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Quality of Care Delivered Before versus After A Quality Improvement Intervention for Acute Geriatric Trauma

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Abstract

Background—Older trauma injury patients had improved recovery after we implemented routine geriatric consultation for patients ≥ age 65 at a level-1 academic trauma center. The intervention aimed to improve quality of geriatric care. However, the specific care processes that improved are unknown.

Study Design—Prospective observation comparing medical care after (December 2007-November 2009) versus before (December 2006-November 2007) implementation of the geriatric consult-based intervention. To measure quality-of-care (QOC) we used 33 previously-validated care-process quality indicators (QIs) from the Assessing the Care of Vulnerable Elders (ACOVE) study, measured by review of medical records for 76 Geriatric Consult [GC] versus 71 control group patients. As pre-specified subgroup analyses, we aggregated QIs by type: geriatric (e.g., delirium screening) versus non-geriatric condition-based care (e.g., thrombosis prophylaxis) and compared QI scores by type of care. Last, we aggregated QI scores into overall, geriatric, and non-geriatric QOC scores for each patient (# QIs passed/# QIs eligible), and compared patient-level QOC for the GC versus control group, adjusting for age, gender, ethnicity, comorbidity, and injury severity.

Results—63% of the GC versus 11% of the control group patients received a geriatric consultation. We evaluated 2505 QIs overall (1664 geriatric-type and 841 non-geriatric QIs). In general, fewer geriatric-type QIs were passed than non-geriatric QIs (71% vs 81%, p<.001). We provided better overall-QOC to the GC (77%) than control group patients (73%, p<.05). However, the difference was not statistically significant after multivariable adjustment (p=.08). We improved *geriatric*-QOC for the GC (74%) compared to the control group (68%, p<.01), a difference that was significant after multivariable adjustment (p=.01).

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Conclusion—Geriatricians and surgeons can collaboratively improve geriatric QOC for older trauma patients.

Introduction

Over the past 15 years, older adults (defined as those aged 65 and older) were the only age group to increase in hospital trauma admissions, compared to no increase for younger adults and decrease among children.[1] Moreover, older adults now comprise 35% all non-fatal acute trauma injury admissions and 27% of all fatal trauma cases nationally despite comprising only 17% of the adult population.[2]

Despite increasing priority on improving hospital care and outcomes among older surgical patients,[3,4] resources to improve the trauma care for older adults hospitalized for injury are still scarce.[5] We have recently reported that a geriatric quality intervention that implemented routine geriatric consultation for all older trauma patients was associated with better functional recovery.[6] Research by others also suggests that geriatric consultation for hip fracture can improve survival,[7] physical function,[8,9] cognitive performance,[10] and quality-of-life,[11] and may reduce delirium[12] and discharge to long-term care facilities.[13] A multidisciplinary geriatric trauma unit decreased mortality and complications.[14] In contrast to trials of a single care-process (such as a procedure or medical treatment), geriatric consultation involves a complex set of care-processes and interactions between providers.

Care-process measures, which are increasingly used to measure clinical performance, can measure the types of care impacted by our geriatric consultation intervention. We used previously-validated quality indicators (QIs) developed by the Assessing the Care of Vulnerable Elders (ACOVE) study to evaluate degree of quality improvement. The ACOVE QIs measure appropriate hospital care of vulnerable community-dwelling elders.[15] Vulnerability was previously defined in ACOVE by advanced age and functional impairment.[16,17] For this study, we considered all older patients with acute trauma as vulnerable and therefore eligible for the ACOVE indicators. By classifying the QIs into different categories of care types, our secondary objective was to test whether “geriatric” care – care provided for geriatric conditions and occurrences (e.g., delirium or delirium prevention) – improved as a result of the intervention. Since our geriatric consultants’ usual practice is to focus on geriatric issues, we hypothesized that any observed improvement would be more likely to occur in geriatric areas of care.

Methods

Design, setting, and subjects

We evaluated the change in quality of care delivered before versus after implementation of a quality implementation as our study design (a “pre-post” observational study). In December 2007, we implemented a quality improvement intervention to routinely provide geriatric consultation to all trauma patients age 65 and older at a Level-1, academic trauma center. Our intervention has been described previously.[6] Briefly, this was a clinical partnership between trauma surgery and geriatric medicine, to routinely request formal geriatric consultation for all trauma patients age 65 and older requiring hospital admission. The

hospital geriatric consultation service consists of geriatric faculty and a rotating geriatric medicine fellow, with a typical practice of daily visits until resolution of geriatric medical and disposition issues. We did not require consultants to prioritize improvement on any particular ACOVE QI. A typical geriatric consultation during this study included identifying risks unique to older patients early in the hospital course, including cognitive and functional impairment, polypharmacy, and inadequate social support for safe discharge. The control group received our medical center's usual care, which included the option of requesting a general medical or geriatric consultation.

