The Journal of Education in Perioperative Medicine

Original Research

Evaluation of Knowledge Acquisition with a Practice Management Course for Anesthesiology Residents: A Pilot Study

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Introduction

Residency education has traditionally been focused on the acquisition of medical knowledge and procedural skills with little formal training devoted to the development of "nontechnical skills," including leadership ability, managerial skills, and financial considerations. Anesthesiology residency education has classically been no exception, with an apprenticeship model focusing on acquiring practical skills under the supervision of an attending anesthesiologist. The need for this model to evolve is clear, as deficiencies in nontechnical skills have been linked to adverse events and inefficiencies in care that negatively affect the health care systems, including patient outcomes and costs.[1-4]

Today, management of the operating rooms (ORs)—often the most cost-intensive and productive unit of a hospital—typically falls under the purview of an anesthesiologist, who traditionally learns "on the job" in lieu of receiving practice management training in residency.[5,6] The current model has become increasingly insufficient as the practice of anesthesiology has evolved. Notably, in 2012, the American Society of Anesthesiologists (ASA) put forward the Perioperative Surgical Home model as a way to increase care quality and cost-effectiveness, with the anesthesiologist as the coordinator of perioperative patient care and the myriad of providers and systems surrounding it.[7,8] In embracing this model, anesthesiology training programs are burdened with the imperative to ensure that residents are equipped with the practice management skills necessary to be effective clinical leaders.

The need for physician leaders is not unique to the field of anesthesiology. The Accreditation Council for Graduate Medical Education (ACGME) has emphasized the importance of nontechnical skills with their inclusion of systems-based practice and interpersonal and communication skills as core competencies of residency education.[9] To this end, residency programs across multiple fields have started incorporating leadership education and the acquisition of other nontechnical skills into training.[10-17] Delivering this training has traditionally been achieved using a variety of pedagogical methods with varying success.[18-21] To date, no standard curriculum for fostering nontechnical skills has been established.

Modern medical education is an evolving field, and it is clear that effective learning requires employing various methods of conveying information and concepts to aid understanding and retention.[22,23] Depending on the subject, this typically involves a combination of multimedia resources such as online modules and textbooks, simulation-based learning as well as methods to enhance reflective learning such as small group discussion.

The purpose of our study was to evaluate knowledge acquisition associated with a novel practice management rotation using a pretest and a posttest assessment.

Methods

Senior Anesthesiology Residents at the Clinical Anesthesia-3 level participated in a novel, 1-month, Ambulatory Anesthesiology—Practice Management Rotation with a detailed practice management curriculum over academic years 2014–2015 and 2015–2016. One resident per month participated in this curriculum with goals and objectives provided at the outset of the rotation. Participants participated in a pretest and a posttest for knowledge acquisition on a voluntary basis following consent. This study was determined to be exempt by the IRB review board at The George Washington University Office of Human Research (IRB number: 041535).

Curriculum

The practice management curriculum was designed to be a multimodal learner experience with the following components: (1) OR manager, (2) readings with follow-up discussions, (3) online, web-based module, and (4) billing exercise.

OR Manager

Each resident participated in a 1-week team leader exercise under the supervision of an attending anesthesiologist. The supervising anesthesiologists were limited to five experienced team leaders, each with over 10 years in the role. The experience entailed: (1) coordinating the case schedule and OR assignments for up to 32 operative locations; (2) assigning anesthesiolo-

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gy personnel for each case, accounting for subspecialty training, interests, interpersonal relationships, and availability; (3) modifying the schedule and anesthesiology personnel assignments in real-time to optimize throughput; (4) engaging in effective communication with nursing and surgical colleagues; and (5) winding down personnel as ORs "close" in accordance with local guidelines. The supervising anesthesiologist then provides both formative and summative feedback to the resident OR team leader via direct discussions and use of an online resident evaluation system (MedHub, Minneapolis, MN).

Didactics and Readings

Throughout the month of the rotation, residents completed a series of readings (Appendix A), followed by complementary discussions with the rotation director (Author GG). There was no requirement for residents to read beyond the materials provided.

Web-based Module

Residents completed a web-based module developed for the American Society of Anesthesiologists (ASA) titled "OR Management Basics: Right Case. Right Time, Right Cost."[6] This 1-hour online module covers the basics of OR management financing and accounting. Residents were provided a password and instructed to access the module after completing the reading assignments. For the purposes of the pilot study, all study participants were granted access to the ASA OR Management Basics module, prior to its release on the ASA website.

