating to CABGS provider hemodynamic knowledge and practice relate to threats to statistical conclusion, internal, construct and external validity. The

threats to statistical conclusion validity, include low statistical power and reliability of measures. Threats to internal validity include history, maturation, selection maturation and selection history. Threats to construct validity include evaluation apprehension and experimenter expectancies. The threats to external validity include interactions between setting and treatment and history and treatment (Cook & Campbell, 1979).

There was inadequate sample size to describe the relationship between CABGS provider hemodynamic knowledge and hemodynamic practice. There was also inadequate sample size to detect differences in CABGS nurse provider manual blood pressure measurement knowledge as assessed by the BPDQ (Sollek, 1988). Inability to detect differences in BPDQ scores between CABGS nurse providers at DOD medical centers with higher and lower crude and risk-adjusted mortality might also have related to the low reliability of the BPDQ in this sample (Kuder-Richardson-20 = .589).

Threats to internal validity of history, maturation, selection-maturation and selection-history relate to the assessment of hemodynamic knowledge and process differences between medical centers with higher and lower crude and risk-adjusted CABGS mortality. CABGS provider knowledge was assessed in the January through June 1995 timeframe, while medical center CABGS mortality was based on January through June 1994 CABGS mortality rates. Although many of the DOD CABGS providers caring for CABGS patients during the January through June 1995 were the same providers caring for CABGS patients during the January through June 1994 timeframe, history, maturation, selection-maturation and selection-history might have affected the hemodynamic knowledge and practice of those CABGS providers between the timeframes. Those CABGS providers might have attended hemodynamic symposia or other events (history) which might have improved their hemodynamic knowledge and practice or their hemodynamic knowledge and practice might have improved due to

maturation--the effect of their growing older, wiser or more experienced. CABGS providers hemodynamic knowledge and practice at DOD medical centers with differing crude and risk-adjusted mortality might have matured at different rates (selection-maturation) or been exposed to unique local events impacting on their hemodynamic knowledge and practice (selection-history). Alternatively, providers caring for CABGS patients during the January through June timeframe might have been replaced by totally new providers. Examination of CABGS nurse and assist provider participants years of open heart experience in the current unit by individual CABGS provider revealed 11(20%) CABGS providers with less than 1 year open heart experience in the current unit.

Evaluation apprehension and experimenter expectancies might have been in operation during the observation of CABGS provider hemodynamic practices. Evaluation apprehension relates to respondent presentation of self to maximize favorable evaluation (Cook & Campbell, 1979)--a Hawthorne effect. Knowing their hemodynamic practice was being watched, CABGS providers might have obtained their measurements in a more technically correct manner than usual--just because they were being watched. Thus an overly-optimistic picture of CABGS provider compliance with hemodynamic measurement criteria might have been portrayed.

Experimenter expectancies may bias data collection (Cook & Campbell, 1979). Investigator beliefs concerning CABGS provider non-compliance with hemodynamic measurement criteria might have biased data collection negatively, resulting in a description that had the CABGS provider appearing less adherent to hemodynamic reliability and validity criteria than they actually were. However, this potential threat was minimized because much of the observation data was collected by a research assistant with no previous background in or preconceptions concerning CABGS provider adherence to hemodynamic measurement reliability and validity criteria.

The threats to external validity include interaction of setting and treatment and interaction of history and treatment. The study was a study of DOD CABGS provider knowledge and practice and as such may not generalizable to civilian CABGS providers or other DOD intensive care practitioners. The study of DOD CABGS provider hemodynamic and practice was conducted in the January through June 1995 timeframe. Due to the constant turnover of personnel within DOD medical centers the results may not be generalizable to other timeframes.

Significance and Implications

The significance of the above findings is that DOD CABGS providers may not have the requisite knowledge to perform and are not performing some of the steps required to obtain reliable and valid pulmonary artery catheter and cuff blood pressure measurements. If CABGS nurses and assist providers are obtaining inaccurate assessments of their patient's pulmonary artery and blood pressure measurements, these patients will have an increased chance of being inaccurately diagnosed and thus of receiving inappropriate therapy(s), decreasing the CABGS patient's potential of attaining a positive outcome. If CABGS physicians do not have the knowledge requisite for measurement, interpretation and treatment of measurements obtained with the pulmonary artery catheter, they will be unable to obtain accurate measurements themselves, unable to detect inaccurate measurements obtained by other care providers and unable to prescribe appropriate therapies for the measurements obtained , again decreasing the CABGS patient's potential of attaining a positive outcome.

Implications relate to administration, education and practice. If accurate hemodynamic assessment is valued, assessment and certification of CABGS provider competence in the area

of hemodynamic assessment and treatment is essential; providers who have not been certified should not be allowed to perform hemodynamic assessments. Assurance of CABGS provider hemodynamic competence has been called for by others including the developers of the pulmonary catheter, Dr. H. J. C. Swan and Dr. W. Ganz (1983), the American Heart Association (Friesinger & Williams, 1990), the European Society of Intensive Care Medicine (1991), and the Technology Sub-committee of the Working Group on Critical Care (1991).

If accuracy of hemodynamic measurement is valued, administration must increase the probability that accurate hemodynamic measurements are obtained by providing CABGS provider personnel with the requisite tools--education and equipment. Education must be directed at teaching DOD CABGS nurses the criteria for obtaining reliable and valid hemodynamic measurements and the importance of adhering to these criteria. Administration must ensure that DOD CABGS providers are given the equipment necessary to obtaining accurate measurements such as transducer calibration instruments, carpenter's levels, damping devices and appropriately sized blood pressure cuffs. Administration must ensure that this equipment is readily accessible to ensure its use. DOD CABGS providers must adhere to hemodynamic device reliability and validity criteria in order to improve their hemodynamic assessments of their patients and thus the chance that their patient will have a positive outcome.

Directions for Future Research

Replication of this study of CABGS provider hemodynamic knowledge and hemodynamic practice and its impact on patient outcome needs to be accomplished in larger samples of civilian CABGS nurse providers and in samples of other DOD and civilian

intensive care nursing specialties. The relationship between knowledge and practice needs to be described and explored.

Differences Between CABGS Provider Collaboration and Critical Path Processes Between DOD Medical Centers with Higher and Lower Crude and Risk-Adjusted CABGS Mortality

Findings

Differences between collaboration and CABGS critical path patient care processes between DOD medical centers with higher and lower crude and risk-adjusted CABGS mortality were analyzed using t-tests. Collaboration processes were described using the between group communication, problem-solving and conflict-avoiding scales of the ICU-RN/MD Questionnaire (Shortell, et al., 1991). Patient care processes were assessed via retrospective chart audit and included: the intra-operative processes of cardiopulmonary bypass time and aortic cross-clamp time; the post-operative critical path processes of intensive care, post-CABGS and hospital lengths of stay; and endotracheal tube, vasoactive drip, pulmonary artery catheter, arterial line, mediastinal tube, pacer wire, foley catheter and oxygen therapeutic device/modality usage times.

There were no significant ($p \leq .0125$, one-tailed) differences between DOD medical centers with lower and higher crude CABGS mortality relating to collaboration as assessed by the between group communication, problem-solving and conflict-avoiding sub-scales of the ICU-RN/MD questionnaire (Shortell, et al., 1991). There were significant ($p \leq .0035$, one-tailed) differences between DOD medical centers with lower and higher crude CABGS mortality relating to the care processes of: cardiopulmonary bypass time ($t = 7.41$, $p = .000$);

aortic cross-clamp time (t = 8.32, p =.000); endotracheal tube usage time (t = 3.00, p = .002); vasoactive drip usage time (t = 5.59, p =.000); mediastinal tube usage time (t = 3.58, p = .000); and pacer wire usage time (t = 5.73, p =.000). There were significant differences between DOD medical centers with lower and higher risk-adjusted CABGS mortality relating to the care processes of: cardiopulmonary bypass time (t = 8.18, p =.000); aortic cross-clamp time (t = 8.88, p =.000); post-CABGS procedure length of stay (t = 3.31, p =.000); hospital length of stay (t = 4.01, p =.000); vasoactive drip usage time (t = 4.93, p =.000); mediastinal tube usage time (t = 3.16, p = .001); and pacer wire usage time (t = 4.56, p =.000).

Limitations

The limitations of the study relating to description of differences in CABGS provider collaboration and critical path patient care processes relate to threats to statistical conclusion, internal and external validity. The threat to statistical conclusion validity is that of low statistical power. The threats to internal validity include history, maturation, selection-maturation and selection-history. The threats to external validity include interactions between setting and treatment and history and treatment (Cook & Campbell, 1979).

The threats to statistical conclusion validity of low statistical power and reliability of measures relate to the description of CABGS provider collaboration via the ICU-RN/MD Questionnaire between-group sub-scales. There was inadequate sample size to detect differences between CABGS providers at DOD medical centers with lower and higher crude and risk-adjusted CABGS mortality.

Threats to internal validity of history, maturation, selection-maturation and selection-history relate to the assessment of collaboration between medical centers with higher and lower

crude and risk-adjusted CABGS mortality. These threats are the same as those described for the assessment of provider hemodynamic knowledge and practice above.

The threats to external validity include interaction of setting and treatment and interaction of history and treatment. The study was a study of DOD CABGS provider collaboration and critical path processes and as such is not generalizable to civilian CABGS providers or intensive care practitioners. The study of DOD CABGS care processes was conducted in the January through June 1994 timeframe. Due to the constant changes in cardiothoracic surgery techniques and in post-operative CABGS patient care due to the institution and revision of critical path procedures the results may not be generalizable to other timeframes.

Significance and Implications

Process difference findings must be interpreted in conjunction with the findings of the risk-adjustment of DOD CABGS mortality for determination of their significance and implications. All DOD medical centers had less than predicted CABGS in-hospital mortality. Differences found between DOD medical centers with "higher" and "lower" crude and risk-adjusted CABGS mortality therefore represent differences that are not indicative of poor quality --since everyone is doing better than expected, but may provide medical centers an opportunity to benchmark their care against that of other providers. Identified differences must be evaluated in context by the providers themselves to determine the need for changes, if any, in their intra- and post-operative processes.

However, it is interesting to note that in evaluating CABGS care process differences between those DOD medical centers at which the chart audit occurred, that Site 11, the only

site with a critical path in place, had the shortest overall process times in the areas of endotracheal tube, vasoactive drip, pulmonary artery catheter, arterial line, mediastinal tube, foley catheter and pacing wire use times and the shortest length of intensive care unit stay.

Directions for Future Research

Care processes of civilian CABGS programs with varying crude and risk-adjusted mortality should be investigated to determine if differences exist. Future research of risk-adjusted outcomes should always be accompanied by process descriptions so that providers might benchmark their care against that of other providers.

Summary

This study was a pilot study of the use of discharge abstract based risk-adjusted outcomes in the Department of Defense. DOD discharge abstract based risk-adjustment is possible and could be used in quality improvement screening to identify outcome, input and process outliers. Collection of clinical process data in conjunction with severity of illness risk-adjustment would give providers information for benchmarking their care against that of other providers and also direction toward the provider inputs and processes requiring improvement.

Although all DOD medical centers had less than expected mortality, input and process differences still existed between DOD medical centers with higher and lower risk-adjusted CABGS mortality indicating areas which could be evaluated for further improvement. Processes identified for potential improvement included the input of CABGS nurse provider pulmonary artery catheter knowledge; the intra-operative processes of cardio-pulmonary artery

bypass and aortic cross-clamp time; and the individual post-operative CABGS critical path processes of vasoactive drip and pacer wire usage times.

Nurse impact on the CABGS care processes of cardiopulmonary and aortic cross-clamp time and pacer wire usage time might be minimal. Nurse impact on the CABGS care inputs and processes identified as varying between higher and lower risk-adjusted mortality medical centers is in the areas of nurse provider knowledge of pulmonary artery catheter measurements and vasoactive drip usage times. Hemodynamic measurement and intervention may be the most critical nursing activities in the initial 48 hours of CABGS patient post-operative care. The life threatening nature of hemodynamic instability warrants extreme vigilance related to the measurement and treatment of hemodynamic parameters such as pulmonary artery wedge and arterial blood pressures. Nurse providers must obtain reliable and valid hemodynamic measurements so that the appropriate treatment(s) is instituted for the CABGS patient.

As the pressures of managed care filter into the DOD from the civilian sector, the need to define "best practice" and engage in benchmarking activities will be even greater. The findings of this study suggest that hemodynamic monitoring post-CABGS is a significant area for future investigation.

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APPENDIX A:

Luft and Romano (1993) and Other Severity of Illness Variable Discharge Abstract ICD-9-CM Code Transformation Statements

```
IF AGE > 0 AND AGE <= 30 THEN NEWAGE = 1
IF AGE > 30 AND AGE <= 40 THEN NEWAGE = 2
IF AGE > 40 AND AGE <= 50 THEN NEWAGE = 3
IF AGE > 50 AND AGE <= 60 THEN NEWAGE = 4
IF AGE > 60 AND AGE <= 70 THEN NEWAGE = 5
IF AGE > 70 AND AGE <= 80 THEN NEWAGE = 6
IF AGE >= 80 AND AGE <= 90 THEN NEWAGE = 7
ARRAY DX# DX1 to DX8
FOR i = 1 TO 8
IF DX#(i) = 411 OR DX#(i) = 413 THEN ANGIN = 1
IF DX#(i) = 4111 THEN ANGIN = 1
IF DX#(i) >= 4130 AND DX#(i) <= 4139 THEN ANGIN = 1
VARLABEL ANGIN 'ANGINA'
IF ANGIN <> 1 THEN ANGIN = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 4111 THEN UNANGIN = 1
VARLABEL UNANGIN 'UNSTABLE ANGINA'
IF UNANGIN <> 1 THEN UNANGIN = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 410 THEN AMI = 1
IF DX#(i) >= 4100 AND DX#(i) <= 4109 THEN AMI = 1
IF DX#(i) >= 41000 AND DX#(i) <= 41092 THEN AMI = 1
VARLABEL AMI 'ACUTE MYOCARDIAL INFARCTION'
IF AMI <> 1 THEN AMI = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 412 OR DX#(i) = 4148 THEN OLDMI = 1
VARLABEL OLDMI 'OLD MYOCARDIAL INFARCTION'
IF OLDMI <> 1 THEN OLDMI = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 428 THEN CHF = 1
IF DX#(i) >= 4280 AND DX#(i) <= 4289 THEN CHF = 1
IF DX#(i) = 39891 THEN CHF = 1
IF DX#(i) = 40201 OR DX#(i) = 40211 OR DX#(i) = 40291 OR DX#(i) = 40401 OR DX#(i
) = 40411 OR DX#(i) = 40491 THEN HPTN = 1
VARLABEL CHF 'CONGESTIVE HEART FAILURE'
IF CHF<> 1 THEN CHF = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) >= 401 AND DX#(i) <= 405 THEN HPTN = 1
IF DX#(i) >= 4010 AND DX#(i) <= 4059 THEN HPTN = 1
IF DX#(i) = 4372 OR DX#(i) = 40200 THEN HPTN = 1
IF DX#(i) = 40301 OR DX#(i) = 40311 OR DX#(i) = 40391 OR DX#(i) = 40402 OR DX#(i
) = 40412 OR DX#(i) = 40492 THEN HPTN = 1
IF DX#(i) = 40210 OR DX#(i) = 40290 THEN HPTN = 1
IF DX#(i) = 40300 OR DX#(i) = 40310 OR DX#(i) = 40390 OR DX#(i) = 40400 OR DX#(i
) = 40410 OR DX#(i) = 40490 THEN HPTN = 1
IF DX#(i) = 40403 OR DX#(i) = 40413 OR DX#(i) = 40493 THEN HPTN = 1
VARLABEL HPTN 'HYPERTENSION'
IF HPTN <> 1 THEN HPTN = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 40201 OR DX#(i) = 40211 OR DX#(i) = 40291 OR DX#(i) = 40401 OR DX#(i
) = 40411 OR DX#(i) = 40491 THEN HPTNCHF = 1
VARLABEL HPTNCHF 'HYPERTENSION + CHF'
IF HPTNCHF <> 1 THEN HPTNCHF = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 40301 OR DX#(i) = 40311 OR DX#(i) = 40391 OR DX#(i) = 40402 OR DX#(i
) = 40412 OR DX#(i) = 40492 THEN HPTNCRF = 1
VARLABEL HPTNCRF 'HYPERTENSION + CHRONIC RENAL FAILURE'
IF HPTNCRF <> 1 THEN HPTNCRF = 0
```

```
NEXT
FOR i = 1 TO 8
IF DX#(i) = 40403 OR DX#(i) = 40413 OR DX#(i) = 40493 THEN HPTCRCHF = 1
VARLABEL HPTCRCHF 'HYPERTENSION + CRF + CHF'
IF HPTCRCHF <> 1  THEN HPTCRCHF = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) >= 2720 AND DX#(i) <= 2724 THEN CHOLIPID = 1
VARLABEL CHOLIPID 'HYPERCHOLESTEROLEMIA/HYPERLIPIDEMIA'
IF CHOLIPID <> 1 THEN CHOLIPID = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 585 THEN CRF = 1
IF DX#(i) = 40301 OR DX# (i) = 40311 OR DX#(i) = 40391 THEN CRF = 1
IF DX#(i) = 40402 OR DX#(i) = 40412 OR DX#(i) = 40492 THEN CRF = 1
IF DX#(i) = 40403 OR DX#(i) = 40413 OR DX#(i) = 40493 THEN CRF = 1
VARLABEL CRF 'CHRONIC RENAL FAILURE'
IF CRF <> 1 THEN CRF = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) >= 490 AND DX#(i) <= 494 THEN COPD = 1
IF DX#(i) = 496 THEN COPD = 1
IF DX#(i) >= 4910 AND DX#(i) <= 4928 THEN COPD = 1
IF DX#(i) = 4932 THEN COPD = 1
IF DX#(i) >= 49120 AND DX#(i) <= 49121 THEN COPD = 1
VARLABEL COPD 'CHRONIC OBSTRUCTIVE PULMONARY DISEASE'
IF COPD <> 1 THEN COPD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 571 THEN CLF = 1
IF DX#(i) >= 5710 AND DX#(i) <= 5719 THEN CLF = 1
IF DX#(i) >= 5722 AND DX#(i) <= 5724 THEN CLF = 1
IF DX#(i) >= 57140 AND DX#(i) <= 57149 THEN CLF = 1
VARLABEL CLF 'CHRONIC LIVER FAILURE'
IF CLF <> 1 THEN CLF = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) >= 440 AND DX#(i) <= 442 THEN ATHANEU = 1
IF DX#(i) >= 4400 AND DX#(i) <= 4429 THEN ATHANEU = 1
IF DX#(i) >= 44020 AND DX#(i) <= 44289 THEN ATHANEU = 1
IF DX#(i) = 4439 THEN ATHANEU = 1
VARLABEL ATHANEU 'ATHEROSCLEROSIS OR ANEURYSM'
IF ATHANEU <> 1 THEN ATHANEU = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 250 THEN DM = 1
IF DX#(i) >= 2500 AND DX#(i) <= 2509 THEN DM =1
IF DX#(i) >= 25000 AND DX#(i) <= 25093 THEN DM = 1
IF DX#(i) = 250 THEN DM = 1
VARLABEL DM 'DIABETES MELLITIS'
IF DM <> 1 THEN DM = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 394 THEN MVD = 1
IF DX#(i) >= 3940 AND DX#(i) <= 3949 THEN MVD = 1
IF DX#(i) = 4240 THEN MVD = 1
VARLABEL MVD 'MITRAL VALVE DISEASE'
IF MVD <>  1 THEN MVD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 395 THEN AVD = 1
IF DX#(i) >= 3950 AND DX#(i) <= 3959 THEN AVD = 1
IF DX#(i) = 4241 THEN AVD = 1
VARLABEL AVD 'AORTIC VALVE DISEASE'
IF AVD <> 1 THEN AVD = 0
```

```
NEXT
FOR i = 1 TO 8
IF DX#(i) = 396 THEN MVDAVD = 1
IF DX#(i) >= 3960 AND DX#(i) <= 3969 THEN MVDAVD = 1
VARLABEL MVDAVD 'MITRAL VALVE AND AORTIC VALVE DISEASE'
IF MVDAVD <> 1 THEN MVDAVD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 3970 OR DX#(i) = 4242 THEN TVD = 1
VARLABEL TVD 'TRICUSPID VALVE DISEASE'
IF TVD <> 1 THEN TVD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 3971 OR DX#(i) = 4243 THEN PVALVD = 1
VARLABEL PVALVD 'PULMONIC VALVE DISEASE'
IF PVALVD <> 1 THEN PVALVD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 4370 OR DX#(i) = 4372 THEN CEREBVD = 1
VARLABEL CEREBVD 'CEREBROVASCULAR DISEASE'
IF CEREBVD <> 1 THEN CEREBVD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) >= 2860 AND DX#(i) <= 2864 THEN COAG = 1
IF DX#(i) >= 2870 AND DX#(i) <= 2873  THEN COAG = 1
IF DX#(i) >= 2878 AND DX#(i) <= 2879 THEN COAG = 1
VARLABEL COAG 'COAGULAPATHY'
IF COAG <> 1 THEN COAG = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 416 THEN PULHD = 1
VARLABEL PULHD 'CHRONIC PULMONARY HEART DISEASE'
IF DX#(i) <> 1 THEN PULHD = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 41410 THEN ANVENT = 1
VARLABEL ANVENT 'VENTRICULAR ANEURYSM'
IF ANVENT <> 1 THEN ANVENT = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = .1 THEN REPCABG = 1
IF DX#(i) >= 41402 AND  DX#(i) <= 41403 THEN REPCABG = 1
VARLABEL REPCABG 'REPEAT CABG'
IF REPCABG <> 1 THEN REPCABG = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 4293 THEN CARDIMEG = 1
VARLABEL CARDIMEG 'CARDIOMEGALY'
IF CARDIMEG <> 1 THEN CARDIMEG = 0
NEXT
FOR i = 1 TO 8
IF DX#(i) = 2780 THEN OBESITY = 1
IF OBESITY <> 1 THEN OBESITY = 0
NEXT
IF SOURCEAD = 0 THEN EMERG = 1
VARLABEL EMERG 'EMERGENCY ADMISSION'
IF EMERG <> 1 THEN EMERG = 0
IF SOURCEAD >= 4 AND SOURCEAD <= 8 THEN TRANSF = 1
VARLABEL TRANSF 'TRANSFER FROM ANOTHER HOSPITAL'
IF TRANSF <> 1 THEN TRANSF = 0
IF DISPOS = 30 THEN DEATH = 1
VARLABEL DEATH 'DIED DURING INPATIENT STAY'
IF DEATH <> 1 THEN DEATH = 0
IF DEATH = 1 OR DISPOS = 21 OR DISPOS = 22 OR DISPOS = 24 OR DISPOS = 25 OR DISP
OS = 27 OR DISPOS = 55 THEN ADVEVEN = 1
```

```
VARLABEL ADVEVEN 'ADVERSE EVENT'
IF ADVEVEN <> 1 THEN ADVEVEN = 0
IF HPTNCHF = 1 OR. HPTNCRF = 1 OR HPTCRCHF = 1 THEN HPTNCOMP = 1
IF HPTNCOMP <> 1 THEN HPTNCOMP = 0
LOS = DATEDIFF(ADMDATE,DISDATE)
ARRAY PRO# PRO1 TO PRO8
FOR j = 1 TO 8
IF PRO#(j) >= 3520 AND PRO#(j) <= 3528 THEN VALVE = 1
VARLABEL VALVE 'CONCURRENT VALVE REPLACEMENT'
IF VALVE <> 1 THEN VALVE = 0
NEXT
FOR j = 1 TO 8
IF PRO#(j) = 3732 THEN VENTAN = 1
VARLABEL VENTAN 'CONCURRENT VENTRICULAR ANEURYSM REPAIR'
IF VENTAN <> 1 THEN VENTAN = 0.
NEXT
FOR j = 1 TO 8
IF PRO#(j) >= 3500 AND PRO#(j) <= 3573 THEN CONCURHT = 1
IF PRO#(j) >= 3591 AND PRO#(j) <= 3599 THEN CONCURHT = 1
IF PRO#(j) = 3603 THEN CONCURHT = 1
IF PRO#(j) = 3732 THEN CONCURHT = 1
VARLABEL CONCURHT 'CONCURRENT OTHER HEART OP'
IF CONCURHT <> 1 THEN CONCURHT = 0.
NEXT
```