To evaluate our multidisciplinary geriatric trauma quality improvement effort, we maintained an intention-to-treat approach, i.e., evaluating the care of patients according to their group assignment even if a geriatric consultation was provided during the control period prior to the intervention or if a consultation was not provided after the intervention began (Figure 1). We first used the hospital trauma registry to identify all eligible patients in the control group, using criteria of age 65 or older, admitted between December 2006 and November 2007, and length of stay > 24 hours, regardless of whether they received a geriatric consultation. This review yielded 80 eligible patients for medical record review. Then, we considered the first 80 sequentially-admitted patients after December 2007 as the Geriatric Consultation (GC) group, using the same criteria. The length of stay criterion of 24 hours was determined apriori as the minimum reasonable time needed to request and obtain a geriatric consultation. We requested all 80 charts in both groups, which would have given us 88% power (at α=.05) for a 10% relative improvement in score based on our apriori expectation of overall quality scores of 50% in the control group and 55% in the GC group (standard error of 10%) based on prior research.[18,19] As part of the original quality improvement intervention study,[6] we obtained institutional approval to enroll patients for human subjects research and a waiver of consent to review the medical record so fall eligible patients regardless of enrollment. This waiver allowed us to study QOC even among those whom we were unable to approach for participation: patients with short stay (< 72 hours) over weekends, observation of minor injury, or grave injury without available proxy consent. To select the 33 QIs, we reviewed all ACOVE-3 quality indicators and selected all the QIs in the hospital care set[15] as well as all indicators for the care of other conditions (e.g., pain management, end-of-life, dementia) that were applicable to a hospitalized trauma patient.[20–24] Please see online Appendix A1 for the QI specifications, sources, and modifications to adapt the QIs for trauma patients. To translate the ACOVE-3hospital QIs from 2007[15] into a structured tool to review medical records at our institution, we adapted materials from the original 2003 ACOVE-1 study (CR)[18] and newer studies regarding end-of-life[25] and hospital care.[26] We piloted the medical record review materials in 2010 (all materials available in online Appendix A2).

Medical record review—We then trained two professional nurse abstractors to review records stored in two electronic medical hospital record systems (one maintained by nursing, the second containing dictated notes from medical providers) and the paper chart (written notes, nursing bedside records, advanced directives, discharge summaries, medical orders, and the medication administration record) from admission to discharge for each hospital stay. Because a substantial number of QIs were measured using information in the paper

chart, we considered a patient's record as missing if we found any portion of the paper records were missing. We measured inter-rater reliability between the two nurses using pooled kappa statistics[27] across 30 QIs for both eligibility and pass versus fail from 15 randomly-selected records abstracted by both nurses. We completed detailed data collection and calculation of quality measures in 2012.

Measures of QOC

The methods for developing ACOVE QIs have been previously described.[17] Briefly, we used literature review and expert panel to identify care processes that are appropriate and/or associated with better health outcomes in vulnerable older adults. Each QI has two components: the first determines eligibility, e.g., IF a hospitalized patient has dementia; the second determined the scoring criterion, e.g., THEN a surrogate decision maker should be identified. A score of 1 indicates appropriate care; a score of zero indicates that recommended care was not provided. Most QIs were based on specific medical conditions and diseases (i.e., sicker, more complex patients are eligible for more QIs[28]), but half of the QIs were applicable based solely on being admitted or discharged from an acute care hospital rather than a specific medical condition. Some QIs were measured multiple times based on a single eligibility criterion (e.g., daily documentation justifying urinary catheter from insertion to discontinuation) or could be eligible multiple times per patient (e.g., multiple surgical procedures). To ensure that each multiply-measured QI had the same importance as the QIs measured only once, we inversely weighted each pass/fail event within the multiply-measured QIs (by the number of measurements within the individual QI or within the patient depending on the level of analysis), therefore resulting in a fractional rather than dichotomous QI score. [26]

Composite scores of QIs can be categorized by conditions, e.g., to compare quality of care delivered for different conditions[18,19] or grouped by domains of care processes.[18,29,30] Delirium prevention and mobility promotion are two high-priority areas of care for geriatric orthopedic surgery patients.[4,12,31] Therefore, we categorized the QIs into three mutually exclusive subtypes: geriatric condition-based care (e.g., delirium screening) versus non-geriatric care (e.g., thrombosis prophylaxis), delirium care (versus all other care), and care to promote mobility (versus all other care). Analogous to prior work in ambulatory care, we also categorized QIs by four domains of care-process: screening or prevention, diagnosis, treatment, and follow-up and continuity.[18]

Next, for each patient, we aggregated QIs as an Overall Quality-Of-Care (QOC) score, calculated as the patient's number of QIs passed divided by the number of QIs eligible, resulting in a score ranging from 0 to 100%. Overall-QOC scores have been previously-validated on an acute medical-surgical service, with higher scores associated with lower 1-year mortality.[26] We also calculated patient-level QOC scores within each of the types of care, e.g., geriatric-QOC, non-geriatric-QOC, mobility-QOC, non-mobility-QOC, etc.

Other variables—We used the hospital trauma registry to capture demographic information, hospital length of stay (LOS) in days, mechanism of injury (dichotomous variables), and the Injury Severity Score (ISS, continous, in points).[32] We used chart review

to collect the Charlson Co-morbidity Score (CCS)[33] conditions (Appendix A3) and calculate the CCS score (continuous, in points).

