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Ambulatory Continuous Peripheral Nerve Blocks and the Perioperative Surgical Home

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A CONTINUOUS peripheral nerve block (CPNB) consists of a percutaneously inserted perineural catheter and subsequent local anesthetic administration to provide site-specific analgesia. With a portable infusion pump, a perineural local anesthetic infusion may be provided for patients at home.¹ An article published in this issue of *ANESTHESIOLOGY* by Eng *et al.*² suggests that, after major elbow surgery, transferring care from the hospital to the perioperative surgical home in the presence of an ambulatory CPNB decreases hospitalization costs without compromising medical outcomes.

Initially, ambulatory CPNB was used solely for postoperative outpatients—patients who were never intended to be hospitalized overnight—to supplement oral analgesics and improve pain control.³ Publication of studies of uncontrolled series of patients discharged the morning after hip and tricompartment knee arthroplasty suggested that ambulatory CPNB might also shorten hospitalizations for procedures in which inpatient stays were related mainly to postoperative pain. Adding to the optimism, previously published evidence had demonstrated that 2 to 3 days of CPNB provided solely within the hospital could shorten long-term rehabilitation stays by improving joint range of motion up to 6 weeks after knee arthroplasty or arthrolysis.^{4,5}

Subsequent randomized, controlled trials found that ambulatory CPNB decreases the time to discharge readiness after knee and hip arthroplasty. However, these subjects were not allowed to actually leave the hospital much earlier than the control group, leaving any benefits of earlier discharge as a theoretical possibility.³ The one randomized, placebo-controlled



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trial demonstrating hastening of actual discharge using ambulatory CPNB investigated the effects on range of motion after shoulder arthroplasty only through the day after surgery.⁶ Although research over the last two decades has led to speculation that ambulatory CPNB might shorten hospitalization after major orthopedic surgery, actual evidence quantifying the benefits and risks remains elusive and worthy of continued investigation. One can imagine a well-functioning acute regional service that delivers state-of-the-art outpatient analgesia as a component for the promise of the perioperative surgical home to be fully realized.⁷

New Study

Providing such evidence makes an article published in this issue of *ANESTHESIOLOGY* by Eng *et al.*² unique and noteworthy. Instead of studying the effects of ambulatory perineural infusion on various endpoints—as has been done previously—the authors investigated the effects of early discharge

by providing all subjects having major elbow surgery with a continuous infraclavicular nerve block for a total of 60 h and randomized them to a control group remaining hospitalized for 3 days, and an experimental group permitted early discharge the day after surgery.

Subjects discharged home the day after surgery had similar elbow range of motion after 2 weeks and 3 months compared with those hospitalized for at least 3 days. Similarly, there were no statistically significant differences in pain scores, opioid consumption, patient satisfaction, and function-related questionnaires. In addition, the cost of care for those hospitalized only one night were lower than for patients staying three nights. Although previous research has suggested the

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Corresponding article on page XXX.

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probability of these findings, this prospective, randomized, controlled design importantly documents that medical care in both the immediate postoperative period and the outcomes as remote as 3 months were not compromised when patients convalesced at home and quantifies the related cost savings.

Benefits versus Risks

Shortening hospitalization may be desirable simply to reduce inpatient costs but may also lead to other benefits such as fewer nosocomial infections and decreased morbidity due to any healthcare provider errors. Many patients also may prefer to recover in the comfort of their own home. Complications of providing CPNB at home appear to occur rarely, and include pain due to catheter dislodgement or infusion pump malfunction, unrecognized local anesthetic toxicity, and pulmonary complications for infusions potentially affecting the phrenic nerve.⁸

Further studies need to address unanswered questions such as whether ambulatory CPNB for this surgery type contributes to the potential for early discharge, if there is a measurable quality-of-life improvement perceived by patients who convalesce at home *versus* the hospital, and a large sample size is needed because of the rare incidence of complications to draw full conclusions on the relative safety of early discharge.

Fiscal Implications

Cost savings of 27 to 34% using ambulatory CPNB combined with earlier discharge after major calcaneal surgery and knee arthroplasty have been reported from retrospective investigations.^{9,10} Similarly, Eng *et al.* found that patients discharged the day after surgery cost an average of \$5,675 *versus* \$6,646 for those hospitalized 3 days (Canadian dollars). These 15% savings (\$971 Canadian dollars) include allocated fixed overhead costs, such as the mortgage on the hospital facility, that do not change in proportion with the number of patients cared for.¹¹ In other words, a hospital implementing the authors' protocol cannot expect to realize a 15% savings, at least in the short term. If fixed costs are excluded, the savings falls to 9% of the total hospital costs (\$639 Canadian dollars).