APPENDIX B: Observation Consent and Checklists

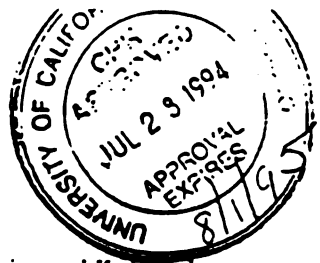
Observation Consent

PAWP Assessment Performance Checklist

Cuff BP Assessment Performance Checklist

Arterial-line BP Assessment Performance Checklist

Hemodynamic Measurement/Intervention Database Codebook



UNIVERSITY OF CALIFORNIA, SAN FRANCISCO
CONSENT TO BE A RESEARCH SUBJECT

Identifying Process Variations Via Risk-Adjusted Outcome

A. PURPOSE AND BACKGROUND

Suzanne Bakken Henry, R.N., D.N.Sc., Assistant Professor at UCSF School of Nursing and Kathryn J. Dolter, R.N., C.C.R.N., Doctoral Candidate at UCSF, MAJ/AN are conducting a study on hemodynamic knowledge and practice variation among coronary artery bypass graft surgery (CABGS) patient care providers at Department of Defense medical centers which I am being asked to participate in.

This study is designed to gather information about my hemodynamic knowledge and my assessment of the organizational culture in which I practice. I have been asked to participate in this study because I am a CABGS patient care provider.

B. PROCEDURES

If I agree to be in the study, the following will occur:

1. I will complete demographic, hemodynamic (pulmonary artery catheter and blood pressure measurement) knowledge assessment, and organizational culture questionnaires. These questionnaires will take about 45 minutes to complete.

2. I will be observed performing hemodynamic measurements (pulmonary artery catheter and blood pressure) and intervening for these measurements (administrating/titrating vasoactive drips, volume expanders, and diuretics) during the normal care I provide a post-operative CABGS patient.

C. RISKS/DISCOMFORTS

Risks or discomforts in participating in this study may be the potential loss of confidentiality concerning my hemodynamic knowledge assessment questionnaire results. Also, there may be some discomfort in having my post-operative patient care observed.

My answers to all questionnaires and any observations of my CABGS patient care processes will be kept as confidential as is possible. I am under no pressure from the commanding officer of my unit or medical center to participate in this study. Study records will be kept as confidential as possible. No individual identities will be used in any reports or publication resulting from this study. The questionnaires will be coded and when completed will then be kept at all times in a confidential file not accessible to any Department of Defense nursing or medical staff. Only the study investigators will have access to them. After the study has been completed all data will be destroyed.

D. BENEFITS

I may benefit in participating in this study due to the feedback provided on my hemodynamic knowledge assessment questionnaires. It is hoped that the information gained from this study will contribute to the development of knowledge concerning hemodynamic practice variations in CABGS patients.

E ALTERNATIVES

I am free to refuse to participate or to withdraw from this research at any time without jeopardizing my position/rank in my organization.

F COSTS

There will be no costs to me as a result of taking part in this study.

G REIMBURSEMENT

I will not be reimbursed for participating in this study.

H QUESTIONS

This study has been explained to me by Dr. Henry, MAJ Dolter or their research assistant. If I have any further questions about this study, I may call MAJ Dolter at (415) 326-6447.

If I have any questions or comments about participation in this study. I should first talk to the investigator. If for some reason I don not wish to do this, I may contact the Committee on Human Research, which is concerned with protection of volunteers in research projects. I may reach the Committee Office between 0800 and 1700 (Pacific Time), Monday through Friday, by calling (415) 476-1814 or by writing to the committee on Human Research, Suite 11, Laurel Heights Campus, Box 0516, University of California, San Francisco, CA 94143.

I. Consent

I have been given a copy of this consent to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY, I am free to decline to be in this study, or to withdraw from it at any point. My decision as to whether or not to participate in this study will have no influence on my present or future status as a health care provider at this or any Department of Defense health care institution.

Date _____ Subject's Signature _____

Person Obtaining Consent _____

Hemodynamic Assessment Performance Checklists

PAWP Assessment Performance Checklists

Unit # _____ Nurse #_____

Patient #_____Date / Time_____

PAWP Assessment Criteria Checklist: (Measurement score calculated by adding up number of responses marked by *, 1 point given for each star *)

Waveform

1. Nurse assessed waveform:
   a. Yes*
   b. No
2. Rater's classification of monitor waveform at initiation of PAWP measurement:
   a. Right ventricle
   b. Pulmonary artery with distinct dicrotic notch*
   c. Pulmonary artery with indistinct dicrotic notch
   d. In and out of Pulmonary artery and PAWP
   e. Atrial type waveform (PAWP or CVP)
   f. Unable to classify

Calibration

3. Nurse performed monitor calibration:
   a. Yes*
   b. No

OR (total of 3 and 4 can only equal 1)

4. Monitor is self calibrating (per manufacturer literature):
   a. Yes *
   b. No
5. Nurse performed transducer calibration:
   a. Yes*
   b. No

Zeroing

6. Nurse performed zeroing of transducer:
   a. Yes*
   b. No
7. If nurse performed zeroing, the stopcock nurse used for zeroing procedure:
   a. Stopcock adjacent to transducer
   b. Stopcock adjacent to patient
   c. Other (describe)_____

Leveling

8. Nurse performed some type of leveling procedure:
   a. Yes*
   b. No
9. If nurse performed leveling procedure, designate the type of leveling device she used:
   a. Eyeball
   b. Carpenter's level*
   c. Height marker
   d. Other (describe)_____
10. Nurse used zeroing stopcock as transducer leveling reference point:
   a. Yes*
   b. No
11. Nurse used phlebostatic axis as patient leveling reference point:
   a. Yes*
   b. No
   c. Describe point on patient leveled to by marking on patient figure provided. (Insert patient figure)
12. Phlebostatic axis / reference point was marked on patient:
   a. Yes*
   b. No
13. Patient position during leveling procedure:
   a. Supine*
   b. Lateral
   c. Other
14. Head of bed elevation, during leveling procedure (approximate)(1 point given if patient in any position < or = 45°*):
   ___ (Enter approximate degrees)

Dynamic Response Assessment

15. Nurse performed square wave / dynamic response check:
   a. Yes*
   b. No
16. Nurse assessed dynamic response on paper:
   a. Yes*
   b. No
17. Nurse troubleshooted inadequate dynamic response until adequate dynamic response obtained:
   a. Yes*
   b. No

Balloon Inflation Technique

18. Nurse assessed waveform during balloon inflation:
   a. Yes*
   b. No
19. PAWP obtained on balloon inflation was adequate:

(a, c, and v waves identifiable: no overwedge detected; phasic with cardiac cycle)
a. Yes*
b. No

20. Cannon "a" or "v" waves, when present in the PAWP waveform, were identified by the nurse and appropriately measured. (Appropriate = mean PAWP was not recorded and peak of a or v waves or end-exhalation mean a wave (if cannon v wave) or end-exhalation mean v wave (if cannon a wave) is a recorded):
a. Yes*
b. No

Digital vs. Graphic PAWP Recording

21. Nurse took PAWP measurement from (1 point for any of * choices):
a. Digital read-out
b. Paper recording*
c. Oscilloscope / Monitor moving graph*
d. Oscilloscope / Monitor freeze frame graph*

Assessment of Respiratory Variation

22. PAWP had respiratory variation:
a. Yes
b. No
23. Nurse assessed waveform for respiratory variation:
a. Yes*
b. No
24. The nurse used the following technique to assess the PAWP when it had respiratory variation:
a. End-exhalation*
b. Averaging
c. Other (describe)_____
25. Rater's judgement of the value obtained by the nurse's assessment of the PAWP with respiratory variation: (was within 2 mm)
a. Accurate*
b. Inaccurate
26. Nurse disconnected patient from vent for PAWP measurement:
a. Yes
b. No*
27. PAWP relationship to PAD (1 point for either b or c):
a. PAWP > PAD
b. PAWP < PAD*
c. PAWP = PAD*
28. Copy of PAWP waveform place in record or kept for review:
a. Yes*
b. No
29. Balloon inflation volume noted on chart:
a. Yes*
b. No

30. Attach copy of PAWP waveform if obtainable:

31. Total = # of Yes Responses/Total: ___/27_.

Patient Variables Affecting PAWP Interpretation

32. Patient's heart rate < 120 beats per minute:
    a. Yes
    b. No
33. Patient On Ventilatory Assistance:
    a. None
    b. Assist-Control or Controlled Mandatory
    c. Synchronized Intermittent Mandatory
    d. Inverse Ratio Ventilation
    e. Pressure Support
    f. CPAP
    g. Other_____
34. Patient on Peep > 10 cm:
    a. Yes
    b. No
35. Patient with history of mitral valve disease:
    a. Yes
    b. No
36. Patient's albumin < 3.5:
    a. Yes
    b. No
37. Patient with history of COPD:
    a. Yes
    b. No
38. Patient's BP < 90:
    a. Yes
    b. No
39. Patient on vasoactive drips:
    a. Yes
    b. No
40. Patient on intra-aortic balloon pump:
    a. Yes
    b. No
41. Patient on ventricular assist device:
    a. Yes
    b. No
42. Patient with diagnosi of ARDS
    a. Yes
    b. No
43. Patient with diagnosis of sepsis:

a. Yes
b. No

44. Patient with history of myocardial infarction:
    a. Yes
    b. No
45. Patient with history of cardiomyopathy:
    a. Yes
    b. No

Cuff BP Assessment Performance Checklists

Unit #_____ Nurse #_____

Patient #_____Date / Time_____

Cuff BP Assessment Criteria Checklist:

(Each * or + response coded as 1)

1. Type of cuff measurement device used:
   a. Manual (* = criteria for manual BP assessment)
   b. Automatic (+ = criteria for automatic assessment)
2. Bladder width 40 - 50% of upper arm circumference:
   a. Yes*+
   b. No
3. Bladder placed appropriately: snugly, centered over artery, arm without clothing:
   a. Yes*+
   b. No
4. Bulb exhaust valve unobstructed:
   a. Yes*
   b. No
5. Cuff tubing without kinks or leaks:
   a. Yes*+
   b. No
6. Mercury meniscus/aneroid manometer at observer eye-level:
   a. Yes*
   b. No
7. Verification of patient systolic pressure by palpation prior to auscultation:
   a. Yes*
   b. No
8. Arm supported at heart level:
   a. Yes*+
   b. No
9. Stethoscope bell used:
   a. Yes*
   b. No
10. Stethoscope bell placed lightly over brachial artery at antecubital fossa:
    a. Yes*
    b. No
11. 2 - 3 second rate of deflation:
    a. Yes*
    b. No
12. Systolic, muffling, and diastolic pressure correctly ascertained:
    (observer with adequate hearing in quiet environment)
    a. Yes*
    b. No
13. Total Manual BP Score = Total # of *___/ 11
14. Total Automatic Score = Total # of + ___/4__

Patient Manual Cuff BP Physiologic Criteria

15. Patient of normal weight:
    a. Yes*
    b. No
16. Patient without peripheral edema:
    a. Yes*
    b. No
17. Patient without peripheral vascular disease:
    a. Yes*
    b. No
18. Patient with normal systemic vascular resistance (no shock or hypothermia):
    a. Yes*
    b. No
19. Patient at rest for 5 minutes:
    a. Yes*
    b. No
20. Patient without pain, anxiety, or discomfort:
    a. Yes*
    b. No

Arterial-line BP Assessment Performance Checklists

Unit #_____

Nurse #_____Patient #_____Date / Time_____

Arterial-Line BP Assessment Checklist:

1. System zeroed to air:
   a. Yes*
   b. No
2. System calibrated electrically:
   a. Yes*
   b. No
3. System calibrated mechanically:
   a. Yes*
   b. No
4. System air reference transducer leveled to phlebostatic axis:
   a. Yes*
   b. No
5. System with adequate dynamic response:
   a. Yes*
   b. No
6. Total A-line Score = Total # of starred Responses___/ 5

Patient A-line BP Physiologic Criteria

7. Patient without atherosclerosis:
   a. Yes
   b. No
8. Patient without altered systemic vascular resistance (hypothermia, shock):
   a. Yes
   b. No
9. Site of catheter:
   a. Yes
   b. No

Module: BUILD, File Information 08-22-1995 Page: 1
File: DRIPBACL

FILTER: None

Created: 12-31-1994 Vars: 86 Bytes: 306848
Modified: 08-03-1995 Obs: 436
Sort Variables: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
1	SITE	MEDICAL CENTER SITE NUMBER	8	0	N	0
2	PTSEQNUM	PATIENT SEQUENCE NUMBER	8	0	N	0
3	PTWT	PATIENT WEIGHT IN KG	8	0	N	0
4	RNSEQNUM	RN SEQUENCE NUMBER	8	2	N	0
5	ADMTIME	TIME ADMITTED TO ICU	8	0	N	0
6	DRIPTIME	TIME DRIPS/VS RECORDED	8	0	N	0
7	HR	HEART RATE	8	0	N	0
8	RR	RESPIRATORY RATE	8	0	N	0
9	CUFALIN	RN USING CUFF OR A-LINE 1 = ARTERIAL LINE 2 MANUAL OR NONIN CUFF 3 = IABP A-LINE 4 = 2ND A-LINE	8	0	N	4
10	SBP	SYSTOLIC BLOOD PRESSURE	8	0	N	0
11	DBP	DIASTOLIC BLOOD PRESSURE	8	0	N	0
12	MAP	MEAN ARTERIAL PRESSURE	8	0	N	0
13	TEMP	TEMPERATURE	8	2	N	0
14	PAS	PUMLMONARY ARTERY SYSTOLIC	8	0	N	0
15	PAD	PULMONARY ARTERY DIASTOLIC	8	0	N	0
16	PAM	PULMONARY ARTERY MEAN	8	0	N	0
17	PAWP	PULMONARY ARTERY WEDGE	8	0	N	0
18	SVO2	MIXED VENOUS O2 SATURATION	8	0	N	0
19	CVP	CENTRAL VENOUS PRESSURE	8	0	N	0
20	CO	CARDIAC OUTPUT	8	2	N	0
21	CI	CARDIAC INDEX	8	2	N	0
22	SVR	SYSTEMIC VASCULAR RESISTANCE	8	0	N	0
23	LVSWI	LEFT VENTRICULAR STROKE WORK INDEX	8	2	N	0
24	RVSWI	RIGHT VENTRICULAR STROKE WORK INDEX	8	2	N	0
25	MTOUTPUT	MEDIASTINAL OUTPUT	8	3	N	0
26	UO	URINE OUTPUT	8	0	N	0
27	HGB	HEMOGLOBIN	8	2	N	0
28	HCT	HEMATOCRIT	8	2	N	0