Analysis

For descriptive statistics, we used appropriate tests (chi-squared, Wilcoxon rank-sum, Fisher's exact, or t-tests) to compare differences between the GC versus control group with respect to receiving consultations in geriatrics orinternal medicine (general or medical sub-specialties), ISS and injury mechanism, ethnicity (white versus non white), co-morbidity, and LOS (days).

First, we compared individual QI scores for the GC versus control group, using appropirate unadjusted tests (chi-squared, Fisher's exact, t-test). Second, we aggregated the individual QIs by the categories of care described above and compared aggregate quality scores by subtype, for example, geriatric-type care versus non-geriatric care, using linear regression to compare the effect of the categories on mean QI scores with cluster adjustment at the level of the patient.

Third, we analyzed Overall-QOC at the level of the patient and compared the mean Overall-QOC scores for GC versus control group patients, using ordinary least-squares regression, both unadjusted and then adjusted for age, gender, ethnicity, comorbidity, and ISS. Last, we compared patient-level QOC scores within the sub-types, unadjusted and with adjustment for patient characteristics, between GC and control groups. To determine the 95% confidence intervals around the effect of the intervention on the QOC scores with adjustment for co-variables, we used the 2.5^{th} and 97.5^{th}percentile in adjusted difference in predicted GC versus control group QOC, calculated from 1000 bootstrapped samples. The predicted GC and control QOC scores presumed the co-variables were set at their mean (age, co-morbidity, injury severity) or mode (gender, ethnicity).

Results

Nine of the eligible control and four of the GC group patients, had incomplete paper records, resulting in final samples of 71 Control and 76 GC patients (Figure 1). The sample analyzed in this current study overlapped with our original geriatric outcomes study[6] (which also tested a GC and control group) by 45 patients in the GC group (59%) and 33 patients in the control group (46%). Patient demographics and clinical characteristics were similar in the two groups (Table 1) with a few exceptions. By design, we provided more geriatric consultations in the GC group than the control group (63% versus 11%). The GC group received more non-geriatric general medical consultation than the control group (41% versus 23%, $p<.02$) and there were more patients of white race in the GC than control group (86% versus 70%, $p<.03$). There was no difference between the two groups with respect to type of injury, CCS, length of stay, ISS, or age (Table 1).

In total we evaluated 2505 QIs across geriatric (upper half of Table 2) and non-geriatric (lower half of Table 2) care and by type of care process (Screening and prevention [S], Diagnosis [D], Treatment [T], Follow-up and continuity [F], Cognitive /Delirium [C], and Mobility [M], noted throughout Table 2). On average, patients were eligible for 17 QIs.

When we compared results of two reviewers (15 patients eligible for a collective 285 QIs), we found good overall inter-rater reliability (pooled Kappa = 74%). Details regarding individual QI kappa scores are available from the authors upon request.

On average, the GC group received significantly better individual QI scores (Table 2) for functional status screening upon admission, post-operative delirium screening, comparison of discharge cognitive status to pre-operative status, documentation of discharge plans, and pain management by the third day of hospitalization.

Of the2505 individual QIs evaluated for the entire sample, the overall QOC score was 75% (Table 3). Two-thirds of the QIs measured geriatric-type care. Aggregate scores by types of care were poorer for Geriatric-QOC, on average, than non-geriatric QOC, 71.2% versus 81.2% ($p<.001$ adjusted for within-patient clustering). We also observed poorer QOC for cognitive/delirium care versus non-cognitive/delirium care (58.8% versus 78.6%, $p<.001$, Table 3) and mobility care versus non-mobility care (77.8% versus 73.4%, $p=.03$). Among the four domains of care, the follow-up/continuity score (60.7%) and diagnosis (65.6%) were statistically worse than screening (84.8%, $p<.001$ for both comparisons). By contrast, treatment scores (85.4%) were not different than screening (84.8%, $p=.7$).

When we analyzed patient-level aggregated QOC scores (Table 4), we found that controlling for clinical characteristics attenuated the differences between the two groups. Overall-QOC scores (i.e., based on all 33 ACOVE QIs) were better in the GC group versus control (76.5% versus 73.2%, a difference of 3.2 absolute percentage-points, $p<.05$ for unadjusted t-test), but after adjustment for patient-level confounders, we found no difference (2.8 percentage-point difference, $p=.08$). However, the GC group had better geriatric-QOC scores (74.0% versus 68.3%, a difference of 5.7 absolute percentage-points), cognitive/delirium QOC (63.9% versus 55.0%, a difference of 8.9 absolute percentage-points), and screening QOC (88.6% versus 83.2%, a difference of 5.4 absolute percentage-points). These differences in QOC scores persisted even after multivariable adjustment, at 5.0 (95% CI 1.2–9.2) for geriatric care, 8.4 (95% CI 0.5–16.4) for cognitive/delirium care, and 6.1 (95%CI 1.2–11.2) absolute percentage-points for screening/prevention (Table 4, right two columns).

Discussion

We previously reported that a quality improvement intervention using a routine geriatric consultation results in improved functional recovery. In this study using detailed chart review to measure 33 objective ACOVE care-process quality indicators, we found that delivery of geriatric care, especially care of delirium, was worse than non-geriatric care. Our geriatric consultation intervention resulted in a modest, 5 percentage-point, improvement in geriatric QOC but had no effect on non-geriatric surgical care processes.