Billing Exercise

Subjects participated in a billing exercise whereby they were given access to the ASA 2015 Relative Value Guide.[24] Using the guide and reviewing the patient chart for insurance carrier, subjects were instructed to complete coding for each patient encounter, inclusive of base unit, time unit, and modifier calculation (Appendix B). Following these determinations, at the end of the month-long rotation, the resident would complete a reimbursement calculator spreadsheet (Excel; Microsoft Corp., Bellevue, WA), created by author JSB, to calculate hypothetical reimbursements for the resident's actual cases during the Ambulatory Anesthesiology Rotation (Appendix C1). The spreadsheet was then reviewed with the Rotation Director and a Summary was completed (Appendix C2), including inputs for resident desired salary and vacation, to determine projected provider "profitability," based solely on professional fees to the group.

Assessment

A written test of practice management knowledge (Appendix D) was administered at the outset of a 1-month Ambulatory Anesthesiology – Practice Management Rotation. The same test was readministered at the conclusion of the rotation. The test, conceived and validated by The University of Vermont,[6] consisted of 27 definitions, multiple choice, and open-ended questions taken from the readings and an online module. The pretest and the posttest were at least 4 weeks separate in time. Residents were made aware that the test results would not affect rotation evaluations as the scoring and results were blinded to the Rotation Director.

Each exam was deidentified with a code that was used to link pretests and posttests for analysis. Tests were graded independently by two blinded reviewers, after all subjects were enrolled, to ensure consistent grading. Partial credit for free-response answers was awarded based upon model answers from a key provided to reviewers. Disagreements in the awarding of partial credit were settled by averaging the scores of the independent reviewers.

Data Analysis

Resident scores were analyzed with SPSS, v25 (IBM, Armonk, NY). The Wilcoxon Signed Rank test for nonparametric data was used, and reliability testing was calculated using the Cronbach alpha (*a*). Interrater consistency was measured using the Cohens kappa (κ). Results with *P* values < .05 were deemed statistically significant.

Results

Twelve out of 14 (86%) CA3 residents who participated in the rotation completed the pretests and posttests. Demographics for subjects were representative of the national sample of anesthesiology residents with respect to gender and age. Resident test scores improved after completion of the course ($P = .004$; $Z = -2.903$). Prerotation test scores averaged 42.7% (SD 12.7%), while postrotation test scores averaged 61.49% (SD 18.65%), which represent a mean improvement of 18.8% (see Table 1). The Cronbach *a* was 0.815, which indicated the test was reliable. The Cohen κ was 0.314, which indicated fair interrater reliability between the two reviewers in the scoring of tests.

Table 1. *Results of Pretest and Posttest Analysis with Wilcoxon Signed Rank Test for Nonparametric Data.*

	Pretest Score		Posttest Score		Z Score	*P* Value
	Average Score (%)	Standard Deviation (%)	Average Score (%)	Standard Deviation (%)		
Subjects (n = 12)	42.7	12.7	61.5	18.7	−2.903	0.004*

*$P < .05$

For the billing exercise, residents reported an average of 39 cases (range 19–52) for analysis, representing a convenience sample of all cases encountered during the rotation, roughly 3 weeks.

Qualitative assessment was gathered from focus group discussion with participants to review the rotation and its curriculum. All participants reported that the use of the standardized, online ASA module was beneficial to their education, and believed it would prepare them for their future ca-

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reers. They highly valued the OR manager experience and universally reported enjoying the billing exercise. Themes that were commonly discussed included the value of learning practice management for future practice, as well as being surprised at the complexity of the OR manager role.

Discussion

While the importance of acquiring nontechnical skills and knowledge during residency is recognized across multiple specialties and by the ACGME, residency programs are still exploring ways to enable residents to improve in these areas.[25,26] Our study demonstrated that a multimodal, 1-month educational intervention in practice management improved practice management knowledge acquisition of senior anesthesiology residents by 18.8%. Further, qualitative analysis revealed that the study intervention was perceived as valuable and educational to participants.