Module: BUILD, File Information 08-22-1995 Page: 2
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Pmt	Type	Value Labels
29	MDNOTVS1	MD NOTIFIED OF VITAL SIGN	8	0	N	22
		1 = TEMP				
		2 = BLOOD PRESSURE				
		3 = HEART RATE				
		4 = PAD				
		5 = PAWP				
		6 = CVP				
		7 = U/O				
		8 = MT OUTPUT				
		9 = HGB/HCT				
		10 = PT/PTT				
		11 = MD AT BEDSIDE				
		12 = ABG				
		13 = ELECTROLYTES				
		14 = CO/CI				
		15 = MD CALLED FOR STAT				
		16 = ANES NOTI PEND EXT				
		17 = PA IN RV				
		18 = CBC/LYTES/ABG/PT/P				
		19 = BLOODY ETS SPUTUM				
		20 = INCREASED ECTOPY				
		21 = STAFF MD CALLED IN				
		22 = POOR PA WAVEFORM				
30	MDNOTVS2	MD NOTIFIED OF VITAL SIGN	8	0	N	22
		1 = TEMP				
		2 = BLOOD PRESSURE				
		3 = HEART RATE				
		4 = PAD				
		5 = PAWP				
		6 = CVP				
		7 = U/O				
		8 = MT OUTPUT				
		9 = HGB/HCT				
		10 = PT/PTT				
		11 = MD AT BEDSIDE				
		12 = ABG				
		13 = ELECTROLYTES				
		14 = CO/CI				
		15 = MD CALLED FOR STAT				
		16 = ANES NOTI PEND EXT				
		17 = PA IN RV				
		18 = CBC/LYTES/ABG/PT/P				
		19 = BLOODY ETS SPUTUM				
		20 = INCREASED ECTOPY				
		21 = STAFF MD CALLED IN				
		22 = POOR PA WAVEFORM				

Module: BUILD, File Information 08-22-1995 Page: 3
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
31	MDNOTVS3	MD NOTIFIED OF VITAL SIGN	8	0	N	22
		1 = TEMP				
		2 = BLOOD PRESSURE				
		3 = HEART RATE				
		4 = PAD				
		5 = PAWP				
		6 = CVP				
		7 = U/O				
		8 = MT OUTPUT				
		9 = HGB/HCT				
		10 = PT/PTT				
		11 = MD AT BEDSIDE				
		12 = ABG				
		13 = ELECTROLYTES				
		14 = CO/CI				
		15 = MD CALLED FOR STAT				
		16 = ANES NOTI PEND EXT				
		17 = PA IN RV				
		18 = CBC/LYTES/ABG/PT/P				
		19 = BLOODY ETS SPUTUM				
		20 = INCREASED ECTOPY				
		21 = STAFF MD CALLED IN				
		22 = POOR PA WAVEFORM				
32	NIPRIDE	NIPRIDE RATE	8	3	N	0
33	NIPINTE	NIPRIDE INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
34	NTG	NTG RATE	8	3	N	0
35	NTGINTE	NTG INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
36	DOBUT	DOBUTAMINE RATE	8	3	N	0
37	DOBUTINT	DOBATAMINE INTERVENTION	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				

Module: BUILD, File Information 08-22-1995 Page: 4
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
38	DOPAMINE	DOPAMINE RATE	8	3	N	0
39	DOPINT	DOPAMINE INTERVENTION (DEP, INDEP, COLL) 0 = NO CHANGE/NO INTER 1 = RN PERF S MD NOT/C 2 = RN PERF P MD NOT/C 3 = MD ORDER S RN NOTI 4 = RN CONSU C ANOT RN 5 RN PERF SIMU C MD OR 6 = ACCIDENTAL DISCON 7 = MD PERFORMED	8	0	N	8
40	INOCOR	INOCOR RATE	8	3	N	0
41	INOINT	INOCOR INTERVENTION (DEP, INDEP, COLL) 0 = NO CHANGE/NO INTER 1 = RN PERF S MD NOT/C 2 = RN PERF P MD NOT/C 3 = MD ORDER S RN NOTI 4 = RN CONSU C ANOT RN 5 RN PERF SIMU C MD OR 6 = ACCIDENTAL DISCON 7 = MD PERFORMED	8	0	N	8
42	ESMOLOL	ESMOLOL RATE	8	3	N	0
43	ESMOINT	ESMOLOL INTERVENTION (DEP, INDEP, COLL) 0 = NO CHANGE/NO INTER 1 = RN PERF S MD NOT/C 2 = RN PERF P MD NOT/C 3 = MD ORDER S RN NOTI 4 = RN CONSU C ANOT RN 5 RN PERF SIMU C MD OR 6 = ACCIDENTAL DISCON 7 = MD PERFORMED	8	0	N	8
44	EPI	EPINEPHRINE RATE	8	3	N	0
45	EPIINT	EPINEPHRINE INTER (DEP, INDEP, COLLABOR) 0 = NO CHANGE/NO INTER 1 = RN PERF S MD NOT/C 2 = RN PERF P MD NOT/C 3 = MD ORDER S RN NOTI 4 = RN CONSU C ANOT RN 5 RN PERF SIMU C MD OR 6 = ACCIDENTAL DISCON 7 = MD PERFORMED	8	0	N	8
46	LEVOP	LEVOPHED RATE	8	3	N	0
47	LEVOINT	LEVOPHED INTERVENTION (DEP, INDEP, COLL) 0 = NO CHANGE/NO INTER 1 = RN PERF S MD NOT/C 2 = RN PERF P MD NOT/C 3 = MD ORDER S RN NOTI 4 = RN CONSU C ANOT RN 5 RN PERF SIMU C MD OR 6 = ACCIDENTAL DISCON 7 = MD PERFORMED	8	0	N	8
48	NEO	NEOSYNEPHRINE RATE	8	3	N	0

Module: BUILD, File Information 08-22-1995 Page: 5
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
49	NEOINT	NEOSYNEPHRINE INTERVENTION (DEP, INDEP,.	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
50	OTHDRIP1	OTHER DRIP 1 RATE	8	3	N	0
51	OTHDRIIN	OTHER DRIP INTERVENTION (DEP, INDEP, COL	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
52	OTHDRIP2	OTHER DRIP 2 RATE	8	3	N	0
53	OTHD2INT	OTHER DRIP 2 INTERVENTION	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
54	OTHDRIP3	OTHER DRIP 3 RATE	8	2	N	0
55	OTHD3INT	OTHER DRIP 3 INTERVENTION (DEP, INDEP,)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
56	OTHDRIP4	OTHER DRIP 4 RATE	8	2	N	0
57	OTHD4INT	OTHER DRIP 4 INTERVENTION (DEP, INDEP,)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
58	OTHER1	OTHER INTERVENTION 1	8	2	N	100
		1.00 = ECHOCARDIOGRAM				
		2.00 = BRONCH				
		3.00 = RETURN TO OR				

Module: BUILD, File Information 08-22-1995 Page: 6
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		4.00 = RE-CARD CATH				
		5.00 = PTCA				
		6.00 = SUCTION				
		7.00 = K+ BOLUS				
		8.00 = MG+ BOLUS				
		9.00 = CA++ BOLU				
		10.00 = PAIN MED				
		11.00 = REPOS NO LEVEL				
		11.10 = REPOS WITH RELEVEL				
		11.20 = REPOS C REL + REZ				
		12.00 = DIURETIC				
		13.00 = ABG				
		14.00 = HGB/HCT				
		15.00 = LYTES				
		16.00 = COAGS				
		17.00 = CXR				
		18.00 = EKG				
		19.00 = MANNITOL				
		20.00 = INSULIN DRIP				
		21.00 = OOB TO CHAIR				
		22.00 = NAHCO3				
		23.00 = EXTUBATE				
		24.00 = DECR VENT RATE				
		25.00 = CPAP				
		26.00 = IMMED POSTOP LABS				
		27.00 = INCR VENT RATE				
		28.00 = PA CATH MANIP				
		29.00 = DECR FIO2				
		30.00 = INDERAL NG				
		31.00 = INCENTIVE SPIRO				
		32.00 = IV DIGOXIN				
		33.00 = VERSED				
		35.00 = IV BOLUS OF NIP				
		36.00 = NIFIDIPINE				
		37.00 = NT PASTE				
		39.00 = TYLENOL				
		42.00 = RELEVEL S LEVEL				
		42.10 = RELEVEL C EYEBA				
		42.20 = REL C CARP LEVE				
		42.30 = MD REL C CARPLE				
		43.00 = RELEVEL				
		44.00 = AMICAR				
		45.00 = PROTAMINE				
		46.00 = PACER CHAN TO DEM				
		48.00 = INCREASE PEEP				
		49.00 = SUFENTA				
		50.00 = PACER ON				
		51.00 = PACER OFF				
		52.00 = PRIMACOR				
		53.00 = MIXED VENOUS				
		53.10 CALIB MIXED VEN				
		54.00 = INSULIN BOLUS				
		55.00 = INCREASE VT				

Module: BUILD, File Information 08-22-1995 Page: 7
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		56.00 = DECREASE PEEP				
		57.00 = CALIBRATE SVO2 MAC				
		58.00 = CALIBRATE CO/CI MA				
		59.00 = LIDOCAINE BOLUS				
		60.00 = ATRIAL EKG				
		61.00 = LOPRESSOR				
		62.00 = PROTAMINE				
		63.00 = HAND FLUSHED PA				
		64.00 = PA REFLOATED				
		65.00 DECR AMNT ALINE TUB				
		66.00 = DECRE ACURRACY %				
		67.00 = PO4 BOLUS				
		68.00 CHANGE TO 2X STR NIP				
		70.00 = PLACED NEW ALINE				
		71.00 = IABP				
		73.00 = LACTATE LEVELS				
		74.00 = PA CATH FLOATED				
		75.00 DC FEM SHEATH/ALINE				
		76.00 = LOPRESSOR BOLUS				
		77.00 = APRESOLINE BOLUS				
		78.00 = OVERDRIVE PACER				
		79.00 = LOADED WITH DIG				
		80.00 IMED INFUS TECH DIF				
		81.00 = EMERGENCY CARDIOV				
		83.00 THREAD NEW PACER WIR				
		84.00 = PROCAINE LEVEL				
		85.00 PACER SETTINS CHANGE				
		86.00 = WEANING PARAMETERS				
		87.00 RECHECKED CUFF/ALINE				
		88.00 CHANGE/CHECK DRUG IV				
		89.00 NIBP PLACE, TIT BY				
		90.00 DEC AMNT ALINE TUBIN				
		91.00 TROUBLESHOOTING ALIN				
		92.30 INCRE FIO2				
		93.30 REINTUBATED				
		94.00 CONTINOUS KCL DRIP				
		95.00 REDRESS OF LEG OOZE				
		97.00 = NORCURON				
		98.00 = KPO4 DRIP				
		100.00 = DDD PACER				
		101.00 = REP IABP SHEATH				
		104.00 = PROPOTHOL DRIP				
		105.00 = TRENDELENBERG				
		106.00 TROUBLESHOOT IABP				
59	OTHER2	OTHER INTERVENTION 2	8	2	N	100
		1.00 = ECHOCARDIOGRAM				
		2.00 = BRONCH				
		3.00 = RETURN TO OR				
		4.00 = RE-CARD CATH				
		5.00 = PTCA				
		6.00 = SUCTION				
		7.00 = K+ BOLUS				
		8.00 = MG+ BOLUS				

Module: BUILD, File Information 08-22-1995 Page: 8
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
9.00		= CA++ BOLU				
10.00		= PAIN MED				
11.00		= REPOS NO LEVEL				
11.10		= REPOS WITH RELEVEL				
11.20		= REPOS C REL + REZ				
12.00		= DIURETIC				
13.00		= ABG				
14.00		= HGB/HCT				
15.00		= LYTES				
16.00		= COAGS				
17.00		= CXR				
18.00		= EKG				
19.00		= MANNITOL				
20.00		= INSULIN DRIP				
21.00		= OOB TO CHAIR				
22.00		= NAHCO3				
23.00		= EXTUBATE				
24.00		= DECR VENT RATE				
25.00		= CPAP				
26.00		= IMMED POSTOP LABS				
27.00		= INCR VENT RATE				
28.00		= PA CATH MANIP				
29.00		= DECR FIO2				
30.00		= INDERAL NG				
31.00		= INCENTIVE SPIRO				
32.00		= IV DIGOXIN				
33.00		= VERSED				
35.00		= IV BOLUS OF NIP				
36.00		= NIFIDIPINE				
37.00		= NT PASTE				
39.00		= TYLENOL				
42.00		= RELEVEL S LEVEL				
42.10		= RELEVEL C EYEBA				
42.20		= REL C CARP LEVE				
42.30		= MD REL C CARPLE				
43.00		= RELEVEL				
44.00		= AMICAR				
45.00		= PROTAMINE				
46.00		= PACER CHAN TO DEM				
48.00		= INCREASE PEEP				
49.00		= SUFENTA				
50.00		= PACER ON				
51.00		= PACER OFF				
52.00		= PRIMACOR				
53.00		= MIXED VENOUS				
53.10		CALIB MIXED VEN				
54.00		= INSULIN BOLUS				
55.00		= INCREASE VT				
56.00		= DECREASE PEEP				
57.00		= CALIBRATE SVO2 MAC				
58.00		= CALIBRATE CO/CI MA				
59.00		= LIDOCAINE BOLUS				
60.00		= ATRIAL EKG				

Module: BUILD, File Information 08-22-1995 Page: 9
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		61.00 = LOPRESSOR				
		62.00 = PROTAMINE				
		63.00 = HAND FLUSHED PA				
		64.00 = PA REFLOATED				
		65.00 DECR AMNT ALINE TUB				
		66.00 = DECRE ACURRACY %				
		67.00 = PO4 BOLUS				
		68.00 CHANGE TO 2X STR NIP				
		70.00 = PLACED NEW ALINE				
		71.00 = IABP				
		73.00 = LACTATE LEVELS				
		74.00 = PA CATH FLOATED				
		75.00 DC FEM SHEATH/ALINE				
		76.00 = LOPRESSOR BOLUS				
		77.00 = APRESOLINE BOLUS				
		78.00 = OVERDRIVE PACER				
		79.00 = LOADED WITH DIG				
		80.00 IMED INFUS TECH DIF				
		81.00 = EMERGENCY CARDIOV				
		83.00 THREAD NEW PACER WIR				
		84.00 = PROCAINE LEVEL				
		85.00 PACER SETTINS CHANGE				
		86.00 = WEANING PARAMETERS				
		87.00 RECHECKED CUFF/ALINE				
		88.00 CHANGE/CHECK DRUG IV				
		89.00 NIBP PLACE, TIT BY				
		90.00 DEC AMNT ALINE TUBIN				
		91.00 TROUBLESHOOTING ALIN				
		92.30 INCRE FIO2				
		93.30 REINTUBATED				
		94.00 CONTINOUS KCL DRIP				
		95.00 REDRESS OF LEG OOZE				
		97.00 = NORCURON				
		98.00 = KPO4 DRIP				
		100.00 = DDD PACER				
		101.00 = REP IABP SHEATH				
		104.00 = PROPOTHOL DRIP				
		105.00 = TRENDELENBERG				
		106.00 TROUBLESHOOT IABP				
60	OTHER3	OTHER INTERVENTION 3	8	2	N	100
		1.00 = ECHOCARDIOGRAM				
		2.00 = BRONCH				
		3.00 = RETURN TO OR				
		4.00 = RE-CARD CATH				
		5.00 = PTCA				
		6.00 = SUCTION				
		7.00 = K+ BOLUS				
		8.00 = MG+ BOLUS				
		9.00 = CA++ BOLU				
		10.00 = PAIN MED				
		11.00 = REPOS NO LEVEL				
		11.10 = REPOS WITH RELEVEL				
		11.20 = REPOS C REL + REZ				

Module: BUILD, File Information 08-22-1995 Page: 10
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Value Type	Labels
		12.00 = DIURETIC				
		13.00 = ABG				
		14.00 = HGB/HCT				
		15.00 = LYTES				
		16.00 = COAGS				
		17.00 = CXR				
		18.00 = EKG				
		19.00 = MANNITOL				
		20.00 = INSULIN DRIP				
		21.00 = OOB TO CHAIR				
		22.00 = NAHCO3				
		23.00 = EXTUBATE				
		24.00 = DECR VENT RATE				
		25.00 = CPAP				
		26.00 = IMMED POSTOP LABS				
		27.00 = INCR VENT RATE				
		28.00 = PA CATH MANIP				
		29.00 = DECR FIO2				
		30.00 = INDERAL NG				
		31.00 = INCENTIVE SPIRO				
		32.00 = IV DIGOXIN				
		33.00 = VERSED				
		35.00 = IV BOLUS OF NIP				
		36.00 = NIFIDIPINE				
		37.00 = NT PASTE				
		39.00 = TYLENOL				
		42.00 = RELEVEL S LEVEL				
		42.10 = RELEVEL C EYEBA				
		42.20 = REL C CARP LEVE				
		42.30 = MD REL C CARPLE				
		43.00 = RELEVEL				
		44.00 = AMICAR				
		45.00 = PROTAMINE				
		46.00 = PACER CHAN TO DEM				
		48.00 = INCREASE PEEP				
		49.00 = SUFENTA				
		50.00 = PACER ON				
		51.00 = PACER OFF				
		52.00 = PRIMACOR				
		53.00 = MIXED VENOUS				
		53.10 CALIB MIXED VEN				
		54.00 = INSULIN BOLUS				
		55.00 = INCREASE VT				
		56.00 = DECREASE PEEP				
		57.00 = CALIBRATE SVO2 MAC				
		58.00 = CALIBRATE CO/CI MA				
		59.00 = LIDOCAINE BOLUS				
		60.00 = ATRIAL EKG				
		61.00 = LOPRESSOR				
		62.00 = PROTAMINE				
		63.00 = HAND FLUSHED PA				
		64.00 = PA REFLOATED				
		65.00 DECR AMNT ALINE TUB				