This work extends results of geriatric consultation literature in acute surgical and trauma care of older adults. Older surgery patients have additional need for geriatric medical care in comparison to younger hospitalized patients, such as for monitoring early signs of delirium and immobility.[34] Prior research interventions utilizing multi-disciplinary geriatric consultative care suggest that delirium can be prevented in older hip fracture[12] and acute

geriatric trauma patients.[13] In addition, geriatric consultation may contribute to survival, functional recovery and quality-of-life outcomes.[6,7,9,11–13,35,36] Due to multi-factorial contributions by these geriatric interventions, however, it is difficult to isolate which particular care process are responsible for the improved outcomes.

There are few studies of care-process measures for older surgery patients. Bergman et al recently used ACOVE care-process QI sin acute-care patients undergoing major abdominal surgery, and found that geriatric QOC was delivered with scores far lower than ours, 16%[37] compared to 75% in our study. An intervention that trained hospitalists to provide better geriatric care on a medical-surgical ward demonstrated that higher QOC scores was associated with better 1-year survival[26] but not functional status.[38] Fallon and associates used an advanced practice geriatric nurse to determine which trauma patients would receive geriatric consultation, providing 40% of patients age 65 and older with a consultation. They provided recommendations to over half of patients regarding pain control and rehabilitationandon over one-third for delirium. More than two-thirds of recommendations regarding delirium and dementia was followed-through by the surgeons.[39] Lenartowicz et al implemented a geriatric consultation for all trauma patients age 60 and older, finding a 93% adherence rate to recommendations, but no change in one explicit care-process measure (restraint use).

Our results suggest that providing better QOC targeted specifically for older trauma patients is worthwhile, and mirrors efforts nationally. To provide surgeons with better tools to care for older patients, the American College of Surgeons (ACS) and the American Geriatrics Society[40] and the ACS Trauma Quality Improvement Program[4] have developed guidelines for the care of geriatric surgical and trauma patients, respectively. Centers with high volumes of geriatric trauma patients have begun to take leadership as self-designated geriatric trauma centers. Indeed, greater experience with geriatric trauma appears to be related with improved mortality in older trauma patients.[41] Further research across institutions to replicate our experience and translate to smaller centers is critical.

Our study has several notable strengths. We maintained the original intention-to-treat assignment of groups in the original[6] as well as this current analysis, i.e., regardless of whether a geriatric consultation was provided, which improves generalizability to future real-world clinical efforts. We also used all medical records from the hospitalization to give maximum credit for all QIs, regardless of the level or specialty of the provider, including all surgery, nursing and ancillary services. Indeed, more medical consultation also occurred in the study year, suggesting that the trauma team utilized hospital resources outside of geriatric consultations. Therefore, we conclude that increased attention to the needs of older trauma patients during the quality improvement intervention improved geriatric QOC and hospital care as whole.

The magnitude of the effect on quality was smaller than achieved in a prior ambulatory care study using ACOVE measures (ACOVE-2), a 21% and 15% absolute percentage point difference for falls and urinary incontinence care, respectively.[42] One possible explanation for the difference in results was that ACOVE-2, in contrast to our study, provided clinicians with structured notes and order sets aimed at improving the measured QIs. The second

potential explanation is that acute care is harder to improve than primary care. A prior controlled study of a geriatric curriculum implemented on an academic hospitalist service also resulted in no improvement in any single ACOVE QI.[43] The third possible reason is that our control group QOC (70% for geriatric-type care) was much higher to begin with than the ACOVE-2 control group (scores of < 25%),[42] therefore leaving less room for improvement. A fourth reason is that our institution already had a pre-existing culture of improving care for older patients, for example, a physician champion (AT) that spearheaded the effort to perform this quality improvement study. Interest in improving geriatric care and obtaining geriatric consults may have already increased during the control period. Last, we may have underestimated the effect of our intervention on certain geriatric QIs, for example the delirium treatment QI. We have previously reported that better screening of geriatric conditions can lead to identification of less severe conditions.[42,44] The GC group may performed more screening, resulting in identification of less-severe delirium symptoms, which may have led to poorer performance on subsequent delirium evaluation and treatment QIs.

There are other limitations to our study. The first is that our quality improvement intervention was facilitated by availability of clinical geriatricians. It may not be feasible to bring geriatric specialists to wider centers due to a nationwide shortage of geriatricians.[45] In the absence of a well-developed geriatric consultant service, a future approach would be to implement geriatric-care protocols on trauma surgery services and focus efforts of medical hospitalists, physician's assistants, and nurse specialists for more complex geriatric patients such as those with complications or multiple morbidities. Second, it is possible that our quality improvement intervention resulted in better documentation of geriatric care, rather than affecting the actual delivery of care. However, for many of the geriatric-type QIs, proper documentation was essential to delivering appropriate care (e.g., treatment preference discussions, assessment of function and cognition). Third, our intervention group had more males and white patients than the control group. Although ethnic and gender differences in recruitment have been reported in research interventions,[46,47] this study (a medical record review) did not require enrollment. We believe that the trend towards fewer minorities and women in our older trauma patient population during the study year was due to randomness or a factor beyond our knowledge. We also controlled for confounding by non-white race in our multivariable analyses, which has been linked in the past with poorer non-geriatric care in older adults.[48] Last, because our overall patient population was mostly white, our results may not apply to other medical centers serving minority populations.

