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Transformation of anesthesia for ambulatory orthopedic surgery: A mixed-methods study of a diffusion of innovation in healthcare

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ABSTRACT

Introduction: To provide insight into how an innovation in healthcare is implemented and diffused, we studied the transition from routine use of general anesthesia to peripheral nerve blocks (PNBs) for ambulatory orthopedic extremity surgery. Rogers' diffusion of innovations (DOI) theory was used as our theoretical framework. We identified themes that would be helpful for others attempting to diffuse innovations into healthcare settings.

Material and methods: A mixed quantitative and qualitative methodology was used. We retrospectively reviewed operative and anesthesia records of patients who underwent ambulatory repair of distal radius fractures or arthroscopic knee meniscus procedures from 1998 to 2012 to identify whether general anesthetics or PNBs were used and the time course of the innovation. We interviewed orthopedic surgeons, anesthesiologists, and a nursing administrator working in the ambulatory surgery unit during the innovation to identify key themes associated with the adoption of PNBs.

Results: From 2003 to 2012, use of PNBs increased from less than 10% to 70% of cases studied. The adoption timeframe followed an S-shaped curve. Key themes included improved safety, quality, efficiency, physician leadership and trust, organizational structure, and technological change. The innovation involved an optional decision-making process and took root in a satellite facility and generally fit with Rogers DOI theory.

Conclusions: The adoption and diffusion of PNBs provides a useful model for understanding innovations with optional decision-making in healthcare. Critical elements in our case were the characteristics of the innovation, which facilitated the decision-making process, and the positioning of the innovation in a peripheral structure away from core clinical facilities.

1. Introduction

A major challenge in healthcare is to identify and implement innovations that improve quality, safety, outcomes, and efficiency while lowering costs.[1] Innovations should address the triple aim of healthcare, described by Berwick et al.,[2] of improved health, better care, and reduced costs. However, healthcare innovations often increase costs and have marginal effects on quality.[3] Identification of innovations that increase quality and reduce costs must be a high priority of efforts to reform healthcare delivery. After identification, another challenge is timely implementation and diffusion of these innovations throughout a delivery system. The time from discovery of a scientific innovation to its routine use has been estimated to be about 17–24 years.[4,5] Innovations in healthcare

Abbreviations: DOI, diffusion of innovations; PNBs, peripheral nerve blocks; GA, general anesthesia; UNM, University of New Mexico; HSC, Health Sciences Center; CPT, current procedural terminology; CI, confidence interval; OSIS, Outpatient Surgery and Imaging Services

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may involve process changes, such as physician behavior, that do not fit the time frame for scientific innovations. Nevertheless, there has been concern and study of the long time frame for their adoption.[6] Shortening this period could have many advantages.

Our study uses the diffusion of innovation (DOI) framework developed by Rogers[7,8] to analyze the diffusion of a recent clinical innovation at our institution, the use of peripheral nerve block (PNB) in orthopedic surgery to replace general anesthesia (GA). We believe this study can serve as a model for other innovations that may lead to improvement of the quality of care and reduce costs and thus improve value in the healthcare system.

The DOI theory was developed as a way to evaluate the process by which an innovation is diffused through a population.[8] Rogers defines diffusion as the process by which an innovation is communicated through channels over time among members of a social system. Important to this process are both the attributes of the innovation and the traits of those who may come to adopt it. The classical DOI model has 4 elements: the time course of the adoption, characteristics of the innovation, communication channels, and the social system.

We used this framework to study the recent diffusion of PNBs, a technique known for many years, but recently adopted to replace GA for many orthopedic surgical procedures. The PNB technique involves local injection of an anesthetic agent around a peripheral nerve to temporarily block the sensation of pain. The advantages of PNBs are pain blockage that continues for several hours after surgery and avoidance of GA which can cause postoperative nausea, vomiting, pain, and (rarely) airway compromise. Recent studies[9–11] suggested that PNBs are safer and more efficient and that their use can decrease overall expenses as a result of a reduced hospital stay compared with GA. These advantages may be enhanced by ultrasound-guided administration of PNBs, which allows visualization of the nerve and more precise placement of the anesthetic agent around the nerve sheath.[9]

Jankowski et al.[10] found that patients who received PNBs reported significantly less postoperative pain at 60, 90, and 120 min after surgery than those who received GA. In addition, patients who had GA were less satisfied with the anesthetic technique and pain control than patients given PNBs or spinal anesthesia. Hadzic et al.[11] observed that patients who received PNBs were more likely to bypass the acute airway recovery requirements after surgery than those who had GA. Patients in the PNB group were discharged to home a mean of 123 min sooner than GA patients, although their time in the operating room was similar. In spite of these advantages PNB has not been widely adopted to replace general anesthesia in orthopedic surgery. We decided to study how and why PNB was adopted at our institution both to assist other institutions attempting to adopt this innovation and to provide a more general perspective on the diffusion of promising clinical innovations in healthcare.