Module: BUILD, File Information 08-22-1995 Page: 11
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		66.00 = DECRE ACURRACY %				
		67.00 = PO4 BOLUS				
		68.00 CHANGE TO 2X STR NIP				
		70.00 = PLACED NEW ALINE				
		71.00 = IABP				
		73.00 = LACTATE LEVELS				
		74.00 = PA CATH FLOATED				
		75.00 DC FEM SHEATH/ALINE				
		76.00 = LOPRESSOR BOLUS				
		77.00 = APRESOLINE BOLUS				
		78.00 = OVERDRIVE PACER				
		79.00 = LOADED WITH DIG				
		80.00 IMED INFUS TECH DIF				
		81.00 = EMERGENCY CARDIOV				
		83.00 THREAD NEW PACER WIR				
		84.00 = PROCAINE LEVEL				
		85.00 PACER SETTINS CHANGE				
		86.00 = WEANING PARAMETERS				
		87.00 RECHECKED CUFF/ALINE				
		88.00 CHANGE/CHECK DRUG IV				
		89.00 NIBP PLACE, TIT BY				
		90.00 DEC AMNT ALINE TUBIN				
		91.00 TROUBLESHOOTING ALIN				
		92.30 INCRE FIO2				
		93.30 REINTUBATED				
		94.00 CONTINOUS KCL DRIP				
		95.00 REDRESS OF LEG OOZE				
		97.00 = NORCURON				
		98.00 = KPO4 DRIP				
		100.00 = DDD PACER				
		101.00 = REP IABP SHEATH				
		104.00 = PROPOTHOL DRIP				
		105.00 = TRENDELENBERG				
		106.00 TROUBLESHOOT IABP				
61	OTHER4	OTHER INTERVENTION 4	8	2	N	100
		1.00 = ECHOCARDIOGRAM				
		2.00 = BRONCH				
		3.00 = RETURN TO OR				
		4.00 = RE-CARD CATH				
		5.00 = PTCA				
		6.00 = SUCTION				
		7.00 = K+ BOLUS				
		8.00 = MG+ BOLUS				
		9.00 = CA++ BOLU				
		10.00 = PAIN MED				
		11.00 = REPOS NO LEVEL				
		11.10 = REPOS WITH RELEVEL				
		11.20 = REPOS C REL + REZ				
		12.00 = DIURETIC				
		13.00 = ABG				
		14.00 = HGB/HCT				
		15.00 = LYTES				
		16.00 = COAGS				

Module: BUILD, File Information 08-22-1995 Page: 12
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		17.00 = CXR				
		18.00 = EKG				
		19.00 = MANNITOL				
		20.00 = INSULIN DRIP				
		21.00 = OOB TO CHAIR				
		22.00 = NAHCO3				
		23.00 = EXTUBATE				
		24.00 = DECR VENT RATE				
		25.00 = CPAP				
		26.00 = IMMED POSTOP LABS				
		27.00 = INCR VENT RATE				
		28.00 = PA CATH MANIP				
		29.00 = DECR FIO2				
		30.00 = INDERAL NG				
		31.00 = INCENTIVE SPIRO				
		32.00 = IV DIGOXIN				
		33.00 = VERSED				
		35.00 = IV BOLUS OF NIP				
		36.00 = NIFIDIPINE				
		37.00 = NT PASTE				
		39.00 = TYLENOL				
		42.00 = RELEVEL S LEVEL				
		42.10 = RELEVEL C EYEBA				
		42.20 = REL C CARP LEVE				
		42.30 = MD REL C CARPLE				
		43.00 = RELEVEL				
		44.00 = AMICAR				
		45.00 = PROTAMINE				
		46.00 = PACER CHAN TO DEM				
		48.00 = INCREASE PEEP				
		49.00 = SUFENTA				
		50.00 = PACER ON				
		51.00 = PACER OFF				
		52.00 = PRIMACOR				
		53.00 = MIXED VENOUS				
		53.10 CALIB MIXED VEN				
		54.00 = INSULIN BOLUS				
		55.00 = INCREASE VT				
		56.00 = DECREASE PEEP				
		57.00 = CALIBRATE SVO2 MAC				
		58.00 = CALIBRATE CO/CI MA				
		59.00 = LIDOCAINE BOLUS				
		60.00 = ATRIAL EKG				
		61.00 = LOPRESSOR				
		62.00 = PROTAMINE				
		63.00 = HAND FLUSHED PA				
		64.00 = PA REFLOATED				
		65.00 DECR AMNT ALINE TUB				
		66.00 = DECRE ACURRACY %				
		67.00 = PO4 BOLUS				
		68.00 CHANGE TO 2X STR NIP				
		70.00 = PLACED NEW ALINE				
		71.00 = IABP				

Module: BUILD, File Information 08-22-1995 Page: 13
File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
		73.00 = LACTATE LEVELS				
		74.00 = PA CATH FLOATED				
		75.00 DC FEM SHEATH/ALINE				
		76.00 = LOPRESSOR BOLUS				
		77.00 = APRESOLINE BOLUS				
		78.00 = OVERDRIVE PACER				
		79.00 = LOADED WITH DIG				
		80.00 IMED INFUS TECH DIF				
		81.00 = EMERGENCY CARDIOV				
		83.00 THREAD NEW PACER WIR				
		84.00 = PROCAINE LEVEL				
		85.00 PACER SETTINS CHANGE				
		86.00 = WEANING PARAMETERS				
		87.00 RECHECKED CUFF/ALINE				
		88.00 CHANGE/CHECK DRUG IV				
		89.00 NIBP PLACE, TIT BY				
		90.00 DEC AMNT ALINE TUBIN				
		91.00 TROUBLESHOOTING ALIN				
		92.30 INCRE FIO2				
		93.30 REINTUBATED				
		94.00 CONTINOUS KCL DRIP				
		95.00 REDRESS OF LEG OOZE				
		97.00 = NORCURON				
		98.00 = KPO4 DRIP				
		100.00 = DDD PACER				
		101.00 = REP IABP SHEATH				
		104.00 = PROPOTHOL DRIP				
		105.00 = TRENDELENBERG				
		106.00 TROUBLESHOOT IABP				
62	HESPAN	HESPAN VOLUME	8	0	N	0
63	HESINT	HESPAN INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
64	PLASMA	PLASMA VOLUME	8	0	N	0
65	PLASINT	PLASMA INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
66	ALBUMIN	ALBUMIN VOLUME	8	0	N	0

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File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
67	ALBINT	ALBUMIN INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
68	NSLR	NORMAL SALINE OR LR VOLUME	8	0	N	0
69	NSLRINT	NORMAL SALINE OR LR VOLUME (DEP, INDEP,.	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
70	CELLSAV	CELLSAVER VOLUME	8	0	N	0
71	AUTOTRAN	AUTOTRANSFUSION VOLUME	8	0	N	0
72	PRBC	VOLUME OF PRBCS	8	0	N	0
73	FFP	VOLUME OF FFP	8	0	N	0
74	PLATELET	VOLUME OF PLATELETS	8	0	N	0
75	OTHBLOOD	TYPE OF OTHER BLOOD PRODUCT	8	0	N	0
76	OTHEBLOO	VOLUME OF OTHER BLOOD PRODUCT	8	0	N	0
77	LIDOC	LIDOCAINE RATE	8	3	N	0
78	LIDINT	LIDOCAINE INTERVENTION (DEP, INDEP, COL)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
79	PRONEST	PRONESTYL RATE	8	3	N	0
80	PROINT	PRONESTYL INTERVENTION (DEP, INDEP, COL)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
81	BRETYL	BRETYLIUM RATE	8	3	N	0

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File: DRIPBACL

FILTER: None

File Pos	Name	Label	Field Width	Prt Fmt	Type	Value Labels
82	BRETINT	BRETYLIUM INTERVENTION (DEP, INDEP, CO)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
83	PACER	PACEMAKER RATE	8	2	N	0
84	LASIX	LASIX DOSE MG	8	0	N	0
85	LASINT	LASIX INTERVENTION (DEP, INDEP, COLLA)	8	0	N	8
		0 = NO CHANGE/NO INTER				
		1 = RN PERF S MD NOT/C				
		2 = RN PERF P MD NOT/C				
		3 = MD ORDER S RN NOTI				
		4 = RN CONSU C ANOT RN				
		5 RN PERF SIMU C MD OR				
		6 = ACCIDENTAL DISCON				
		7 = MD PERFORMED				
86	BUMEX	BUMEX DOSE MG	8	0	N	0

APPENDIX C: The Questionnaire Packets

CABGS Physician Packet:

Cover Letter
Information Sheet
Demographic Questionnaire
ICU Physician Questionnaire
Pulmonary Artery Catheter Study Group Questionnaire

CABGS Nurse and CABGS Assist Packet:

Cover Letter
Information Sheet
Demographic Questionnaire
ICU Nurse Questionnaire
Blood Pressure Determination Questionnaire
Pulmonary Catheter Knowledge Assessment Questionnaire

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO
PHYSICIAN RESEARCH SUBJECT INFORMATION SHEET

Identifying Process Variations Via Risk-Adjusted Outcome

A. PURPOSE AND BACKGROUND

Suzanne Bakken Henry, R.N., D.N.Sc., Assistant Professor at UCSF School of Nursing and Kathryn J. Dolter, R.N., C.C.R.N., Doctoral Candidate at UCSF, MAJ/AN are conducting a study on hemodynamic knowledge and practice variation among coronary artery bypass graft surgery (CABGS) patient care providers at Department of Defense medical centers which I am being asked to participate in.

This study is designed to gather information about my hemodynamic knowledge and my assessment of the organizational culture in which I practice. I have been asked to participate in this study because I am a CABGS patient care provider.

B. PROCEDURES

If I agree to be in the study, the following will occur:

> I will complete the demographic, pulmonary artery catheter knowledge assessment and organizational culture questionnaires. These questionnaires will take about 30 - 40 minutes to complete.

C. RISKS/DISCOMFORTS

Risks or discomforts in participating in this study may be the potential loss of confidentiality concerning my hemodynamic knowledge assessment questionnaire results.

My answers to all questionnaires will be kept as confidential as is possible. I am under no pressure from the commanding officer of my unit or medical center to participate in this study. Study records will be kept as confidential as possible. No individual identities will be used in any reports or publication resulting from this study. The questionnaires will only be coded with the number assigned the participating medical center and a sequence number. When completed, questionnaires will be kept at all times in a confidential file not accessible to any Department of Defense nursing or medical staff. Only the study investigators will have access to them. After the study has been completed all data will be destroyed.

D. BENEFITS

I may benefit in participating in this study due to the feedback provided on my hemodynamic knowledge assessment questionnaires which I may obtain by requesting results by the questionnaire sequence number. It is hoped that the information gained from this study will contribute to the development of knowledge concerning hemodynamic practice variations in CABGS patients.

E. ALTERNATIVES

I am free to refuse to participate or to withdraw from this research at any time without jeopardizing my position/rank in my organization.

F. COSTS

There will be no costs to me as a result of taking part in this study.

G. REIMBURSEMENT

I will not be reimbursed for participating in this study.

H. QUESTIONS

This study has been explained to me by Dr. Henry, MAJ Dolter or their research assistant. If I have any further questions about this study, I may call MAJ Dolter at (415) 326-6447.

If I have any questions or comments about participation in this study. I should first talk to the investigator. If for some reason I don not wish to do this, I may contact the Committee on Human Research, which is concerned with protection of volunteers in research projects. I may reach the Committee Office between 0800 and 1700 (Pacific Time), Monday through Friday, by calling (415) 476-1814 or by writing to the Committee on Human Research, Suite 11, Laurel Heights Campus, Box 0962, University of California, San Francisco, CA 94143.

I. Consent

I have been given a copy of this consent to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY, I am free to decline to be in this study, or to withdraw from it at any point. My decision as to whether or not to participate in this study will have no influence on my present or future status as a health care provider at this or any Department of Defense health care institution.

Consent to participate in the questionnaire portion of the study is implied by completion of the questionnaires enclosed in this packet.

Identifying Process Variation Via Risk-Adjusted Outcome
Questionnaire Packet Contents / Instructions

DIRECTIONS:

1) Read the Study Consent Form / Information Sheet

2) a) IF YOU WOULD LIKE TO PARTICIPATE IN THE STUDY:

1) Complete the Demographic Questionnaire Sheet and the Multiple Choice questionnaire by writing your answers DIRECTLY on each questionnaire.

2) Enclose all questionnaires in the stamped, addressed envelope provided. SEAL the envelope and MAIL the envelope to MAJ Kathy Dolter, the study Principal Investigator.

b) IF YOU DO NOT CARE TO PARTICIPATE IN THE STUDY:

1) ENCLOSE THE UNCOMPLETED QUESTIONNAIRES in the stamped, addressed envelope provided, SEAL the envelope and MAIL the envelope to Major Kathy Dolter, the study Principal Investigator.

Participation is voluntary and anonymous. Responses are confidential. The number that appears on the side of the envelope and on the forms is for site tracking purposes only and cannot be linked to any particular individual. Only aggregate responses will be analyzed or reported.

BENEFITS TO QUESTIONNAIRE COMPLETION:

Feedback concerning your unit's aggregate scores on the questionnaires and other related study results (patient severity- of- illness and care process description) as well as the anonymous results of the other participating Department of Defense medical centers will be presented formally after the study is completed. This will allow you to assess your comparative performance and assist you in continuous quality improvement activities related to the quality of CABG patient care.

ANY QUESTIONS which you have concerning the study or questionnaire completion should be directed to Principal Investigator, Major Kathy Dolter at phone number (415) 326-6447 OR your facility's Local Principal Investigator (listed below).

Site	Local Principal Investigator	Phone/Beeper #
BAMC	LTC LINDA YODER	916-6937 / 118-1959
DDEAMC	LTC FRAN ANDERSON	787-8881 /
FAMC	MAJ ELIZABETH HILL	361-3077 / ---
MAMC	DIANE PIERSON	968-2289 / ---
TAMC	LTC KATIE DEVLIN	433-3033 / 577-7773
WBAMC	LTC SHIRLEY PARDIE	564-6876 /
WRAMC	LTC CONNIE CRAUN	782-6401 /
NNMC	LT PATRICE DRAPEAU-BIBEAU	295-2606 / ---
NMC-SAN DIEGO	CDR JANE HOURIGAN	532-9070 / 979-1802
KEESLER	MAJOR ELIZABETH BRIDGES	377-6206 /
WHMC	CPT PAUL LANGLOS	670-3987 /
WRIGHT-PATTERSON	MAJ NED MORAN	257-9013 /

YOUR PARTICIPATION WILL BE VERY MUCH APPRECIATED.

Questionnaire Packet::

Please fill in the blank or circle the best response response (as appropriate) on each of the following questionnaires.

Physician Provider Demographic Questionnaire

Unit # _____

Provider # _____

1. What is your age?_____

2. Sex
   a. Male
   b. Female

3. Are you military or civilian:
   a. Military
   b. Civilian

4. Professional category:
   a. Resident
   b. Staff

5. Years of thoracic surgical experience:_____

6. Approximate volume of coronary artery bypass grafts you performed / assisted:

   1 January through 31 June 1994:____
   1 July through 31 December 1994____

7. Approximately how many hours of your formal medical education (medical school, internship, residency) was devoted to hemodynamic measurement and measurement interpretation? _____

Multiple-Choice Questionnaires:

ICU Physician Questionnaire

Excerpted for The Organization and Management of Intensive Care Units.

This questionnaire was originally utilized as part of a nation-wide study of the organization, management and performance of intensive care units conducted by Stephen Shortell, Ph.D. (Principal Investigator) and Denise M. Rousseau and Edward F. X. Hughes, M.D., M.P.H. (Senior Investigators), J. L. Kellogg Graduate School of Management and The Center for Health Services and Policy Research, Northwestern University.

The purpose of Shortell's study was to examine the organization and management practices of ICUs and their relationship to patient severity adjusted outcomes. That purpose is similar to the purpose of this study--examining the hemodynamic knowledge and practice and organization and management practices of ICUs caring for coronary artery bypass graft (CABG) patients in Department of Defense (DOD) medical centers and their relationship to risk-adjusted patient outcomes.

Directions to ICU Physician Questionnaire

Respond to each question as you believe the situation really exists, not as your think it should be or wish it to be. Please keep in mind that questions pertaining to physicians refer to cardiothoracic residents and cardiothoracic attending physicians who regularly care for CABG patients on this unit.

SECTION ONE: RELATIONSHIPS AND COMMUNICATIONS WITHIN THE ICU

I. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
Physician-to-Physician Relationships: These statements refer to relationships between physicians.					
1. It is easy for me to talk openly with the physicians of this ICU.	1	2	3	4	5
2. I can think of a number of times when I received incorrect information from physicians in this unit.	1	2	3	4	5
3. Communication between physicians in this unit is very open.	1	2	3	4	5
4. It is often necessary for me to go back and check the accuracy of information I have received from physicians in this unit.	1	2	3	4	5
5. I find it enjoyable to talk with other physicians of this unit.	1	2	3	4	5
6. When physicians talk with each other in this unit, there is a good deal of understanding.	1	2	3	4	5
7. The accuracy of information passed among physicians of this unit leaves much to be desired.	1	2	3	4	5
8. It is easy to ask advice from physicians in this unit.	1	2	3	4	5
9. I feel that certain ICU physicians don't completely understand the information they receive.	1	2	3	4	5
Nurse-to-Physician Relationships: These statements refer to relationships between nurses and physicians.					
10. It is easy for to talk openly with nurses in this ICU.	1	2	3	4	5
11. I can think of a number of times when I received incorrect information from nurses in this unit.	1	2	3	4	5

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
12. Communication between nurses and physicians in this unit is very open.	1	2	3	4	5
13. It is often necessary for me to go back and check the accuracy of information I have received from nurses in this unit.	1	2	3	4	5
14. I find it enjoyable to talk with nurses of this unit.	1	2	3	4	5
15. When nurses talk with physicians in this unit, there is a good deal of understanding.	1	2	3	4	5
16. The accuracy of information passed between nurses and physician of this unit leaves much to be desired.	1	2	3	4	5
17. It is easy to ask advice form nurses in this unit.	1	2	3	4	5
18. I feel that certain ICU nurses don't completely understand the information they receive.	1	2	3	4	5

General Relationships and Communications: These statements refer to general relationships and communications within the ICU.

19. I get information on the status of patients when I need it.	1	2	3	4	5
20. When a patient's status changes, I get relevant information quickly.	1	2	3	4	5
21. There are needless delays in relaying information regarding patient care.	1	2	3	4	5
22. In matters pertaining to patient care, nurses call physicians in a timely manner.	1	2	3	4	5

SECTION TWO: TEAMWORK AND LEADERSHIP

II. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5

Nursing Leadership: These statements refer to your overall judgement of the characteristics of the ICU nursing leadership (i.e., nurse manager, assistant nurse manager, clinical nurse specialist, charge nurse: this excludes hospital administration). "Unit physicians" refers to all cardiothoracic residents and cardiothoracic attending physicians who regularly care for CABG patient in your ICU. The terms "staff" and "unit members" refer to all nurses and physicians caring for CABG patients on your unit.