In conclusion, implementation of a routine geriatric consultation onto an acute Level-1 trauma service for older patients does improve quality of acute geriatric care, mainly as a result of improving delirium prevention and treatment and coordination of care at discharge. This intervention has previously been associated with improved long-term functional outcomes. Therefore, in future efforts to improve care and outcomes, one promising direction would be to further enhance these particular areas of care using more targeted approaches, such as using co-morbidity, cognitive status, or prior functional status as ways to prioritize geriatric consultation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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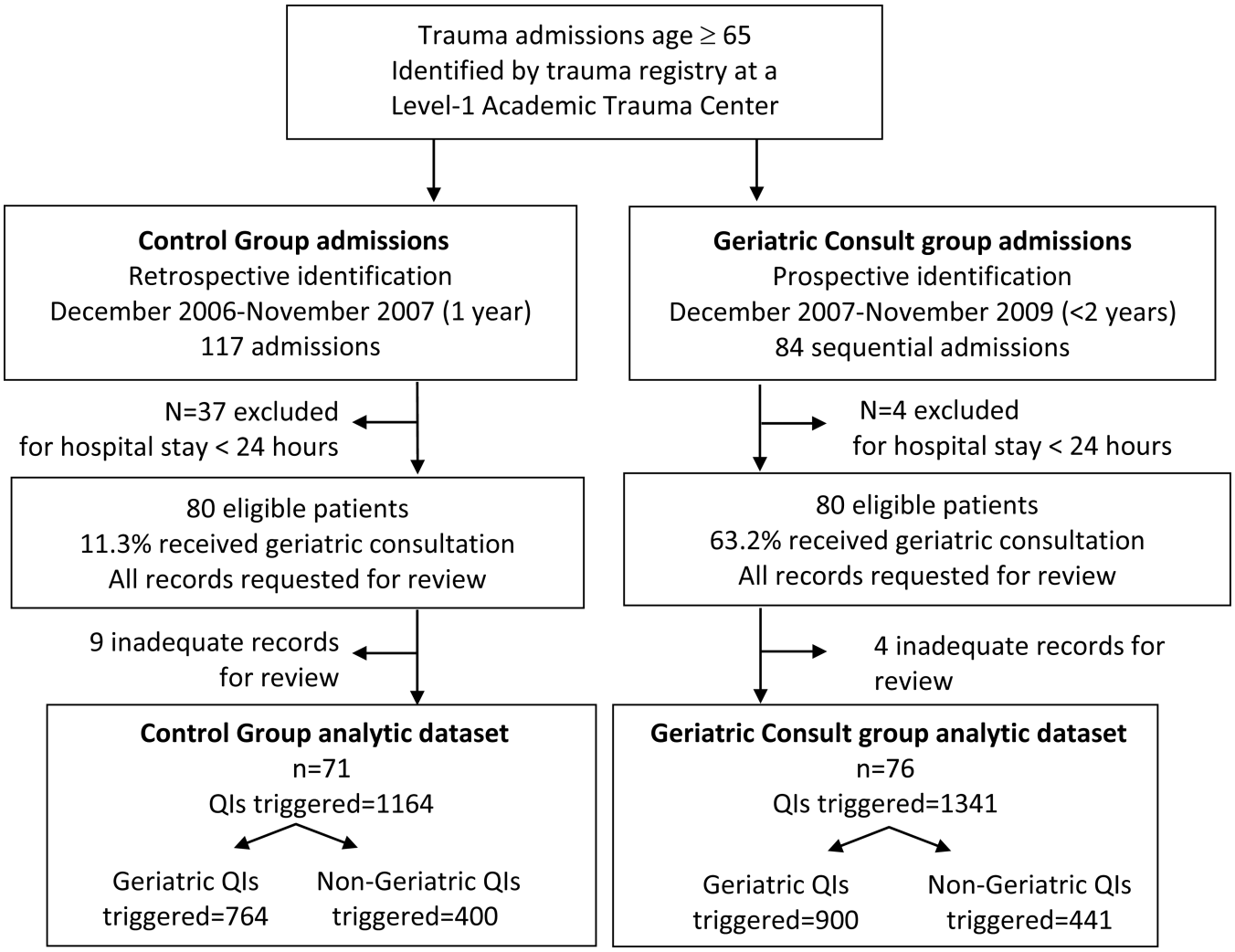

Figure 1. Flow of data describing identification of eligible patients for evaluation of medical records in the Control versus GC groups

QI = care-process quality indicator to be evaluated by medical record review

Table 1

Comparison of Patient Characteristics for Geriatric Consult (GC) and Control Groups