The performance improvement noted in the present study is supported by modern educational theory. Using a variety of sensory approaches to optimize learner comprehension and retention is known to be effective.[28] These models have applied concepts from cognitive science that manipulate the transfer between sensory, working, and long-term memory.[29] Multimodal strategies capitalize on a blended learning theoretical framework to approach learning from a variety of sensory inputs, such as visual, auditory, and kinesthetic models. Our study employed didactics (visual) with complementary lectures (auditory), an interactive online module, and a supervised OR Manager experience (kinesthetic). These strategies encourage application of working memory, which can then be consolidated via reflective exercises. We used an OR billing exercise and debrief (reflective) to accomplish this element of the framework.

The assessment of the intervention, a linked pretest and posttest of knowledge gained, addresses a basic element of Bloom's Taxonomy of Educational Objectives.[30] However, because the test incorporates definitions, multiple choice responses, and open-ended responses, it is likely that improved scoring reflects not only knowledge improvement but also gains in comprehension and application. This additional learning suggests that residents who participated in this intervention may have gleaned secondary benefits.

Feasibility of setting up this educational experience at another facility should be evaluated based on the time, costs, and special skills employed to administer the experience. The time requires a 1-month rotation; the authors suggest an ambulatory anesthesiology rotation because it exposes residents to many cases, simulating private practice, and allowing for more meaningful data collection for the billing experience. Further, the rotation requires flexible staffing to allow the resident to be relieved from clinical responsibilities for one week to participate in the OR Manager role. Senior trainees are likely to benefit the most from this activity given their proficiency in clinical care and proximity to independent practice. The experience is best served by identifying a faculty champion to direct the rotation; typically, this can be a faculty member with interest in the subject of practice management, perhaps with an advanced degree such as a Master in Healthcare Administration or a Master in Business Administration. Finally, the materials required to administer the course (ie, readings and billing exercise) are readily available or easily created. While the ASA module that was used in this study does not appear to be available, the ASA has a repository of practice management resources for resident members that could easily substitute.[27]

While this multimodal practice management curriculum was modestly successful, both quantitatively and qualitatively, there are limitations that suggest caution in interpreting the results. The sample size of residents at a single site, urban, mid-Atlantic academic health center, while capturing nearly all of residency class for two consecutive years may not represent the overall population of anesthesiology residents. Further, certain elements of practice management are locale-specific and may not translate from one region to another. In addition, a 1-month intervention is limited in its ability to improve knowledge; this intervention did not assess long-term knowledge retention. In previous studies, the assessments demonstrated slightly higher resident scores, ranging from 56% pretest to 86% posttest.[6] This may reflect regional variation in practice management exposure, baseline differences in knowledge, or true differences in the effectiveness of the curriculum with respect to the assessment objectives. Nevertheless, the improvement in the present study was noteworthy and nonskewed. Finally, given the length of the study period, the multimodal and time-sequence variability of the educational intervention, the sequential nature of resident participation, the potential for outside resource contamination, and the numerous attending anesthesiologists involved in administering the program, variation in course experience among residents can be assumed to some extent. It is possible this may have influenced posttest performance, though review of standard deviations pretest and posttest suggest otherwise.

In spite of the aforementioned limitations, the multimodal curriculum presented successfully transfers practice management knowledge to senior anesthesiology residents within a 1-month, well-regarded rotation. The next step will be to evaluate outcomes, such as long-term retention of knowledge, leadership positions, and control-group comparisons via surveys of program graduates and their employers.

Acknowledgments

The authors would like to thank Richard Amdur, PhD, for his support with the statistical analysis of this submission. In addition, we would like to acknowledge the ASA for permitting use of their practice management web-based module for this study.

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This work has not been published and is not under consideration for publication from any other journal. The authors all contributed to the submission and agree upon its contents. The authors have no conflicts of interest to report.

Abstract

Physicians routinely rely on nontechnical skills—including leadership ability, managerial skills and financial considerations—when delivering patient care. Efficient practice management is a commonplace expectation of attending anesthesiologists, but there is no uniform residency training to foster the expertise required to succeed in this endeavor. The purpose of this study is to evaluate a novel practice management course for anesthesiology residents.

Methods: Senior anesthesiology residents (Clinical Anesthesia-3) at The George Washington University were eligible to participate in a 1-month Ambulatory Anesthesiology–Practice Management Rotation focusing on the acquisition of nontechnical skills and knowledge applicable to becoming an effective clinical leader. The rotation included 1-week service as operating room manager, completion of an online module, assigned readings with follow-up discussions, and completion of a billing and reimbursement exercise. The interventions, in aggregate, were measured with a preknowledge and a postknowledge test.