23. ICU nursing leadership emphasizes standards of excellence to the staff.	1	2	3	4	5
24. ICU nursing leadership is sufficiently sensitive to the different needs of unit members.	1	2	3	4	5
25. The ICU nursing leadership fails to make clear what they expect from unit members.	1	2	3	4	5
26. The ICU nursing leadership discourages physicians form taking initiative.	1	2	3	4	5
27. Unit physicians are uncertain where they stand with the ICU nursing leadership.	1	2	3	4	5
28. The ICU nursing leadership is out of touch with physician perceptions and concerns.	1	2	3	4	5
29. ICU nursing leadership often makes decisions without input from unit physicians.	1	2	3	4	5
30. ICU nursing leadership effectively adapts its problem-solving style to changing circumstances.	1	2	3	4	5

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
Physician Leadership: These statements refer to your overall judgement of the characteristics of the Cardiothoracic surgeon in charge of Cardiothoracic patient care. "Unit physicians" refers to all resident and attending Cardiothoracic surgeons. The terms "staff" and "unit members" refer to all nurses and physicians associated with the care of CABG patients.					
31. ICU physician leadership emphasizes standards of excellence to the staff.	1	2	3	4	5
32. ICU physician leadership is sufficiently sensitive to the different needs of unit members.	1	2	3	4	5
33. The ICU physician leadership fails to make clear what they expect from unit members.	1	2	3	4	5
34. ICU physician leadership discourages physicians from taking initiative.	1	2	3	4	5
35. Unit physicians are uncertain where they stand with the ICU physician leadership.	1	2	3	4	5
36. The ICU physician leadership is out of touch with physician perceptions and concerns.	1	2	3	4	5
37. The ICU physician leadership often makes decisions without input from unit physicians.	1	2	3	4	5
38. ICU physician leadership effectively adapts its problem-solving style to changing circumstances.	1	2	3	4	5
General: These statement refer in general to teamwork and leadership in the ICU.					
39. Our unit has constructive work relationships with other groups in this hospital.	1	2	3	4	5
40. Our unit does not receive the cooperation it needs from other hospital units.	1	2	3	4	5
41. Other hospital subunits seem to have a low opinion of us.	1	2	3	4	5
42. Inadequate working relationships with other hospital groups limit our effectiveness.	1	2	3	4	5

SECTION THREE: PERCEIVED EFFECTIVENESS

III. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
43. Our unit almost always meets its patient care treatment goals.	1	2	3	4	5
44. Given the severity of the patients we treat our unit experiences very good outcomes.	1	2	3	4	5
45. Our unit does a good job of meeting family member needs.	1	2	3	4	5
46. Our unit does a good job of applying the most recently available technology to patient care needs.	1	2	3	4	5
47. We are able to recruit the best ICU nurses.	1	2	3	4	5
48. We do a good job of retaining ICU nurses in this unit.	1	2	3	4	5
49. We are able to recruit the best ICU physicians.	1	2	3	4	5
50. We do a good job of retaining ICU physicians in the unit.	1	2	3	4	5
51. Overall, our unit functions very well together as a team.	1	2	3	4	5
52. Our unit is very good at responding to emergency situations.	1	2	3	4	5

SECTION FOUR–PART A: MANAGING DISAGREEMENT BETWEEN PHYSICIANS

IV–PART A: Consider what happens when there is a disagreement or conflict between ICU physicians. Based on your experience in this unit how likely is it that:

Statement	Not at all likely 1	Not so likely 2	Somewhat likely 3	Very likely 4	Almost certain 5
53. When physicians disagree, they will ignore the issue, pretending it will "go away".	1	2	3	4	5
54. Physicians will withdraw from the conflict.	1	2	3	4	5
55. All points of view will be carefully considered in arriving at the best solution of the problem.	1	2	3	4	5
56. All the physicians will work hard to arrive at the best possible solution.	1	2	3	4	5
57. The physicians involved will not settle the dispute until all are satisfied with the decision.	1	2	3	4	5
58. Everyone contributes from their experience and expertise to produce a high quality solution.	1	2	3	4	5
59. Disagreements between physicians will be ignored or avoided.	1	2	3	4	5

SECTION FOUR–PART B: MANAGING DISAGREEMENTS BETWEEN NURSES AND PHYSICIANS

IV–PART B: Consider what happens when there is a disagreement or conflict between the nurses and physicians caring for CABG patients. Based on your experience in this unit, how likely is it that:

60. When nurses and physicians disagree, they will ignore the issue, pretending it will go away.	1	2	3	4	5
61. Both parties will withdraw from the conflict.	1	2	3	4	5
62. All points of view will be carefully considered in arriving at the best solution of the problem.	1	2	3	4	5
63. The nurses and physicians will work hard to arrive at the best possible solution.	1	2	3	4	5
64. Both parties involved will not settle the dispute until all are satisfied with the decision.	1	2	3	4	5
65. Everyone contributes from their experience and their expertise to produce a high quality solution.	1	2	3	4	5
66. Disagreements between nurses and physicians will be ignored or avoided.	1	2	3	4	5

SECTION FIVE: AUTHORITY

V. For each of the following statement circle the number on the scale that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
A. Our ICU Medical Director has sufficient authority regarding:					
67. Admitting and discharging patients.	1	2	3	4	5
68. Treatment protocols.	1	2	3	4	5
69. Budgeting.	1	2	3	4	5
70. Hiring and firing physician staff.	1	2	3	4	5
71. Equipment purchases.	1	2	3	4	5
B. Our ICU Nurse Manager/Head Nurse has sufficient authority regarding:					
72. Admitting and discharging patients.	1	2	3	4	5
73. Treatment protocols.	1	2	3	4	5
74. Budgeting.	1	2	3	4	5
75. Hiring and firing staff.	1	2	3	4	5
76. Equipment purchases.	1	2	3	4	5

SECTION SIX: SATISFACTION

77. Overall how satisfied are you with your job? Circle the appropriate response.

A. Very dissatisfied

B. Dissatisfied

C. Neither dissatisfied nor satisfied

D. Satisfied

E. Very satisfied

10

MULTICENTER PULMONARY ARTERY CATHETER STUDY GROUP QUESTIONNAIRE

ABBREVIATIONS:

HR	= Heart rate/min	PCW	= Pulmonary capillary wedge pressure
RR	= Respiratory rate	SAP	= Systolic arterial pressure
MAP	= Mean arterial pressure	F_IO_2	= Fraction of inspired oxygen
CVP	= Central venous pressure	MVO_2	= Mixed venous O_2 saturation
PAP	= Pulmonary artery pressure	CI	= Cardiac index
CO	= Cardiac output		

1. After uneventful PA catheter insertion, the tracing appears quite damped. The catheter was inserted via the right sub-clavian approach. A possible cause of this problem is:

   A. Kinking of the catheter as it passes through the introducer.
   B. Air in the transducer chamber.
   C. A decrease in the pressure in the fluid monitoring system.
   D. The venous line pressure setting is set for arterial pressures.
   E. All of the above.

2. The pulmonary artery wedge pressure is BEST determined:

   A. As the mean of the diastolic pressures.
   B. At end expiration.
   C. With the patient holding his/her breath.
   D. Following inflation of the balloon for at least 30 seconds.
   E. As the mean pressure given by the bedside monitor.

3. The following data are obtained on an ICU patient:

Height 60 inches	Weight 140 pounds	Body surface area 1.5 m2
Temp. 37.5	HR 114	MAP 60
PAP 40/20	PCW 18	CVP 10
CO 4 L/min	Hgb 10.0 gm%	F_IO_2 80%
pH 7.39	pCO_2 40	pO_2 70
Art Hgb sat 95%	MVO_2 sat 75%	MVO_2 28.

   Assume 1.34 ml of O_2 per gram Hgb at 100% saturation. What is the cardiac index ($L/min/m^2$)?

   A. 1.8
   B. 2.3
   C. 2.7
   D. 3.4
   E. 6.8

4. What is the systemic vascular resistance ($dyne/sec/cm^5$) of the patient in question 79?

   A. 840
   B. 1000
   C. 1300
   D. 1900
   E. 2200

5. What is the arterial oxygen content (ml O_2/100 ml blood) of the patient in question 79?

A. 5.1
B. 8.3
C. 10.1
D. 12.9
E. 16.8

6. When inserting a pulmonary artery catheter, as the catheter passes from the right ventricle into the pulmonary artery, which of the following pressures being recorded from the catheter changes MOST:

A. Diastolic pressures.
B. Systolic pressures.
C. Mean pressures.
D. Central venous pressure.
E. All of the above equally.

7. Systemic vascular resistance:

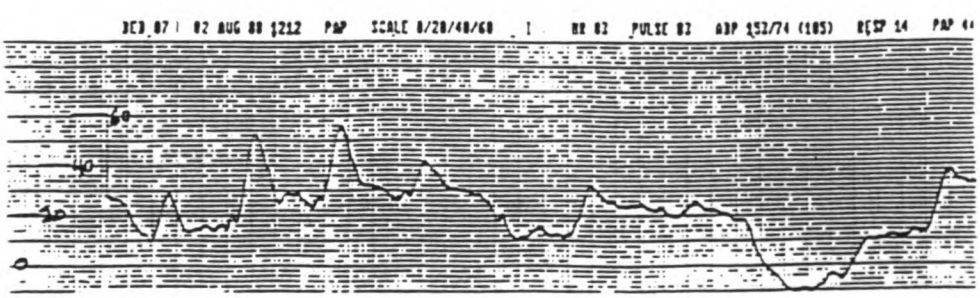
A. Is a measurement obtained directly from the PA catheter.
B. Can be calculated by (MAP - PCW / CO) x 80
C. Can be calculated by (SAP - PCW / CO) x 80
D. Can be calculated by (SAP - PCW / MAP) x 80
E. Can be calculated by (MAP - CVP/ CO) x 80

8. During a right sub-clavian vein catheterization attempt, a 35 year-old female patient became tachypneic, tachycardic, hypotensive and hemiplegic. Auscultation of the chest revealed breath sounds to be present and symmetrical in all areas. Heart sounds were obscured by a crunching murmur that had not been present previously. Which of the following is the MOST appropriate initial maneuver?

A. Immediate pericardiocentesis
B. Left lateral decubitus and Trendelenburg position
C. Immediate systemic heparinization
D. Needle decompression of the right chest
E. Chest x-ray

9. What is the wedge pressure of this spontaneously breathing patient (see tracing below):

A. 10
B. 20
C. 30
D. 40
E. 50



10. Which of the following are needed to calculate oxygen delivery from pulmonary artery catheter data:

    A. Cardiac output, hemoglobin, arterial O_2 saturation, arterial pO_2.
    B. Stroke volume, hemoglobin, pulmonary artery pO_2, arterial saturation.
    C. Arterial pO_2, pulmonary artery pO_2, arterial saturation, cardiac output.
    D. Pulmonary artery saturation, arterial saturation, cardiac output, oxygen consumption.
    E. None of the above.

11. Which of the following disorders is **MOST LIKELY** to increase central venous pressure and simultaneously decrease pulmonary artery occlusive pressure:

    A. Left ventricular myocardial infarction.
    B. Excessive administration of IV fluids.
    C. Rupture of a mitral valve papillary muscle.
    D. Acute pulmonary embolism.
    E. Acute dissecting aneurysm with aortic regurgitation.

12. An 18 year-old male is injured in a head-on collision in which he was the driver of the vehicle. At surgery he had repair of a liver laceration and resection of his pancreas and spleen. On admission to the ICU his B/P is 60/40 mm Hg, HR 120 and he is mechanically ventilated. He is given 500 cc of fluid without response and a pulmonary artery catheter is inserted revealing CI 2.0 $L/min/m^2$, CVP 2, PCW 1 and PAP 15/5. The **MOST LIKELY** diagnosis is:

    A. Cardiac contusion.
    B. Hypovolemia.
    C. Overventilation.
    D. Cardiac tamponade.
    E. Pneumothorax.

13. Pulmonary artery catheter data on a 68 year-old cirrhotic patient reveals an elevated cardiac index, decreased systemic vascular resistance, normal pulmonary vascular resistance, elevated MVO_2, increased O_2 delivery, and decreased arterial-venous oxygen difference. These calculations may suggest all of the following **EXCEPT**:

    A. Hyperdynamic picture of sepsis.
    B. Hyperdynamic picture of cirrhosis.
    C. Pulmonary embolism.
    D. Previously arterio-venous fistula.
    E. None of the above.

14. The pulmonary artery wedge pressure gives an accurate measure of:

    A. Left ventricular compliance.
    B. Intravascular volume.
    C. Left ventricular volume.
    D. Ventricular interdependence.
    E. None of the above.

15. Ventricular compliance may be increased by:

A. Myocardial ischemia.
B. Cardiac shock.
C. Right ventricular overload.
D. Vasodilators.
E. Pericardial effusion.

16. Large V-waves on the PCW tracing may indicate all of the following EXCEPT:

A. Papillary muscle rupture.
B. Ruptured chordae tendineae.
C. Dilated mitral annulus.
D. 2:1 AV block.
E. Papillary muscle ischemia.

17. Which of the following may cause an abnormal elevation in the saturation of blood drawn from the distal port:

A. Ventricular septal defect.
B. Catheter in the wedge position.
C. Peripheral arterio-venous fistula.
D. Severe mitral regurgitation.
E. All of the above.

18. If the pulmonary artery catheter balloon ruptures and 1.5 cc of air is inadvertently injected, which of the following is MOST LIKELY to occur to the patient:

A. No detectable change.
B. Transient dyspnea.
C. Ventricular arrhythmia.
D. Infiltrate on STAT chest x-ray.
E. None of the above.

19. Which of the following interventions will cause oxygen delivery to rise MOST:

A. Increase the pO_2 from 75 to 100 mm Hg.
B. Increase the cardiac output by 10%.
C. Increase the hematocrit from 20% to 30%.
D. Interventions a, b and c will have an equal effect.
E. None of the above will raise the delivery of oxygen.

20. All of the following may raise the pO_2 of blood from the distal port of a pulmonary artery catheter in a patient with no cardiorespiratory pathology EXCEPT:

A. Early sepsis.
B. Increased cardiac output.
C. Arterio-venous fistula.
D. Malignant hyperthermia.
E. Inotropic agents.

21. When determining the cardiac output, injection of less than the set amount of volume (i.e., 9 cc instead of 10 cc) will lead to:

    A. An underestimation of the cardiac output.
    B. An overestimation of the cardiac output.
    C. No change in the determined cardiac output.
    D. An unpredictable change in the cardiac output.
    E. The cardiac output computer will read "error."

22. A 76 year-old patient with a history of coronary artery disease who is clinically stable and has a normal physical exam undergoes elective PA catheter insertion. The following data are obtained: HR 90, BP 150/75 mm Hg, Co 4.5 L/min, PCW 6 mm Hg. Suddenly the patient complains of tight chest pain and a 12 lead EKG shows lateral wall ischemia. New pulmonary artery catheter data reveal: HR 125, BP 160/80, CO 5.0 L/min., PCW 17 mm Hg. The change in PCW MOST LIKELY represents:

    A. A change in total body volume.
    B. An increase in the left ventricular volume.
    C. Intravascular volume overload.
    D. A change in the ejection fraction.
    E. A decrease in left ventricular compliance.

23. Which of the following statements is true:

    A. In a critically ill patient, changes in the central venous pressure parallel changes in the pulmonary wedge pressure.
    B. Positive end expiratory pressure increases the pulmonary wedge pressure by 1 mm Hg for every 1 cm water pressure.
    C. Insertion of the catheter in a patient with a LBBB is absolutely contraindicated.
    D. Prophylactic lidocaine should be administered prior to insertion of PA catheters.
    E. None of the above.

24. In an 18 year-old woman who is 4 ft. 6 in. tall, a pulmonary catheter is inserted and reaches a satisfactory wedge position at 35 cm. Repeated cardiac output determinations vary 2-10 liters per minute. All the equipment is checked and found to be in good working order. Which of the following is the problem:

    A. The cardiac output is so high that it cannot by accurately measured.
    B. The proximal port is not in the right heart.
    C. There is a large change in the cardiac output with respiration.
    D. The body surface area is underestimated.
    E. None of the above.

25. A 74 year-old patient with a history of CHF and COPD is admitted to the ICU with BP 70/40, RR 35/min, rales 1/3rd up both lung fields and an ABG on F_IO_2 40% of pH 7.01, pCO_2 58 and pO_2 of 50. The CBC, Na, K, Glu, and BUN are within normal limits. The EKG reveals the patient to be in atrial fibrillation with a ventricular response of 135/min. A CXR has been ordered. Your first maneuver should be:

A. Insert a PA catheter from a non-subclavian site to avoid a pneumothorax.
B. Insert a PA catheter with the patient in a sitting position.
C. Give 1 amp of bicarbonate and insert the PA catheter.
D. Insert the PA catheter from any sit as soon as possible prior to initiating any therapy.
E. None of the above.

26. In a 180 cm tall, 70 kg patient with normal anatomy, at what cm length should a pulmonary artery catheter reach the wedge position if inserted via the right internal jugular approach:

A. 25 -34 cm.
B. 35 - 44 cm.
C. 45 - 59 cm.
D. 60 - 75 cm.
E. > 75 cm.

27. Several hours after an uneventful catheter insertion, it is noted that the volume of air needed to inflate the balloon to obtain a wedge tracing is less than previously required. The **MOST LIKELY** cause is:

A. Air in the pressure tubing.
B. The catheter tip is occluded by the vessel wall.
C. Balloon rupture.
D. Distal migration of the catheter.
E. Calibration error.

28. Which of the following attempts at pulmonary artery catheter placement should be discontinued:

A. Blood aspirated from the PA catheter introducer in the left internal jugular puncture reveals a pH 7.29, pO_2 60, saturation 90%.
B. Five-beat ventricular tachycardia occurs while passing through the right ventricle.
C. While attempting catheterization the nurse points out that the patient had a LBBB on the admission EKG.
D. The patient complains of pain at the insertion site.
E. Large v-waves are seen on the monitor.

29. In a supine patient, the PA catheter generally flows to:

A. Posterior dependent lung zones.
B. Superior lung zones.
C. Inferior lung zones.
D. Anterior lung zones.
E. Areas with high ventilation to perfusion ratios.

30. Upon aspiration of blood from the distal port of the PA catheter in an attempt to obtain a MVO_2, a pO_2 of 83 (saturation 90%) is measured. Which of the following is the MOST LIKELY cause:

    A. High levels of supplemental O_2.
    B. The arterial pO_2 is greater than 100.
    C. The catheter is coiled in the right ventricle.
    D. The catheter is in the wedge position.
    E. The patient is septic.with a high cardiac output.