Variable		Geriatric Consult (GC) Group (N=76)	Control Group (N=72)	P Value*
Received geriatric consult, n (% of total)		48 (63.2%)	8 (11.3%)	<.0001
Received a non-geriatric medicine consult, n (% of total)		31 (40.8%)	16 (22.5%)	0.02
Age, mean (SD) (range 65–98 years)		77.8 (8.42)	76.7 (7.74)	0.42
Male gender, n (% of total)		46 (60.5%)	35 (49.3%)	0.17
CCS, mean (SD) (range 0–8 points)		1.1 (1.72)	1.0 (1.13)	0.26
Surgery, n (% of total)		34 (44.7%)	22 (31.0%)	0.09
White race, n (% of total)		65 (85.5%)	50 (70.4%)	0.03
ISS, mean (SD) (range 0–50 points)		15.3 (9.08)	14.3 (9.28)	0.51
LOS, mean (SD) (range 1–52 days)		11.3 (9.74)	9.6 (8.45)	0.15
MOI, n (% of total)	Fall, ground level	12 (15.8%)	10 (14.1%)	.56
	Fall, above ground level	13 (17.1%)	13 (18.3%)	
	Motor vehicle accident	19 (25.0%)	25 (35.2%)	
	Pedestrian	16 (21.1%)	17 (23.9%)	
	Bicycle rider	5 (6.6%)	2 (2.8%)	
	Motorcycle rider	2 (2.6%)	0 (0.0%)	
	Assault	3 (3.9%)	2 (2.6%)	
	Other	6 (2.8%)	2 (7.9%)	

* p-value for comparison of GC vs. Control groups: chi-square for dichotomous variables (consultation, gender, surgery, ethnicity), Fisher's exact test for mechanism of injury, t-tests for normally-distributed continuous variables (age, ISS), and Wilcoxon rank-sum test for non-normally distributed continuous variables (LOS, CCS).

SD = Standard deviation
MOI = Mechanism of injury
ISS = Injury severity score
CCS = Charlson-Deyo co-morbidity score [49]
LOS = Length of stay

Table 2

Quality Indicators Measured in the Geriatric Consultation and Control Groups

Abbreviated Text of Acute Care Quality Indicators for Vulnerable Elders, Organized by Geriatric versus non-Geriatric condition care [Inclusion as part of other sub-categories of care as indicated in brackets]		Unadjusted Quality Score %†			
		Quality score in GC Group (n=Eligible)	Quality score in Control Group (n=Eligible)	Difference in Scores, in Absolute Percentage Points††	P Value§
Geriatric Condition Care (Mobility and function, dementia, delirium, pressure ulcers)					
IF admitted, **THEN** document a plan to increase mobility < 48 hours. [T, M]		98.7 (n=76)	97.1 (n=70)	1.6	.61
IF admitted, **THEN** document cognitive function. [S, C]		96.0 (n=75)	91.3 (n=69)	4.7	.31
IF admitted, **THEN** document functional status. [S, M]		90.5 (n=74)	77.5 (n=71)	13.0*	.03
IF admitted, **THEN** document < 48 hours: (1) Patient's surrogate decision maker OR (2) documentation of a discussion to identify/search for surrogate decision maker [F]		88.2 (n=76)	85.9 (n=71)	2.3	.69
IF physically restrained, **THEN** document justification (behavioral disturbance/safety issue) and communicate to guardian. [T, M]		96.8 (n=31)	95.8 (n=24)	1.0	>0.99
IF severe dementia and admitted, **THEN** document care preferences/attempt to obtain < 48 hours. [F]		50.0 (n=2)	0.0 (n=2)	50.0	>0.99
IF cognitively vulnerable (dementia, pharmacologically sedated, or head injury) **AND** gastrostomy or J-tube tube placed, **THEN** document: (1) Preferences concerning tube feeding and (2) Discussion of preferences or formal decision process [T]		40.0 (n=5)	40.0 (n=5)	0.0	>0.99
IF limited bed mobility **THEN** risk assessment for pressure ulcers every 48 hours. [S]		99.2 (n=62)	100.0 (n=59)	−0.8	.33
IF "at risk" for pressure ulcer **THEN** institute preventive interventions. [S]		60.5 (n=43)	56.3 (n=32)	4.2	.71
IF "at risk" for pressure ulcer and has malnutrition, **THEN** assess and treat malnutrition. [S]		94.4 (n=18)	100.0 (n=5)	−5.6	>0.99
IF pressure ulcer, **THEN** assess location, depth, stage, size, and wound bed. [D]		64.7 (n=17)	56.5 (n=23)	8.2	.60
IF hospitalized, **THEN** evaluation of oral intake should be documented during the hospitalization. [D]		53.6(n=56)	38.1 (n=42)	15.5	.13
IF suspected/definite delirium, **THEN** document attempt at diagnosing etiology. [D, C]	Documentation of clinical features	98.0 (n=51)	86.8 (n=38)	11.2	.08
	Investigate causes of delirium	74.5 (n=51)	84.2 (n=38)	−9.7	.27
	Direct treatment of underlying etiologies	84.1 (n=44)	85.3 (n=34)	−1.2	>0.99