Results: Twelve residents out of 14 (86%) completed the preknowledge and postknowledge tests. Residents scored significantly higher on the postcourse exam (61.49%, SD 18.65%) than the pretest (42.7%, SD 12.7%) ($P < .004$).

Conclusion: A curriculum designed to develop the practice management skills required of a physician anesthesiologist is feasible and effective at improving knowledge within a 1-month, senior resident rotation.

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Appendix

Appendix A. List of Readings Provided to Resident During Rotation

Ordered alphabetically by author.

Amalberti R. The paradoxes of almost totally safe transportation systems. *Saf Sci* 2001;37:109-26.
Christensen CM. *How Will You Measure Your Life.* HBS No. R1007B. Harvard Business School Publishing, Boston, MA, 2010.
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Appendix *continued*

Appendix B. Medical Case Billing Reporting Sheet

Case #
Patient label

Discard in shredder when entered in spreadsheet and completed.

Date _____

Procedure _____

_____

_____

_____

Insurer	(from facesheet; circle one)	Mcare	Mcaid	Private
CPT code	_____			
Base Units			(BU)	
Time (min)	Start _____			
	Finish _____			
	Total time (TT) _____			
Time Units	(TT/15 min; whole number = TU			
Modifiers				
Name/Code:	1 _____		(MU)	
	2 _____		(MU)	
	3 _____		(MU)	
	4 _____		(MU)	
	5 _____		(MU)	
		Total Modifiers (TMU)		
Total Units		(BU+TU+TMU)		

Notes for completion:

If you are relieved from a case or take a case over,
please count case if you participated to a significant degree

Appendix *continued*

Appendix C-1.

Medical Billing Spreadsheet

To be completed during rotation on a regular basis

Fill in all boxes in this color:

Rotation: **Ambulatory Anesthesiology**

Year of Residency: CA3

Date		Enter date in the format XX/YY/20ZZ
Total Units		Enter from daily case cards (Appendix A)
Conversion factor	$	See table above
Total dollars billed	$0	
Collection rate	%	See table
Total dollars collected	$0	
Minus collection charge	7% $0	Additional cost of collections
Total reimbursement	$0	

Notes:

Table:

if:	Conversion factor	Collections
Medicaid	$12	100%
Medicare	$22	100%
Commercial	$55	50%

Appendix C-2.

Rotation Summary Data

To be completed and reviewed at conclusion of rotation

Fill in all boxes in this color:

Name of Resident:		Type name
Total # weeks	4	Enter whole number of weeks for rotation minus vacation week if taken
Desired vacation weeks per year		Enter whole number from 0-12
Total annual reimbursement	$	
Practice overhead	30%	Practitioner salary/benefits and support staff effort
Salary desired?	$	Enter number
Group profit (loss)	$	

Notes

Appendix *continued*

Appendix D. The Pretest and Posttest Administered for the Course

1. After January 1, 1998, carriers determined payment for the physician's medical direction service furnished on the bases of 50% of the allowance for the service of the physician alone. Medical direction occurs if the physician medically directs qualified individuals in two, three, or four concurrent cases. Name the seven requirements the physician must meet in order to bill at the medically directed rate.
2. When should a case be billed as medically supervised by an anesthesiologist?
3. Although a physician who is concurrently directing the administration of anesthesia to not more than four surgical procedures cannot ordinarily be involved in furnishing additional services to other patients, there are six other activities that an anesthesiologist may provide as long as the anesthesiologist "remains physically present and available for immediate diagnosis and treatment of emergencies." Name them.
4. True or False: An anesthesiologist is prohibited from performing a preoperative evaluation when medically directing two, three, or four concurrent cases.
5. True or False: If anesthesiologists are in a group practice, one physician member may provide the pre-anesthesia examination and evaluation while another fulfills other criteria.
6. True or False: Concurrency is defined as the maximum number of procedures that the physician is medically directing within the context of a single procedure and whether these other procedures overlap with each other.
7. True or False: If an anesthesiologist ends a medically directed, non-Medicare case at 10:01 AM and begins another Medicare case at 10:01, these cases would not be concurrent.
8. Physicians must report the appropriate anesthesia modifiers to denote whether the service was personally performed, medically directed, or medically supervised. Match the following anesthesia claim modifiers to the correct definitions.