31. A patient with Adult Respiratory Distress Syndrome is on an F_IO_2 of 60%, Positive End Expiratory Pressure of 17 with an ABG of pH 7.3, pCO_2 40, and pO_2 55. When estimating the PCW the current recommendation is:

    A. Temporarily disconnect the patient from the ventilatory and measure the PCW at end expiration.
    B. Determine the pressure at end expiration and follow the trend.
    C. Determine the pressure at end inspiration.
    D. Do not follow the PCW; at best it will be misleading.
    E. A and B.

THANK YOU FOR YOUR PARTICIPATION!

Please place the questionnaires in the envelope provided and return it either to MAJ Dolter or to your facility's Local Principal Investigator listed on the instructions cover sheet.

If you have any comments regarding these questionnaires or the study in general please record them in the space below.

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO
NURSE RESEARCH SUBJECT INFORMATION SHEET

Identifying Process Variations Via Risk-Adjusted Outcome

A. PURPOSE AND BACKGROUND

Suzanne Bakken Henry, R.N., D.N.Sc., Assistant Professor at UCSF School of Nursing and Kathryn J. Dolter, R.N., C.C.R.N., Doctoral Candidate at UCSF, MAJ/AN are conducting a study on hemodynamic knowledge and practice variation among coronary artery bypass graft surgery (CABGS) patient care providers at Department of Defense medical centers which I am being asked to participate in.

This study is designed to gather information about my hemodynamic knowledge and my assessment of the organizational culture in which I practice. I have been asked to participate in this study because I am a CABGS patient care provider.

B. PROCEDURES

If I agree to be in the study, the following will occur:

> I will complete demographic, hemodynamic (pulmonary artery catheter and blood pressure measurement) knowledge assessment, and organizational culture questionnaires. These questionnaires will take about 50-60 minutes to complete.

C. RISKS/DISCOMFORTS

Risks or discomforts in participating in this study may be the potential loss of confidentiality concerning my hemodynamic knowledge assessment questionnaire results.

My answers to all questionnaires will be kept as confidential as is possible. I am under no pressure from the commanding officer of my unit or medical center to participate in this study. Study records will be kept as confidential as possible. No individual identities will be used in any reports or publication resulting from this study. The questionnaires will be only be coded with the number assigned the participating medical center and a sequence. When completed, questionnaires will be kept at all times in a confidential file not accessible to any Department of Defense nursing or medical staff. Only the study investigators will have access to them. After the study has been completed all data will be destroyed.

D. BENEFITS

I may benefit in participating in this study due to the feedback provided on my hemodynamic knowledge assessment questionnaires by requesting my results by the questionnaire sequence number. It is hoped that the information gained from this study will contribute to the development of knowledge concerning hemodynamic practice variations in CABGS patients.

E. ALTERNATIVES

I am free to refuse to participate or to withdraw from this research at any time without jeopardizing my position/rank in my organization.

F. COSTS

There will be no costs to me as a result of taking part in this study.

G. REIMBURSEMENT

I will not be reimbursed for participating in this study.

H. QUESTIONS

This study has been explained to me by Dr. Henry, MAJ Dolter or their research assistant. If I have any further questions about this study, I may call MAJ Dolter at (415) 326-6447.

If I have any questions or comments about participation in this study. I should first talk to the investigator. If for some reason I don not wish to do this, I may contact the Committee on Human Research, which is concerned with protection of volunteers in research projects. I may reach the Committee Office between 0800 and 1700 (Pacific Time), Monday through Friday, by calling (415) 476-1814 or by writing to the Committee on Human Research, Suite 11, Laurel Heights Campus, Box 0962, University of California, San Francisco, CA 94143.

I. Consent

I have been given a copy of this consent to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY, I am free to decline to be in this study, or to withdraw from it at any point. My decision as to whether or not to participate in this study will have no influence on my present or future status as a health care provider at this or any Department of Defense health care institution.

Consent to participate in the questionnaire portion of the study is implied by completion of the questionnaires enclosed in this packet.

Identifying Process Variation Via Risk-Adjusted Outcome

Questionnaire Packet Contents / Instructions

DIRECTIONS:

1) **Read the Study Consent Form / Information Sheet**

2) a) **IF YOU WOULD LIKE TO PARTICIPATE IN THE STUDY:**

1) Complete the Demographic Questionnaire and the Multiple Choice questionnaires by writing your answers DIRECTLY on each questionnaire.

2) Enclose all questionnaires in the stamped, addressed envelope provided. SEAL the envelope and MAIL the sealed envelope to MAJ Kathy Dolter, the study Principal Investigator.

b) **IF YOU DO NOT CARE TO PARTICIPATE IN THE STUDY:**

1) ENCLOSE THE UNCOMPLETED QUESTIONNAIRES in the stamped, addressed envelope provided, SEAL the envelope and MAIL the sealed envelope to Major Kathy Dolter, the study Principal Investigator.

Participation is voluntary and anonymous. Responses are confidential. The number that appears on the side of the envelope and on the forms is for site tracking purposes only and cannot be linked to any particular individual. Only aggregate responses will be analyzed or reported.

BENEFITS TO QUESTIONNAIRE COMPLETION:

1) If you remember your questionnaire number, you may find out your level of knowledge relating to pulmonary artery and blood pressure measurement by looking up the score corresponding to that number up on a print-out of individual PA and BP questionnaire results.

2) Feedback concerning your unit's aggregate scores on the questionnaires and other related study results (patient severity- of- illness and process-of-care) as well as the anonymous results of the other participating Department of Defense medical centers will be presented formally after the study is completed. This will allow you to assess your unit's comparative performance and assist you in continuous quality improvement activities related to the quality of CABG patient care.

ANY QUESTIONS which you have concerning the study or questionnaire completion should be directed to the Principal Investigator, Major Kathy Dolter, at phone number (415) 326-6447 OR your facility's Local Principal Investigator (listed below).

Site	Local Principal Investigator	Phone/Beeper #
BAMC	LTC LINDA YODER	916-6937 / 118-1959
DDEAMC	LTC FRAN ANDERSON	787-8881 /
FAMC	MAJ ELIZABETH HILL	361-3077 / —
MAMC	DIANE PIERSON	968-2289 / —
TAMC	LTC KATIE DEVLIN	433-3033 / 577-7773
WBAMC	LTC SHIRLEY PARDIE	564-6876 /
WRAMC	LTC CONNIE CRAUN	782-6401 /
NNMC	LT PATRICE DRAPEAU-BIBEAU	295-2606 / —
NMC-SAN DIEGO	CDR JANE HOURIGAN	532-9070 / 979-1802
KEESLER	MAJOR ELIZABETH BRIDGES	377-6206 /
WHMC	CPT PAUL LANGLOS	670-3987 /
WRIGHT-PATTERSON	MAJ NED MORAN	257-9013 /

Questionnaire Packet:

Nurse Provider Demographic Questionnaire

Unit # _____Provider#_____

Please fill in the blank or circle the most appropriate response directly on this questionnaire.

1. Age___

2. Sex
   a. Male
   b. Female

3. Are you military, or civilian government service or agency?
   a. Military
   b. Civilian: Government Service
   c. Civilian Agency
   d. Other_____

4. If you are military, what is your rank?___

5. How many years in service do you have?____

6. Professional Status
   a. RN
   b. LVN
   c. Corpsman/Aide

7. Highest Nursing Degree Held:
   a. Associate Degree
   b. Diploma
   c. BSN
   d. MA/MS
   e. PhD

8. Number of years of nursing experience_____

9. Number of years of ICU nursing experience_____

10. Number of years of experience in caring for open heart surgery patients_____

11. Number of years caring for open heart surgery patients on this unit_____

12. If you are an RN, do you have your Service's ICU Skill Identifier? (i.e., USA - 8A, USAF - , USN-)
    a. Yes
    b. No
    c. Applied for: approval pending

13. If you are an RN, do you have your CCRN?
    a. Yes
    b. No

14. Have you attended one of your Service's Critical Care Nursing Course?
    a. Yes
    b. No

15. If you have you attended any Critical Care Nursing Course, how many weeks was the course?
    _____

16. How many hours of critical care education have you had concerning hemodynamic assessment and intervention?_____

17. How many hours of orientation to this unit was devoted to hemodynamic monitoring?
    _____

Multiple-Choice Questionnaires:

ICU Nurse Questionnaire

Excerpted for The Organization and Management of Intensive Care Units.

This questionnaire was originally utilized as part of a nation-wide study of the organization, management and performance of intensive care units conducted by Stephen Shortell, Ph.D. (Principal Investigator) and Denise M. Rousseau and Edward F. X. Hughes, M.D., M.P.H. (Senior Investigators), J. L. Kellogg Graduate School of Management and The Center for Health Services and Policy Research, Northwestern University.

The purpose of Shortell's study was to examine the organization and management practices of ICUs and their relationship to patient severity adjusted outcomes. That purpose is similar to the purpose of this study--examining the hemodynamic knowledge and practice and organization and management practices of ICUs caring for coronary artery bypass graft (CABG) patients in Department of Defense (DOD) medical centers and their relationship to risk-adjusted patient outcomes.

Directions to ICU Nurse Questionnaire

Respond to each question as you believe the situation really exists, not as your think it should be or wish it to be. Please keep in mind that questions pertaining to physicians refer to cardiothoracic residents and cardiothoracic attending physicians who regularly care for CABG patients on this unit.

SECTION ONE: RELATIONSHIPS AND COMMUNICATIONS WITHIN THE ICU

I. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
Nurse-to-Nurse Relationships: These statements refer to relationships between nurses.					
1. It is easy for me to talk openly with the nurses of this ICU.	1	2	3	4	5
2. I can think of a number of times when I received incorrect information from nurses in this unit.	1	2	3	4	5
3. Communication between nurses in this unit is very open.	1	2	3	4	5
4. It is often necessary for me to go back and check the accuracy of information I have received from nurses in this unit.	1	2	3	4	5
5. I find it enjoyable to talk with other nurses of this unit.	1	2	3	4	5
6. When nurses talk with each other in this unit, there is a good deal of understanding.	1	2	3	4	5
7. The accuracy of information passed among nurses of this unit leaves much to be desired.	1	2	3	4	5
8. It is easy to ask advice from nurses in this unit.	1	2	3	4	5
9. I feel that certain ICU nurses don't completely understand the information they receive.	1	2	3	4	5
Nurse-to-Physician Relationships: These statements refer to relationships between nurses and physicians.					
10. It is easy for to talk openly with physicians in this ICU.	1	2	3	4	5
11. I can think of a number of times when I received incorrect information from physicians in this unit.	1	2	3	4	5

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
12. Communication between nurses and physicians in this unit is very open.	1	2	3	4	5
13. It is often necessary for me to go back and check the accuracy of information I have received from physicians in this unit.	1	2	3	4	5
14. I find it enjoyable to talk with physicians of this unit.	1	2	3	4	5
15. When nurses talk with physicians in this unit, there is a good deal of understanding.	1	2	3	4	5
16. The accuracy of information passed between nurses and physician of this unit leaves much to be desired.	1	2	3	4	5
17. It is easy to ask advice form physicians in this unit.	1	2	3	4	5
18. I feel that certain ICU physicians don't completely understand the information they receive.	1	2	3	4	5

General Relationships and Communications: These statements refer to general relationships and communications within the ICU.

19. I get information on the status of patients when I need it.	1	2	3	4	5
20. When a patient's status changes, I get relevant information quickly.	1	2	3	4	5
21. There are needless delays in relaying information regarding patient care.	1	2	3	4	5
22. In matters pertaining to patient care, nurses call physicians in a timely manner.	1	2	3	4	5

SECTION TWO: TEAMWORK AND LEADERSHIP

II. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
Nursing Leadership: These statements refer to your overall judgement of the characteristics of the ICU nursing leadership (i.e., nurse manager, assistant nurse manager, clinical nurse specialist, charge nurse: this excludes hospital administration). "Unit physicians" refers to all cardiothoracic residents and cardiothoracic attending physicians who regularly care for CABG patient in your ICU. The terms "staff" and "unit members" refer to all nurses and physicians caring for CABG patients on your unit.					
23. ICU nursing leadership emphasizes standards of excellence to the staff.	1	2	3	4	5
24. ICU nursing leadership is sufficiently sensitive to the different needs of unit members.	1	2	3	4	5
25. The ICU nursing leadership fails to make clear what they expect from unit members.	1	2	3	4	5
26. The ICU nursing leadership discourages nurses form taking initiative.	1	2	3	4	5
27. Unit nurses are uncertain where they stand with the ICU nursing leadership.	1	2	3	4	5
28. The ICU nursing leadership is out of touch with nurse perceptions and concerns.	1	2	3	4	5
29. ICU nursing leadership often makes decisions without input from unit nurses.	1	2	3	4	5
30. ICU nursing leadership effectively adapts its problem-solving style to changing circumstances.	1	2	3	4	5

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5

Physician Leadership: These statements refer to your overall judgement of the characteristics of the Cardiothoracic surgeon in charge of Cardiothoracic patient care. "Unit physicians" refers to all resident and attending Cardiothoracic surgeons. The terms "staff" and "unit members" refer to all nurses and physicians associated with the care of CABG patients.

31. ICU physician leadership emphasizes standards of excellence to the staff.	1	2	3	4	5
32. ICU physician leadership is sufficiently sensitive to the different needs of unit members.	1	2	3	4	5
33. The ICU physician leadership fails to make clear what they expect from unit members.	1	2	3	4	5
34. ICU physician leadership discourages nurses from taking initiative.	1	2	3	4	5
35. Unit nurses are uncertain where they stand with the ICU physician leadership.	1	2	3	4	5
36. The ICU physician leadership is out of touch with nurse perceptions and concerns.	1	2	3	4	5
37. The ICU physician leadership often makes decisions without input from unit nurses.	1	2	3	4	5
38. ICU physician leadership effectively adapts its problem-solving style to changing circumstances.	1	2	3	4	5

General: These statements refer in general to teamwork and leadership in the ICU.

39. Our unit has constructive work relationships with other groups in this hospital.	1	2	3	4	5
40. Our unit does not receive the cooperation it needs from other hospital units.	1	2	3	4	5
41. Other hospital subunits seem to have a low opinion of us.	1	2	3	4	5
42. Inadequate working relationships with other hospital groups limit our effectiveness.	1	2	3	4	5

SECTION THREE: PERCEIVED EFFECTIVENESS

III. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
43. Our unit almost always meets its patient care treatment goals.	1	2	3	4	5
44. Given the severity of the patients we treat our unit experiences very good outcomes.	1	2	3	4	5
45. Our unit does a good job of meeting family member needs.	1	2	3	4	5
46. Our unit does a good job of applying the most recently available technology to patient care needs.	1	2	3	4	5
47. We are able to recruit the best ICU nurses.	1	2	3	4	5
48. We do a good job of retaining ICU nurses in this unit.	1	2	3	4	5
49. We are able to recruit the best ICU physicians.	1	2	3	4	5
50. We do a good job of retaining ICU physicians in the unit.	1	2	3	4	5
51. Overall, our unit functions very well together as a team.	1	2	3	4	5
52. Our unit is very good at responding to emergency situations.	1	2	3	4	5

SECTION FOUR–PART A: MANAGING DISAGREEMENT BETWEEN NURSES

IV--PART A: Consider what happens when there is a disagreement or conflict between ICU nurses. Based on your experience in this unit how likely is it that:

Statement	Not at all likely 1	Not so likely 2	Somewhat likely 3	Very likely 4	Almost certain 5
53. When nurses disagree, they will ignore the issue, pretending it will "go away".	1	2	3	4	5
54. Nurses will withdraw from the conflict.	1	2	3	4	5
55. All points of view will be carefully considered in arriving at the best solution of the problem.	1	2	3	4	5
56. All the nurses will work hard to arrive at the best possible solution.	1	2	3	4	5
57. The nurses involved will not settle the dispute until all are satisfied with the decisions.	1	2	3	4	5
58. Everyone contributes from their experience and expertise to produce a high quality solution.	1	2	3	4	5
59. Disagreements between nurses will be ignored.	1	2	3	4	5

SECTION FOUR–PART B: MANAGING DISAGREEMENT S BETWEEN NURSES AND PHYSICIANS

IV–PART B: Consider what happens when there is a disagreement or conflict between the nurses and physicians caring for CABG patients. Based on your experience in this unit, how likely is it that:

60. When nurses and physicians disagree, they will ignore the issue, pretending it will go away.	1	2	3	4	5
61. Both parties will withdraw from the conflict.	1	2	3	4	5
62. All points of view will be carefully considered in arriving at the best solution of the problem.	1	2	3	4	5
63. The nurses and physicians will work hoard to arrive at the best possible solution.	1	2	3	4	5
64. Both parties involved will not settle the dispute until all are satisfied with the decision.	1	2	3	4	5
65. Everyone contributes from their experience and their expertise to produce a high quality solution.	1	2	3	4	5
66. Disagreement between nurses and physicians will be ignored.	1	2	3	4	5

SECTION FIVE: AUTHORITY

V. For each of the following statement circle the number under the response that best reflects your judgement.

Statement	Strongly Disagree 1	Disagree 2	Neither Disagree Nor Agree 3	Agree 4	Strongly Agree 5
A. Our ICU Medical Director has sufficient authority regarding:					
67. Admitting and discharging patients.	1	2	3	4	5
68. Treatment protocols.	1	2	3	4	5
69. Budgeting.	1	2	3	4	5
70. Hiring and firing physician staff.	1	2	3	4	5
71. Equipment purchases.	1	2	3	4	5
B. Our ICU Nurse Manager/Head Nurse has sufficient authority regarding:					
72. Admitting and discharging patients.	1	2	3	4	5
73. Treatment protocols.	1	2	3	4	5
74. Budgeting.	1	2	3	4	5
75. Hiring and firing staff.	1	2	3	4	5
76. Equipment purchases.	1	2	3	4	5

SECTION SIX: SATISFACTION

77. Overall how satisfied are you with your job?

A. Very dissatisfied

B. Dissatisfied

C. Neither dissatisfied nor satisfied

D. Satisfied

E. Very satisfied

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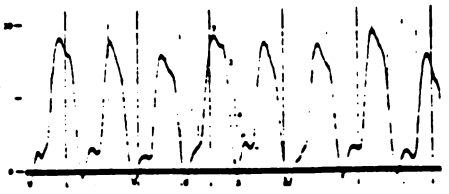
PULMONARY ARTERY CATHETER KNOWLEDGE ASSESSMENT TEST

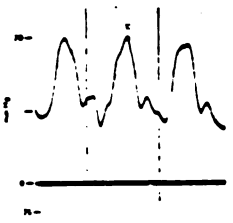
Please circle the best answer to the following items.

For items 1 through 5, match the pressure waveform with cardiac/pulmonary position(s) it is characteristic of (a waveform may be used more than once):

A.



B.



C.