Abbreviated Text of Acute Care Quality Indicators for Vulnerable Elders, Organized by Geriatric versus non-Geriatric condition care [Inclusion as part of other sub-categories of care as indicated in brackets]		Unadjusted Quality Score %†			
		Quality score in GC Group (n=Eligible)	Quality score in Control Group (n=Eligible)	Difference in Scores, in Absolute Percentage Points††	P Value§
IF suspected/definite delirium, **THEN** identified causes should be treated. [D, C]	Direct pharmacologic treatment of symptoms	19.6 (n=51)	21.1 (n=38)	−1.5	.88
	Non-pharmacologic therapy of delirium	51.0 (n=51)	44.7 (n=38)	6.3	.56
IF fall in the hospital, **THEN** document prodromal symptoms and review medications. [D, M]		(n=0)	100.0 (n=2)	n/a	
IF major surgery and not in ICU: attempt ambulation by post-op day 2. [S, M]		96.9 (n=32)	100.0 (n=20)	−3.1	>0.99
IF major surgery, **THEN** screen for delirium daily for 3 days. [S, C]		30.2 (n=43)	0.0 (n=32)	30.2***	.00
IF discharged, **THEN** document all of the following: (1) level of independence, (2) need for home health services, (3) discharge summary containing medications, treatment plan, and follow-up plans [F, M]		40.6 (n=62)	22.0 (n=50)	18.6*	.02
IF major surgery, **THEN** assess cognition prior to discharge and compare to preoperative cognition. [F, C]		45.8 (n=72)	28.1 (n=64)	17.7*	.03
IF major surgery, **THEN** assess functional status prior to discharge and compare to preoperative function. [F, M]		71.6 (n=74)	71.8 (n=71)	−0.2	.98
Non-geriatric Condition Care					
IF high risk for venous thrombosis, **THEN** order DVT prophylaxis (pharmacologic or compression). [S]		98.7 (n=76)	95.8 (n=71)	2.9	.35
IF diabetic and major surgery, **THEN** control glucose to < 200 mg/dL for 3 days. [T]		39.5 (n=43)	46.9 (n=32)	−7.4	.53
IF indwelling bladder catheter placed, **THEN** document continued need q3 days until removal. [F]		84.2 (n=54)	89.8 (n=47)	−5.6	.17
IF ordered opioids 3+ days **THEN** offer bowel regimen. [T]		84.7 (n=72)	82.0 (n=61)	2.7	.67
IF admitted to ICU, **THEN** document care preferences/attempt within 48 hours. [F]		24.1 (n=29)	30.0 (n=20)	−5.9	.65
IF mechanical ventilation, **THEN** document preferences for ventilation or attempt within 48 hours. [F]		50.0 (n=12)	60.0 (n=10)	−10.0	.69
IF order written for DNR **THEN** document that elder participated or why unable to participate in decision. [T]		79.2 (n=24)	90.9 (n=22)	−11.7	.42
IF order written for DNR or preference for withholding of advanced care **THEN** they should be honored. [T]		100.0 (n=13)	100.0 (n=13)	0.0	n/a
IF dyspnea in the last 3 days of life dies an expected death, **THEN** document	Last day of hospitalization	50.0 (n=2)	85.7 (n=7)	−35.7	.42

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Abbreviated Text of Acute Care Quality Indicators for Vulnerable Elders, Organized by Geriatric versus non-Geriatric condition care [Inclusion as part of other sub-categories of care as indicated in brackets]		Unadjusted Quality Score %†			
		Quality score in GC Group (n=Eligible)	Quality score in Control Group (n=Eligible)	Difference in Scores, in Absolute Percentage Points††	P Value§
dyspnea care and follow-up. [T]	Second to last day of hospitalization	100.0(n=2)	85.7 (n=7)	14.3	>0.99
	Third to last day of hospitalization	100.0 (n=2)	100.0 (n=5)	0.0	n/a
IF ventilator withdrawn/held, **THEN** document dyspnea and order palliative treatment. [T]		0.0 (n=1)	0.0 (n=4)	0.0	n/a
IF hospitalized and conscious during any of the last 3 days of life, **THEN** document pain. [D]	Last day of hospitalization	100.0 (n=2)	100.0 (n=6)	0.0	n/a
	Second to last day of hospitalization	100.0 (n=2)	100.0 (n=6)	0.0	n/a
	Third to last day of hospitalization	50.0 (n=2)	100.0 (n=4)	−50.0	.33
IF hospitalized, screen for pain during first 3 days. [D]	Day of surgery	90.8 (n=76)	91.2 (n=68)	−0.4	.94
	Day after surgery	82.9 (n=76)	84.1 (n=69)	−1.2	.85
	2nd day after surgery	87.5 (n=72)	78.1 (n=64)	9.4	.15
IF hospitalized and has pain treat (pharmacologic or non-pharmacologic) and reassess within 2 hours. [T]	1st day of hospitalization	90.2 (n=61)	96.2 (n=52)	−6.0	.28
	2nd day of hospitalization	89.7(n=58)	94.4 (n=54)	−4.7	.49
	3rd day of hospitalization	95.9 (n=49)	77.5 (n=40)	18.4*	.01

† The quality score was the number of quality indicators passed divided by the number of quality indicators eligible.