Eng *et al.* also broke down costs as direct—those that can be directly linked to patient care—and indirect, which cannot be linked to the care of specific patients. At first glance, indirect costs may appear analogous to fixed costs and direct analogous to variable costs (*e.g.*, disposable supplies) that do vary if the number of cases changes. However, as the cost accounting of their study shows, a cost can be direct and also fixed at the same time. An example might be the operating room nurse supervisor whose work is directly attributable to the surgical patients but does not vary based on the caseload and as a result would be fixed. Approximately 12% of the total hospitalization costs measured for the study patients were deemed as direct fixed costs.

The investigation by Eng *et al.* found that 76% of total hospital costs were variable (change in proportion with patient volume). This is a high percentage relative to what is typically found as the majority of hospital costs are fixed overhead (*e.g.*, buildings, equipment, and salaried labor). This difference could be due to several factors including whether labor is considered fixed or variable, or the use of different accounting methodologies at different facilities. Regardless, it suggests that practices with a lower percentage of variable costs than 76% of this Canadian study (commonly less than 20% within the United States)¹¹ could anticipate savings of much less than the 9% reported by Eng *et al.* Moreover, if *per diem* (*i.e.*, daily) payments were decreased with rapid hospital discharge (common for payers within the United States), and if the costs of an ambulatory CPNB program are included (*e.g.*, ultrasound capital outlay), any cost savings might actually become a deficit.

In contrast, earlier discharge might increase hospital revenue if there are limited orthopedic ward beds that are limiting the use of excess operating room capacity. Because the majority of surgery-related revenue comes from operating room charges (Eng *et al.* reported 61 to 77%)—and not postoperative recovery—increasing operating room volume would potentially have a positive effect on overall revenue.

Generalizability

There are health system differences among countries that limit the generalizability of the study findings. For example, the use of continuous passive motion used in the study by Eng *et al.*—and presumably increased analgesic requirements—is neither standard of care nor paid for as an inpatient expense by Medicare (or most private insurers) in the United States. Also, the elbow procedures studied would not typically result in even one night's stay in the United States, and Medicare or private insurers may not approve any payments for any hospital ward admission.

Finally, it is important to realize that applying CPNB in the ambulatory environment and shortening hospitalization by facilitating the perioperative surgical home has limited applicability due to multiple factors. Currently, most surgical procedures require a hospital admission for indications other than pain control, and even those that do are not always amenable to CPNB. Even for surgeries in which CPNB is most applicable such as knee and hip arthroplasty, lower extremity perineural infusion is associated with an increased risk of falling, calling into question its use after these procedures outside of the monitored hospital environment.¹² There simply are not many procedures that currently require hospitalization exclusively for potent analgesia that are amenable to ambulatory CPNB.

In conclusion, the study by Eng *et al.* provides evidence that permitting earlier discharge in the presence of ambulatory CPNB after major elbow surgery in healthy adults does not result in inferior outcomes and does decrease hospital

costs in Canada. Further study is warranted to ascertain additional benefits (and risks) of early discharge and ambulatory CPNB (*e.g.*, patient quality of life at home *vs.* hospitalized), and whether results of the study by Eng *et al.* may be replicated for other health systems, surgical procedures, postoperative protocols, and patient populations.

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Competing Interests

Dr. Ilfeld has received research funding from several infusion pump manufacturers, including Baxter Healthcare (New Providence, New Jersey), Smiths Medical (St. Paul, Minnesota), and Summit Medical (Sandy, Utah); has received research funding from a perineural catheter manufacturer, Teleflex Medical (Morrisville, North Carolina); has received research funding from a cyro-analgesic device manufacturer, Myoscience (Fremont, California); and, has acted as a consultant for Pacira Pharmaceuticals (Parsippany, New Jersey), manufacturer of a long-acting liposome bupivacaine formulation. These companies had no input into any aspect of manuscript conceptualization or preparation. Drs. Meunier and Macario declare no competing interests.

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