D. None of the above waveforms

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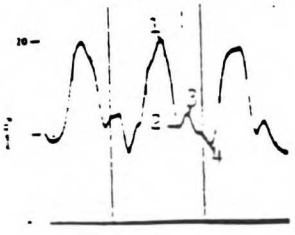
1. **Right atrium**
2. **Right ventricle**
3. **Pulmonary artery**
4. **Pulmonary artery wedge**
5. **Left atrium**

6. The point on the following waveform which represents end-diastolic pressure is
   A. 1.
   B. 2.
   C. 3.
   D. 4.



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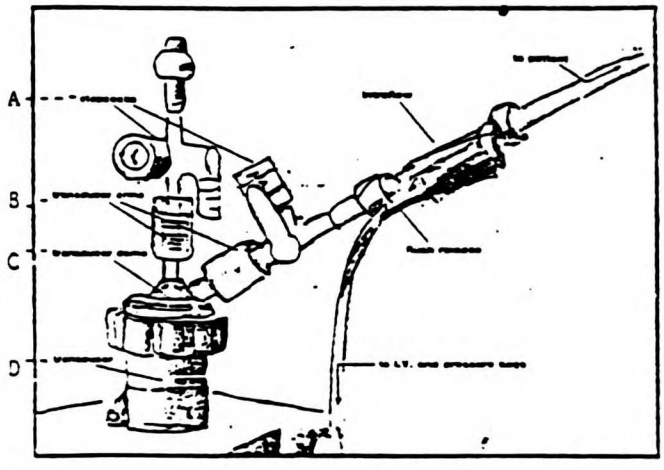
7. What point on the pictured transducer-flush system apparatus would you level to the patient's phlebostatic axis?
   A.
   B.
   C.
   D.



8. The air water interface of the transducer/flush system should be leveled to the patient's
   A. mid-axillary line.
   B. mid-axillary line at the 4th intercostal space.
   C. mid-anterior-posterior diameter at the 4th intercostal space.
   D. 2/3 of the patient's anterior-posterior diameter at the 4th intercostal space.

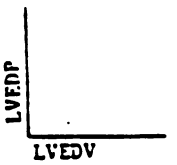
9. Positioning the air-fluid interface of the transducer 1 inch above the patient's phlebostatic axis will result in recorded hemodynamic measurements being
   A. higher than the patient's true hemodynamic measurements.
   B. lower than the patient's true hemodynamic measurements.
   C. the same as the patient's true hemodynamic measurement.

10. The recommended minimum balloon inflation volume to achieve a "wedge" waveform with a 7.5 French pulmonary artery catheter is
    A. 0.5 cc air.
    B. 0.8 cc air.
    C. 1.0 cc air.
    D. 1.2 cc air.

11. The recommended maximum balloon inflation volume to achieve a "wedge" waveform is
    A. 1.0 cc air.
    B. 1.5 cc air.
    C. 2.0 cc air.
    D. 2.5 cc air.

12. Which of these is not a complication of PA catheter balloon inflation?
    A. Pulmonary infarct
    B. Pulmonary artery rupture
    C. Hemoptysis
    D. Pneumothorax

13. LVEDP (left ventricular end diastolic pressure) as depicted in the following graph is related to LVEDV (left ventricular end diastolic volume) by
    A. end diastolic fiber length.
    B. compliance.
    C. contractility.
    D. preload.
    E. all of the above.



14. Pulmonary artery wedge pressure (PAWP) is usually equal to
    A. pulmonary artery systolic pressure.
    B. mean central venous pressure.
    C. mean left atrial pressure.
    D. right ventricular systolic pressure.

15. PAWP provides an estimate of
    A. preload.
    B. afterload.
    C. contractility.

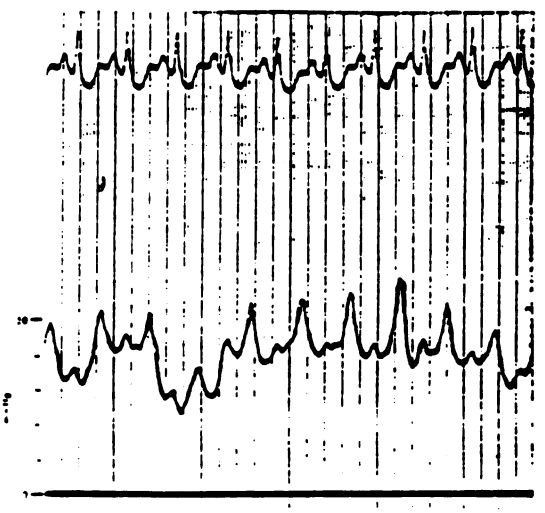
16. PAedp (pulmonary artery end diastolic pressure) provides a good estimate of PAWP except in cases of
    A. pulmonary hypertension.
    B. hypoxia.
    C. COPD.
    D. all of the above.
    E. none of the above.

17. A patient who has an elevated PAWP and a large PAWP-PAedp gradient (a large difference between the PAWP and PAedp) probably has
    A. hypervolemia.
    B. pulmonary disease with no cardiac problem.
    C. pulmonary and cardiac pathology.
    D. left ventricular failure with no pulmonary involvement.

18. "V" waves in the PAWP waveform follow the
    A. P wave of the EKG.
    B. QRS complex of the EKG.
    C. T wave of the EKG.

19. "a" waves in the PAWP waveform follow the
    A. P wave of the EKG.
    B. QRS complex of the EKG.
    C. T wave of the EKG.

20. The following waveform appears on the oscilloscope when wedging the balloon in the pulmonary artery (Figure 3). It may be caused by
    A. mitral stenosis.
    B. mitral regurgitation.
    C. tricuspid stenosis.
    D. tricuspid regurgitation.
    E. all of the above.



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21. The pressure from the previous waveform would be recorded by
    A. identifying the mean pressure and recording it as the PAWP.
    B. identifying the mean pressure and recording it as a PAWP with a v wave component.
    C. identifying the systolic pressure of the "v" wave and recording it as the PAWP.
    D. identifying the systolic pressure of the "a" wave and recording it as the PAWP with an "a" wave component.
    E. identifying the systolic pressure of the v wave and recording it as a v wave.

22. Mean PAWP as an estimate of LVEDP (left ventricular end diastolic pressure) is invalidated by all of the following EXCEPT
    A. altered left ventricular compliance.
    B. altered pulmonary compliance.
    C. mechanical obstructions between the balloon catheter tip and the left ventricle.
    D. altered left atrial compliance.
    E. mitral valve dysfunction.

23. Mean PAWP is invalidated as an estimate of LVEDV (left ventricular end diastolic volume) by
    A. altered left ventricular compliance.
    B. altered pulmonary compliance.
    C. mechanical obstructions between the balloon catheter tip and the left ventricle.
    D. mitral valve dysfunction.
    E. all of the above.

24. The patient's mean PAWP is 8 mm Hg greater than the PAedp; this measurement may indicate
    A. zone 2 lung catheter placement.
    B. mitral stenosis or regurgitation.
    C. overwedge.
    D. all of the above.
    E. none of the above.

25. A wedge waveform is seen on the patient's monitor without balloon inflation. In determining if the pulmonary artery catheter needed to be pulled back by the physician you should not
    A. stimulate the patient to cough.
    B. reposition the patient.
    C. flush the catheter with the intraflow.
    D. check to make sure the catheter and/or tubing isn't kinked.

26. You obtain the following hemodynamic measurements on your patient: PA pressures - 35/11: PAWP 25; Balloon inflation volume was 0.3 cc. You should
    A. record the measurement.
    B. record the measurement and notify the MD of pulmonary artery catheter peripheral migration.
    C. not record the measurement since it doesn't make physiological sense; re-attempt to wedge the catheter.
    D. not record the measurement since it doesn't make physiological sense; notify the MD of the catheter's peripheral migration.

27. PAedp should not be used to estimate PAWP:
    A. when the patient has pulmonary hypertension.
    B. when the patient's heart rate is greater than 120 beats per minute.
    C. Both of the above.
    D. None of the above.

* * * * * *

For items 28 - 38, choose one of the following responses:

A. is not affected as a measure of LVEDP.
B. is increased in relation to LVEDP.
C. is decreased in relation to LVEDP.
D. varies in its relationship to LVEDP.

28. In conditions which there is pulmonary venous obstruction (mean pulmonary embolus), mean PAWP . . .

29. In conditions of pulmonary hypertension, mean PAWP. . .

30. When the patient is on 10 cm H_2O or less of PEEP, mean PAWP. . .

31. When the patient is on greater than 10 cm of PEEP, mean PAWP. . .

32. In patient with significant tricuspid stenosis (large a waves), mean PAWP. . .

33. In a patient with significant mitral stenosis (large v waves), mean PAWP. . .

34. In a patient with significant tricuspid regurgitation (large v waves), mean PAWP . . .

35. In a patient with significant mitral regurgitation (large v waves), mean PAWP. . .

36. In a patient whose pulmonary artery catheter is located in Zone 2 lung [lung zone where pulmonary artery pressure (P_{PA}) is greater than alveolar pressure (P_{ALV}), which is in turn greater than pulmonary venous pressure (P_{PV})--(lung zone where $P_{PA} > P_{ALV} > P_{PV}$)], mean PAWP . . .

37. In a patient whose pulmonary artery catheter is located in Zone 3 lung [lung zone where pulmonary artery pressure (P_{PA}) is greater than pulmonary venous pressure (P_{PV}), which is in turn greater than alveolar pressure (P_{ALV})---(lung zone where $P_{PA} > P_{PV} > P_{ALV}$)], mean PAWP . . .

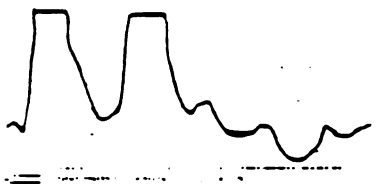
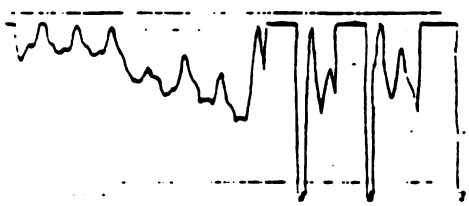
38. When the balloon catheter is "overwedged," mean PAWP . . .

* * * * * *

39. The proper location in the lung for a pulmonary artery catheter is
    A. Zone 1 ($P_{ALV} > P_{PA} > P_{PV}$).
    B. Zone 2 ($P_{PA} > P_{ALV} > P_{PV}$).
    C. Zone 3 ($P_{PA} > P_{PV} > P_{ALV}$).

40. Air bubbles within the transducer-catheter system affect hemodynamic reading by causing
    A. an increase in systolic pressure and a decrease in diastolic pressures obtained.
    B. a decrease in systolic pressure and an increase in diastolic pressures obtained.
    C. a decrease in both systolic and diastolic pressures obtained.
    D. an increase in both systolic and diastolic pressures obtained.

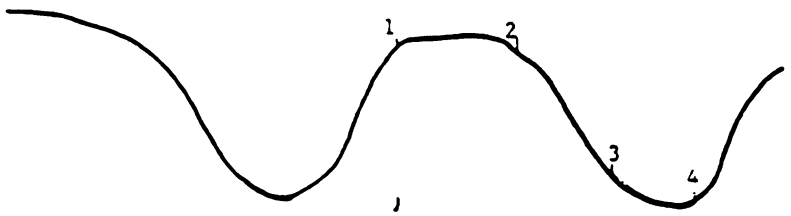
41. In a simple bedside check of the dynamic response of the monitor-transducer-catheter system, one should
    A. zero and calibrate the system, observing the calibration waveform.
    B. stimulate the patient to cough and observe the waveform.
    C. flush the catheter with the intraflow and observe the waveform.
    D. jiggle the catheter tubing and observe the waveform.

42. A good dynamic response waveform should look similar to
    A.
    
    B.
    
    C.
    

43. With too much "noise," "fling," or "whip" in the hemodynamic waveform with a wedge obtainable on balloon inflation with 1 cc of air, the nurse should
    A. place a damping device on the system.
    B. notify the physician so that the pulmonary artery catheter can be refloated further out into the pulmonary artery.
    C. rezero and recalibrate the system.
    D. none of the above.

44. Inflating the balloon of a pulmonary artery catheter in Zone 2 lung until the waveform flattens will give you a measure of
    A. PAWP.
    B. overwedge pressure.
    C. eccentric balloon inflation pressure.
    D. alveolar pressure.

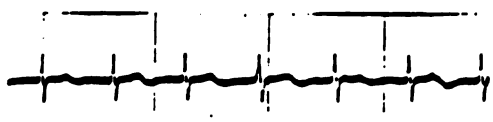
45. In the following simulated waveform representing a PAWP waveform obtained from a patient on a ventilator, which point on the diagram represents end-expiration?
    A. 1
    B. 2
    C. 3
    D. 4

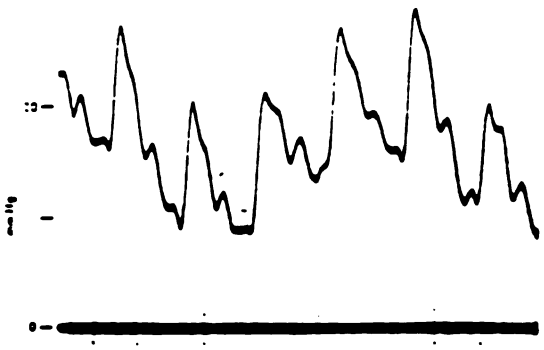


46. In the previous simulated waveform now representing a PAWP waveform obtained from a spontaneously breathing patient which point on the waveform represents end-expiration?
    A. 1
    B. 2
    C. 3
    D. 4

47. The most stable portion of the respiratory cycle at which intravascular pressures can be assessed is
    A. peak inspiration.
    B. end inspiration.
    C. peak expiration.
    D. end expiration.

48. The systolic pressure you would record from the following waveform recorded from a spontaneously breathing patient is
    A. 25 mm Hg.
    B. 20 mm Hg.
    C. 15 mm Hg.
    D. 22 mm Hg.





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49. The end diastolic pressure you would record from the previous waveform recorded from a spontaneously breathing patient is
    A. 18 mm Hg.
    B. 10 mm Hg.
    C. 25 mm Hg.
    D. 20 mm Hg.

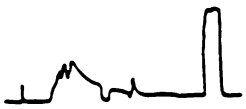
49. Inaccurate cardiac output measurements are obtained by all of the following except
    A. deviation from exact injectate volume.
    B. injection of fluid into the distal port.
    C. incorrect computation constant for the size / type pulmonary artery catheter.
    D. proximal/RA port within the catheter introducer sheath.
    E. use of room temperature injectate.

50. Cardiac output injectate should be delivered within
    A. 2 seconds.
    B. 4 seconds.
    C. 6 seconds.
    D. 8 seconds.
    E. 10 seconds.

51. A technically accurate thermodilution curve is depicted by

A

B.



C.

* * * * * *

For the questions 53 - 60 choose one of the following responses:

A. . . . the cardiac output measurement obtained will be <u>invalid</u> due to violation of a cardiac output measurement principle.
B. . . . the cardiac output measurement obtained will be <u>valid</u> but will be <u>decreased</u> in relation to the patient's previous cardiac output measurement.
C. . . . a cardiac output measurement obtained will be <u>valid</u> but will be <u>increased</u> in relation to the patient's previous cardiac output.
D. . . . a cardiac output measurements obtained will be <u>valid</u> and <u>unchanged</u> from the patient's previous measurement.

53. Your patient has chronic tricuspid regurgitation, the physician orders another cardiac output . . .

54. Your patient has chronic mitral regurgitation, the physician orders another cardiac output . . .

55. Your patient has chronic pulmonic regurgitation, the physician orders another cardiac output . . .

56. Your patient has chronic aortic regurgitation, the physician orders another cardiac output . . .

57. Your patient develops ventricular bigeminy, the physician orders a cardiac output . . .

58. Your patient has been on hemodialysis for 30 minutes, the physician orders a cardiac output . . .

59. Your ventilated patient has had his PEEP increased by 5 cm. H_2O, the physician orders a cardiac output. . . .

60. Your patient has an intraventricular cardiac shunt, the physician orders another cardiac output . . .

* * * * * *

61. The most common cause of cardiac output inaccuracies is . . .
A. cardiac injection technique.
B. use of room temperature injectate.
C. injecting the fluid at variable times during the respiratory cycle.

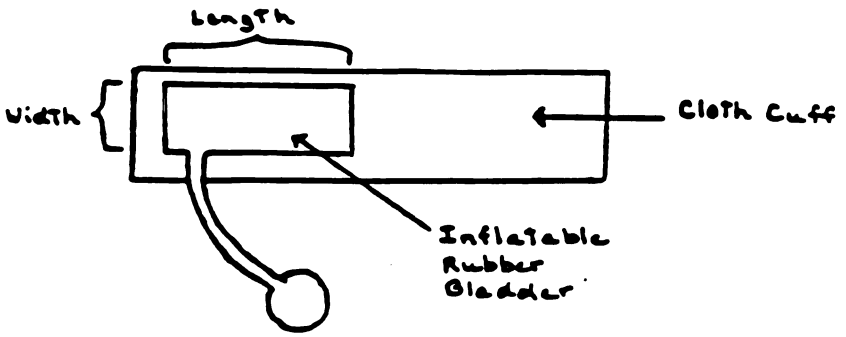
BLOOD PRESSURE DETERMINATION QUESTIONNAIRE

Please circle the best answer for each of the following items.

1. Which of the following observer factors can influence the proper determination of blood pressure?
   A. Hearing.
   B. Eyesight
   C. Proper training in blood pressure measurement.
   D. A and B
   E. A, B, and C.

2. The normal range for blood pressure in an adult is
   A. 120/80 to 170/110.
   B. 105/70 to 155/100.
   C. 90/60 to 140/90.
   D. 75/50 to 125/80.

3. On the dial or gauge of the sphygmomanometer, each mark is equal to
   A. 1 mm of Hg.
   B. 2 mm of Hg.
   C. 4 mm of Hg.
   D. 5 mm of Hg.



4. Which of the following indicates the correct blood pressure cuff width? (Refer to the above diagram.)
   A. Twice the diameter of the arm.
   B. The same diameter as the arm.
   C. 20% wider than the arm diameter.
   D. 60% wider than the arm diameter.

5. If a standard adult cuff is used on an obese adult, the measured blood pressure is likely to be:
   A. falsely high.
   B. falsely low.
   C. accurate.
   D. at first falsely high and then accurate.

6 If the blood pressure cuff is not applied snugly to the arm, the blood pressure measurement will be:
A. falsely low.
B. falsely high.
C. accurate.
D. at first falsely high and then accurate.

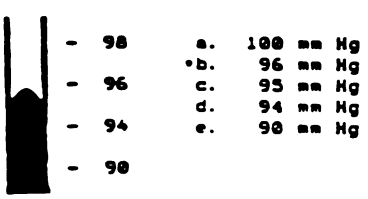
7. Which of the following factors regarding the inflating system, exhaust valve, and tubing of the sphygmomanometer can influence the accuracy of blood pressure measurement?
A. Pressure leaks of greater than 1 millimeter Hg/sec.
B. Sticky exhaust valves.
C. Intermittent failure of the bulb to fill with air.
D. A and B.
E. A, B, and C.