†† Unadjusted difference in quality score in absolute % points.

§ Statistical testing (i.e, the magnitude of the p-values) between individual QI scores for GC versus control groups should be interpreted with caution, especially when the sample sizes drop below 5 in any cell. We performed Chi-square test (or Fisher's exact test if n<5in any cell) to test the difference in mean proportion in each group who passed. For QIs where all or none of the patients passed, or if no patients qualified in one group, then we did not perform a statistical comparison for that QI. Two of the QIs (documenting reason for indwelling urinary catheter placement and assessing for pressure ulcer if mobility was poor) were re-measured at regular intervals while a patient was eligible so we inversely weighted by the number of measurements resulting in a fractional score. Therefore we used t-test to compare the mean scores between the groups.

* p<.05

** p<.01

*** p<.001

S: Screening and prevention
D: Diagnosis
T: Treatment

F: Follow-up and continuity
C: Cognitive /Delirium
M: Mobility

Table 3

Quality of Care Compared Between Types of Care Processes

Categorization scheme		Number of QIs in Category	Number of Times QIs were Eligible (% of total)		Aggregate Quality Score* (%)	P-value for difference between scores for categories§
Geriatric		20	1664	(66%)	71.2	<.001
Non Geriatric		13	841	(34%)	81.2	
Cognitive/Delirium		5	513	(20%)	58.8	<.001
Non Cognitive/Delirium		28	1992	(80%)	78.6	
Mobility		7	648	(26%)	77.8	.031
Non Mobility		26	1857	(74%)	73.4	
Domains of care	Screening/ Prevention	8	753	(30%)	84.8	(Reference group)
	Diagnosis	7	457	(18%)	65.6	<.001
	Treatment	10	579	(23%)	85.4	.7
	Follow-up and continuity	8	716	(29%)	60.7	<.001
All QIs (no categorization)		33	2505	(100%)	74.9	

*Aggregate quality scores within each of the categories were calculated as number of quality indicators passed divided by number of quality indicators eligible within each category expressed as a continuous variable from 0–100%. For individual quality indicators that could be eligible multiple times per patient (e.g., multiple surgeries, pressure ulcers) or were measured at regular intervals (e.g., documenting need for indwelling catheters), the score for each measurement was inversely weighted so that any patient could contribute a maximum of 1 QIs passed and eligible for any single QI.

§P-values correspond to the statistical significance of the effect (beta-coefficient) of the QI category type (e.g., geriatric) versus QIs not in the category (e.g., non-geriatric) on quality scores. For domains of care (screening, diagnosis, treatment, and follow-up), the screening category was the reference group to the other three domains. To compare individual QI scores (ranging from 0 to 1, including fractions) between types of care, we used linear regression with standard errors corrected for patient-level clustering.

QI = Quality Indicators

Table 4

Quality of Care (QOC) Delivered to Patients in the Control versus Geriatric Consult group: Overall and By Type of Care

Type of Care	Unadjusted Mean Quality-of-Care (QOC) Scores (% of eligible quality indicators passed)				Adjusted	
	Consult Group (76 patients)	Control Group (71 patients)	Difference (Absolute % Points)	95% CI	Difference (Absolute % Points)	95% CI
Overall	76.5	73.2	3.2*	0.1, 6.3	2.8	−0.5, 6.3
Geriatric	74.0	68.3	5.7**	1.8, 9.5	**5.0***	**1.2, 9.2**
Cognitive/ Delirium	63.9	55.0	8.9*	1.5, 16.2	**8.4***	**0.5, 16.4**
Mobility	80.0	74.0	6.0	−0.5, 12.5	4.7	−1.7, 11.3
Screening/ Prevention	88.6	83.2	5.4*	1.0, 9.8	**6.1****	**1.2, 11.2**
Diagnosis	70.5	68.5	2.0	−4.9, 8.9	2.1	−5.7, 9.9
Treatment	86.3	86.4	−0.1	−5.2, 5.0	0.3	−5.3, 6.0
Follow-up and Continuity	62.4	58.8	3.6	3.1, 10.3	1.8	−4.5, 8.6

Each patient's QOC score was calculated as the number of QIs passed divided by QIs eligible. QIs that were measured multiple times per patient were inversely weighted within patient before aggregation into the QOC score. Difference = GC minus control group QOC scores, in absolute percentage points. Adjusted model results (last two columns) are the predicted difference in quality scores for consult versus control group obtained by linear regression controlling for age (continuous, in years), Injury Severity Score (continuous), gender, ethnicity (white versus non-white), and Charlson-Deyo comorbidity scale (continuous). Confidence intervals around adjusted difference are obtained by bootstrapping 1000 repetitions with covariates set at their means/modes (age = 77 years, ISS = 15 points, comorbidity = 1 point, gender = male, ethnicity = white).

* $p<.05$

** $p<.01$ for the unadjusted comparison, we used two-tailed unpaired t-test of unadjusted mean QOC scores between GC and control group; for adjusted comparison, the p-value corresponds to the significance of the beta coefficient associated with the GC versus control group in the multivariable regression controlling for age, injury severity score, gender, ethnicity, and comorbidity.