In this study, we used the DOI framework to conduct a mixed-methods study at the University of New Mexico (UNM) Health Sciences Center (HSC) on the rate and timing of change to use of PNBs for a subset of orthopedic procedures during a 10-year period. We identified key factors in the decision-making process in the implementation and acceptance of the innovation by interviewing anesthesiologists, surgeons, and a nurse involved in the innovation.

2. Materials and methods

Our study was a mixed-methods[12] investigation with both quantitative and qualitative arms to provide a comprehensive analysis of the innovation. The Human Research Review Committee of the UNM HSC approved the study design and protocol.

2.1. Quantitative methods

The quantitative arm of the study documented the time course of change from GA to PNBs. The purpose was to describe the arc of change as the innovation diffused into the anesthesia care system and to verify recollections of the interviewees in the qualitative arm of the study in regard to the time course of the innovation.

We conducted a structured retrospective review of the medical records of patients who underwent upper and lower extremity procedures in the UNM Hospital system between January 1998 and December 2012. We identified subjects by using the current procedural terminology (CPT) codes for distal radius fracture repairs, arthroscopic knee meniscectomies, and arthroscopic knee meniscus repairs (CPT codes 25606, 25607, 25608, 25609, 25620, 29880, 29881, and 29882). Exclusion criteria were age under 18 years, intubation before arrival in the operating room, and multiple or bilateral procedures or a meniscus procedure in combination with anterior cruciate ligament reconstruction.

We reviewed the operative report and anesthesiology record for the enrolled patients to determine whether a PNB was administered during their operation. Other data collected included age at the time of surgery, operating surgeon, facility (off-site outpatient surgical center or main hospital), and procedure performed. All data collected were de-identified. Any procedure performed with use of a PNB without other forms of anesthesia, was considered a case in which PNB anesthesia was employed. Procedures performed with use of both PNB and GA or spinal or epidural anesthesia, were considered to be non-PNB cases because we were interested in the replacement of GA by PNB. However, we also separately analyzed the time frame of the adoption of PNB used together with GA, under the theory that as PNB diffused into the system it might be adopted as a transitional step in the adoption of PNB.

Because we understood that PNBs were rarely used before 2003, we examined a sample of 20 randomized charts per year for the five years prior, to verify the starting point of our study of PNB usage. We decided that when the use of PBNs reached a threshold level of 10% of cases we would increase our sampling of charts to accurately characterize PNB usage. Previously reported mathematical estimates of S-shaped diffusion curves indicated that the "tipping point" for takeoff of an innovation is between 2.5% and 13.5%.[8,13,14]

We conducted a proportion-based power analysis and found that a sample size of 90 cases per year was sufficient to detect a year-to-year difference of 15% with $\beta=0.20$ and $\alpha=0.05$. We set our level of a clinically relevant difference at 15% absolute. The total number of randomized cases reviewed per year ranged from 100 to 138, which constituted a percentage of total cases ranging from almost 70% in the early years to 27% in the later years. The proportion of procedures performed with use of PNB anesthesia was determined for each year, and a 95% confidence interval (CI) was calculated by using a Wilson score interval.[15] SAS version 9.3 software (SAS Institute, Cary, NC) was used for all statistical analyses.

2.2. Qualitative methods

The qualitative arm of the study examined: (1) the process of change; (2) the attributes of the innovations; (3) the communication systems; and (4) the social system. Using the interview guide based upon the DOI framework, three members of the research team trained by a qualitative researcher conducted interviews with orthopedic surgeons, anesthesiologists, and a nurse administrator to record their opinions regarding factors responsible for successful adoption of the innovation. We triangulated the results from the quantitative arm with the observations of the participants in the qualitative arm.[12]

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