8. When using a mercury manometer, which of the following could result in inaccurate blood pressure measurement?
A. Dirt in the glass tube of the manometer.
B. Oxidation of mercury.
C. Sluggish movement of mercury.
D. A and B.
E. A, B, and C.

9. Which of the following should be checked prior to using a mercury manometer?
A. Level of the mercury meniscus when the cuff is completely deflated.
B. Air vent at the top of the glass tube
C. Calibration against an aneroid manometer.
D. A and B.
E. A, B, and C.

10. Which of the following is most likely to impair the accuracy of an aneroid manometer?
A. Frequent calibration.
B. Stop pin at the zero mark.
C. Jarring or rough handling.
D. B and C.
E. A, B, and C.

11. The blood pressure reading from the accompanying diagram should be



A. 100 mm Hg.
B. 96 mm Hg.
C. 95 mm Hg.
D. 94 mm Hg.
E. 90 mm Hg.

12. When excessive pressure is exerted by the observer on the stethoscope end piece (i.e., when the end piece leaves an indentation in the skin)
A. the systolic reading is falsely high.
B. the systolic reading is falsely low.
C. the diastolic reading is falsely high.
D. the diastolic reading is falsely low.

13. The patient should be comfortably seated with the whole forearm supported
    A. above heart level.
    B. at heart level.
    C. below heart level.
    D. A or B.
    E. A, B or C.

14. After pumping up the blood pressure cuff, the pressure should be released at a rate of
    A. 0 -.5 mm Hg per second.
    B. 2 - 3 mm Hg per second.
    C. 4 - 8 mm Hg per second.
    D. as rapidly as possible.

15. Systolic blood pressure in the adult can best be indicated by which of the following?
    A. First Korotkoff sound (appearance of sound)
    B. Second Korotkoff sound (swishing)
    C. Fourth Korotkoff sound (muffling)
    D. Fifth Korotkoff sound (disappearance of sound)

16. Diastolic blood pressure in the adult can best be indicated by which of the following?
    A. First Korotkoff sound (appearance of sound)
    B. Second Korotkoff sound (swishing)
    C. Fourth Korotkoff sound (muffling)
    D. Fifth Korotkoff sound (disappearance of sound)

17. The observer noted the following pressures while auscultating the blood pressure:

    150 mm Hg - 1st Korotkoff phase (appearance of sound)
    140 mm Hg - 2nd Korotkoff phase (swishing)
    100 mm Hg - 3rd Korotkoff phase (increased intensity)
    90 mm Hg - 4th Korotkoff phase (muffling)
    0 mm Hg - 5th Korotkoff phase (disappearance of sound)

    What is the best way to record this reading?
    A. 150 / 90
    B. 150 / 0
    C. 150 / 140 / 90
    D. 150 / 100 / 0
    E. 150 / 90 / 0

18. Auscultatory gap is a serious source of error in blood pressure measurement. Which of the following is the best definition of auscultatory gap? A temporary absence of sound between
    A. phases I and II.
    B. phases III and IV.
    C. phases IV and V.
    D. phases I and V.

19. Which of the following could occur if the client has an auscultatory gap?
    A. Underestimation of the systolic pressure.
    B. Overestimation of the diastolic pressure.
    C. Overestimation of the systolic pressure.
    D. A or B.
    E. B or C.

20. Which of the following is the best method for preventing errors due to the auscultatory gap?
    A. Listen with the bell of the stethoscope for the brachial artery pulse and proceed with pressure measurement.
    B. Listen with the stethoscope and inflate the cuff until the radial artery pulse can no longer be heard and proceed with blood pressure measurement.
    C. Inflate the cuff rapidly to 300 mm Hg and listen with the stethoscope until the brachial artery pulse appears and then disappears.
    D. Palpate the pressure at which radial pulse disappears then inflate the cuff to 30 mm Hg greater than that pressure and proceed with blood pressure measurement.

21. If several blood pressure measurements are to be made on a patient, the observer should wait a minimum of _____ minutes before remeasurement.
    A. 30 seconds
    B. 1 - 2 minutes
    C. 5 - 6 minutes
    D. 6 - 8 minutes

22. It is important to wait this recommended interval of time before retaking a blood pressure because
    A. the patient can become too anxious.
    B. a thrombophlebitis could occur.
    C. it allows for catecholamine levels to return to normal.
    D. it allows venous drainage of the limb distal to the cuff.
    E. arterial spasm can be prevented.

23. Which of the following factors below can affect a person's blood pressure?
    A. Changes in environmental temperature
    B. Emotional turmoil
    C. Anxiety
    D. Urinary bladder distention
    E. All of the above

24, The patient should be allowed to rest quietly in one position for a minimum of ____ minutes before measuring the blood pressure.
    A. 2 minutes
    B. 5 minutes
    C. 15 minutes
    E. 20 minutes

25. In general, after the initial blood pressure is measured in both arms, it is recommended that the blood pressure be measured in
    A. the arm with the lowest pressure.
    B. the arm with the highest pressure.
    C. either arm.
    D. alternate arms.

26. Which of the following blood pressures should be recorded as the blood pressure for a client outpatient visit?
    A. The first pressure measured.
    B. The last pressure measured.
    C. The average of at least two pressures.
    D. The lowest pressure.
    E. The highest pressure.

27. If an individual's blood pressure is remeasured at monthly intervals, the pattern most often seen over the monitoring period is
    A. a gradual decrease.
    B. a gradual increase.
    C. a gradual increase and then decrease.
    D. no change.

28. An elevated systolic blood pressure without elevated diastolic pressure is found more commonly in
    A. the elderly.
    B. young adults.
    C. children.
    D. the obese.

29. This problem is known as
    A. isolated systolic hypertension.
    B. elevated systolic blood pressure.
    C. isolated diastolic hypotension.
    D. acute systolic hypertension.

30. An elevation in which of the following indicates that the client is at increased risk for developing atherosclerosis?
    A. elevated systolic pressure.
    B. elevated diastolic pressure.
    C. labile hypertension.
    D. A and B.
    E. A, B and C.

31. Which diastolic range is defined as mild hypertension?
    A. 80 - 89 mm Hg
    B. 85- 95 mm Hg
    C. 90 - 104 mm Hg
    D. 95 - 115 mm Hg

32. According to the latest national standards, if a client's diastolic blood pressure is 85 -89 mm Hg during a clinic visit, the blood pressure should be rechecked
    A. immediately.
    B. within 6 months
    C. at least within a year.
    D. at least within two years.

33. The nurse determines that the client's blood pressure is 165 / 125. The appropriate referral should be
    A. make an appointment in the clinic next week.
    B. call physician for an appointment tomorrow.
    C. go immediately to a physician.
    D. call an ambulance.

34. The nurse determines that the client's blood pressure is 150 / 100. What would be the most appropriate action?
    A. Refer immediately to a physician.
    B. Recommend confirmation of the blood pressure tomorrow.
    C. Recommend confirmation of the blood pressure within 2 weeks.
    D. Recommend confirmation of the blood pressure within 2 months.

THANK YOU FOR YOUR PARTICIPATION

Please place the questionnaires in the envelope provided and return it either to Major Dolter or your facility's Local Principal Investigator listed on the packet instructions.

If you'd like your questionnaire results on the PA and BP questionnaire, write down your questionnaire number so that you may look up your own results on the print-out of individual results to be provided your unit.

If you have any comments regarding these questionnaires or the study in general please record them in the space below.

APPENDIX D: Chart Audit Instruments and Unit Demographic Questionnaire

CABGS Chart Audit Form
Clinical Severity Score
CABG Care Checklist
Morbidity/Mortality/Utilization Checklist
CABGS Chart Audit Form Used to Collect Data

Unit Demographic Questionnaire

Clinical Severity Score

1. Emergency case
   a. Yes = 6 pts
   b. No = 0 pts

2. Serum creatinine
   a. ≥ and ≤ 1.8 = 1 pt
   b. ≥ 1.9 = 4 pts

3. Severe left ventricular dysfunction
   a. Yes = 3 pts
   b. No = 0 pts

4. Reoperation
   a. Yes = 3 pts
   b. No = 0 pt

5. Operative mitral valve insufficiency
   a. Yes = 3 pts
   b. No = 0 pts

6. Age
   a. ≥ 65 and ≤ 74 = 1 pt
   b. ≥ 75 = 2 pts

7. Prior vascular surgery
   a. Yes = 2 pts
   b. No = 0 pts

8. Chronic obstructive pulmonary disease
   a. Yes = 2 pts
   b. No = 0 pts

9. Anemia (hematocrit ≤ .34)
   a. Yes = 2 pts
   b. No = 0 pts

10. Operative aortic valve stenosis
   a. Yes = 1 pt
   b. No = 0 pt

11. Weight ≤ 65 kg
   a. Yes = 1 pt
   b. No = 0 pts

12. Diabetes on oral or insulin therapy
   a. Yes = 1 pt

b. No = 0 pts

13. Cerebrovascular disease
   a. Yes = 1 pt
   b. No = 0 pts

CABG Care Checklist

(All time in hours. Indicate hours or Not applicable (N/A)

Time from admit from OR until:

1. Normal temperature (36.5)_____
2. Patient awakens from anesthesia (Glasgow Coma Scale 15 or back to baseline)_____
3. Vasoactive drips being titrated turned off_____
4. Vasoactive drips at "straight rate" of (i.e., NTG at 10 mcg/min or Dopamine at 3 3 mcg/kg/min)_____
5. Extubation_____
6. Pulmonary artery catheter discontinued_____
7. Arterial line discontinued_____
8. Central venous access discontinued (i.e., Cordis)____
9. O_2 discontinued_____
10. Mediastinal/chest tube(s) discontinued_____
11. Pacer wires out_____
12. Foley catheter discontinued_____
13. Transferred from ICU_____
14. Discharge from hospital_____

Morbidity/Mortality/Utilization Checklist

Mortality

1. Discharge status
   a. Alive
   b. Dead

Morbidity One or more of the following (Higgins, et al., 1992)

2. Cardiac Complication
(Myocardial infarction based on new Q waves ≥ 40 milliseconds long and an R wave of ≥ to 25% with Creatinine phosphokinase MB ≥ 50 IU AND/OR low cardiac output syndrome requiring intra-aortic balloon pump or ventricular assist device)
   a. Yes
   b. No

3. Prolonged Ventilation (≥ 3 days)
   a. Yes
   b. No

4. Central Nervous System Complication
   (Focal brain lesion by exam or computerized axial tomography, diffuse encephalopathy with severely altered mental status for > 24 hours, or failure to awaken post-operatively)
   a. Yes
   b. No

5. Oliguric or anuric renal failure
   (Urine output < 400 cc day and/or institution of dialysis or ultrafiltration)
   a. Yes
   b. No

6. Serious infection
   (Culture proven mediastinitis or septicemia)
   a. Yes
   b. No

7. Morbidity Present
   a. One or more of the items 1 - 6 marked yes (since mortality precludes finding morbidity) = 1
   b. None of items 2- 6 marked yes = 0

Utilization Indicators:

1. Return to Operating Room
   a. Yes
   b. No

2. Non-autologous blood products given
   a. Units Packed red blood cells____
   b. Units Fresh frozen plasma____
   c. Units platelets_____
   d. None

3. Vasoactive medications Utilized
   a. Nitroglycerin
   b. Nipride
   c. Dobutamine
   d. Dopamine
   e. Amrinone
   f. Esmolol
   g. Epinephrine
   h. Levophed
   i. Neosynephrine
   j. Isuprel
   h. Other

4. Volume expanders
   a. # 250 cc Hespan
   b. # 50 cc Albumin
   c. # 250 cc Plasmanate

SITE____
REGISNUMBER__
SEQNUMBER___
ADMISDATE__
DCDATE____
ADMISSTAT___
SURGPRO#__
IMAPRO#___
AGE_____
RACE____
SEX_____
PROCEDURE__
BYPASTIME___
CROSSTIME___
CONCURROP___
IMA___
INOPCOMP1____
INOPCOMP2__
INOPCOMP3____
OTHMAJPR___
MEDS
ANTIPLATE____
ACE___
ANTIDYS__
PREDIUR__
BETABLO___
NITRATES___
INOTROP__
CAANTAG__
ANTICOAG__
STEROIDS___

History AMI____
ASA___
AVDIS___
CARDSHOCK___
CARDIMEG____
CEREBVVD___
CHF___
CLF____
COPD_____
CXRINFIL__
CHFONCXR__
CVA___
DIABETES____
EMERCABG____
EXTCAB____
HXMI_____
HYPERLIPID___
HPTN____
LVANEUR___
LVDYS___
MVALDIS___
PREHTSUR____
PREIABP____
PRVASSUR____
PTCA____
PVD____
RALES____
RECMI____
RENFAIL___
REOPERA_____
UNANGINA____

Preop vs + labs
HCT____
BUN____
CR_____
HR_____
PREOPSBP____
PREOPDBP____
HT____
WT____
UNIT
TEMPONARRIV___
TIMTOUN___
TIMNORMT__
TIMVASOFF__
TIMPADC___
TIMALDC___
SUREAL____
TIMEEXT___
TIME02DC___
SURE02____
TIMEMTDC___
SUREMT___
TIMEFOLEYDC_
SUREFOLEY__
TIMEWIRES__
SUREWIRES__
TIMETRANS___
DCSTATUS___
COMPLI
ARF___
CARDCOMP___

CNSCOMP___
PROLVENT___
RETTOICU__
RETTOOR__
SERINFEC__
OTHCOMP___
VOLUME
NONAUTBP_
NUMPLTS__
NUMFFP__
NUMOTH__
HESPAN__
ALB5__
ALB25__
PLAS__
DRIPS
ANTDYS__
DOBUT__
DOPA___
ESMOLOL__
EPI__
INOCOR__
LEVO___
NEO__
NIPRIDE__
NTG___
OTHER__
POSTIABP__
POSTLVAD__
DIURETIC__
PACER__

Unit Demographic Questionnaire

Unit # _____

1. Volume of CABG surgeries for two week observation period____

2. Volume of CABG surgeries for Jan-Jun 1994____

3. Medical Center Bed Size_____

4. Type of unit
   a. Cardiovascular ICU
   b. Combined Cardiovascular ICU and Surgical ICU

5. Unit bed size___

4. Unit Staffing
   a. # of RNs_____
   b. # of LVNs_____
   c. # of corpsmen/aides____
   d. # of unit secretaries

5. Staff Mix Caring For CABG
   a. Only RN
   b. RN and LVN
   c. RN and corpsmen/aides

6. Average Unit Acuity (Workload Management System for Nursing)_____

7. Cardiovascular Clinical Nurse Specialist to:
   a. Unit
   b. Patient population
   c. No Cardiovascular CNS

8. # of RNs with Service ICU Skill Identifier____

9. # of RNs with CCRN_____

10. # of RNs who have attended Service ICU course_____

11. Length of service ICU course_____

12. Hours of inservice provided on unit per month____

13. Number of Certified Cardiothoracic Surgeons___

14. Total Number of Cardiothoracic Surgeons_____

15. Cardiovascular Residency Program
    a. Yes
    b. No

16. Mortality: Crude _____ Actual Versus Expected_____

APPENDIX E: Letters of Permission

Instrument Permissions

* Letter of Permission Included Immediately Before Instrument
NOTE: Ms. Sollek did not sign her letter, but signed her FAX.
Dr. Liebowitz sent a PASG Test with "Do Not Duplicate" stamped on it.

Permission from Joint Commission on Healthcare Accreditation for Use of Figure 2-4

Margaret V. Sollek, RN, MN
Cardiovascular Clinical Nurse Specialist
Dept. of Cardiology
Virginia Mason Medical Center
1100 Ninth Avenue
Seattle, WA 98111
Phone: 1-206-625-7221
Fax: 1-206-223-8824
March 1, 1994

Kathryn J. Dolter
1108 Marcussen Drive
Menlo Park, CA 94025

Ms Dolter,

Thank you for your request. I formally give my permission for you to use my "Blood Pressure Determination Questionnaire" in your study of hemodynamic knowledge and practice variation in Department of Defense medical centers. It is my understanding that the tool would be unmodified and used only for this study. Participants will have no opportunity to make further photocopies. My name and the title of the instrument will be identified on the Questionnaire.

Thank you for sharing the results of the research with me at the conclusion of the study. I am enclosing a copy of the Questionnaire and the answer key in this fax.

Margaret V. Sollek RN, MN
Virginia Mason Medical Center
Seattle, WA 98111

Kellogg J.L. Kellogg Graduate School of Management Northwestern University

Stephen M. Shortell, Ph.D.
A. C. Buehler Distinguished Professor
of Health Services Management
Professor of Organization Behavior

February 24, 1994

Kathryn J. Dolter
AMEDD Student Detachment
11008 Marcussen Drive
Menlo Park, CA 94025

Dear Ms. Dolter:

I am writing in response to your recent letter requesting permission to use our ICU nurse-physician questionnaire. This letter should serve as formal indication that you have our permission to use the questionnaire as long as it is cited in any publications and written materials that may result from your research. The proper citation for use is: "Excerpted from The Organization and Management of Intensive Care Units. Copyright 1989, Shortell and Rousseau." I would like to re-confirm that permission does not extend to Section II (The Workplace and Facilities) or Section III (The Organization Culture) of the original full-length questionnaire which are under control of Human Synergistics and require written permission from Human Synergistics. As indicated in the shortened questionnaires, you have our permission to change terminology/titles etc. in questions or use only portions of the questionnaire to make them suitable for your purposes. We have also included a list of our scales with their component questions. If you have any questions, please call Robin Gillies, ICU Project Director at 708/491-2687.

We would be very interested in learning of the results of your research. Our best wishes in your work.

Sincerely,

Stephen M. Shortell

Stephen M. Shortell, Ph.D.

Leverone Hall 2001 Sheridan Road Evanston, Illinois 60208-2007 708-491-5541 Fax 708-491-2683

Mount Sinai

The Mount Sinai Medical Center
The Mount Sinai Hospital
Mount Sinai School of Medicine

One Gustave L. Levy Place
New York, NY 10029-6574

Kathryn J. Dolter, RN, MA, CCRN, MAJ/AN
1108 Marcussen Drive
Menlo Park, CA 94025

Dear Ms. Dolter,

I am responding to your letter of February 17, 1994 regarding the PA catheter study. Dr. Iberti passed away last year and I am therefore responding to your letter. I am sending you a copy of the instrument. My only request is that credit in any publication or other academic writing be given where it is due, as is common courtesy. I wish you luck in your project and hope to here from you soon.

Sincerely,

Andrew B. Leibowitz, M.D.

Joint Commission
on Accreditation of Healthcare Organizations

Organization: Kathryn J Dolter
400 Alma Apt A
Menlo Park, CA 94025

Publication Title: Quality Review Bulletin 18(5) May 1992
Pages: 151
Figure or Table Numbers: Figure 1. Cause and Effect Diagram for Continuous Improvement in ICUs
Number of Copies: N/A

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Permission granted by Helen Malone Date: 8/3/95