G8	___MAC for deep, complex, or markedly invasive procedures
G9	___MAC for a patient who has a history of a severe cardiopulmonary condition
AA	___MAC service
AD	___Medical direction of one certified CRNA by an anesthesiologist
QK	___CRNA service without medical direction by a physician
QX	___Medical direction of two, three, or four concurrent anesthesia procedures involving qualified individuals
QZ	___Anesthesia services performed personally by the anesthesiologists ___Medical supervision by a physician; more than four concurrent anesthesia procedures

9. An anesthesiologist provides services for a 30 y/o male construction worker who has suffered a left femur fracture and a right radial distal fracture after falling off a ladder. The anesthesiologist may bill for which of the following:
    a. The anesthesia procedure with the highest base unit valve with the multiple procedure modifier "–51" and the total time for all the procedures.
    b. The anesthesia procedure with the lowest base unit valve with the multiple procedure modifier "–51" and the total time for all the procedures.
    c. The anesthesia procedure with both base unit values with the multiple procedure modifier "–51" and the time for the longest procedure.
    d. The anesthesia procedure with both base unit values with the multiple procedure modifier "–51" and the time for the shortest procedure.
    e. The anesthesia procedure with the lowest base unit value with the multiple procedure modifier "–51" and the total time for the longest procedure.

Appendix *continued*

10. What is the conversion factor for Medicare reimbursements?
    a. $5 per unit
    b. $17 per unit
    c. $22 per unit
    d. $45 per unit
    e. $50 per unit
11. What is the collections rate for commercial insurance carriers?
    a. 10%
    b. 25%
    c. 50%
    d. 75%
    e. 100%
12. What is the collections charge for most anesthesiology practices?
    a. 1%
    b. 7%
    c. 15%
    d. 30%
    e. 50%
13. Define under-utilized OR time.
14. Define over-utilized OR time.
15. Define OR tardiness.
16. What is the approximate "cost" of over-utilized OR time?
17. Define raw and adjusted utilization rates.
18. First case of the day start delays are a popular hospital management tactic when it comes to OR management. Often, the metric followed is the percentage of on-time starts. From a financial perspective, which scenario results in greater institutional costs?
    a. Three OR are scheduled for 10-hour days (07:00–17:00). OR #1 and OR #2 each start their first case at 08:00, but both rooms end at 17:00. OR #3 starts at 07:00 and ends at 17:00. This is calculated as a 33% on-time start for the day.
    b. Three OR are scheduled for 10 hour days (07:00–17:00). OR #1 and OR #2 each start at 07:00 and the rooms finish at 17:00. OR #3 starts at 07:00 but ends at 19:00. This is calculated as a 66% on-time start for the day.
    c. Three OR are scheduled for 10-hour days (07:00–17:00). OR #1 starts at 08:00 finishes at 17:00. OR #2 and OR #3 both start at 07:00 and end at 17:00. This is calculated as a 66% on-time start for the day.
19. A general surgeon at your institution has approached your anesthesiology group and asked to implement a high-throughput OR. He believes that he can perform an extra laparoscopic cholecystectomy each day by scheduling consecutive laparoscopic cholecystectomies on the same day. He argues that by performing the same type of surgery sequentially, he will reduce the variation in OR setup for the nurses and perioperative management for the anesthesiologists. He currently has a scheduled block from 07:00–15:00. His surgical time (skin incision, a dressing applied) on average is 75 minutes, and he is able to complete 5 laparoscopic cholecystectomies on a scheduled day. He approaches you, the Vice Chair of Clinical Affairs, and believes that he can perform an additional surgery each day because the new system will save him 15 minutes per case (5 cases multiplied by 15 minutes time savings/case = 75 minutes). How do you proceed?
    a. Reduce the number of unnecessary tests,
    b. Reduce the number of cancellations on the day of surgery,
    c. Decrease the number of delayed cases in the OR,
    d. Reduce the number of unnecessary laboratory tests ordered by surgeons and primary care physicians
    e. All of the above

Appendix *continued*

20. Preoperative evaluation clinics have been shown to do which of the following:

    a. Reduce the number of unnecessary tests,

    b. Reduce the number of cancellations on the day of surgery,

    c. Decrease the number of delayed cases in the OR,

    d. Reduce the number of unnecessary laboratory tests ordered by surgeons and primary care physicians

    e. All of the above

21. The CEO of the hospital has come to your group about creating an OR dashboard to measure the "efficiency" of the OR. He believes that the current metric using surgeon satisfaction has created a poor, deflated organizational culture and that raw utilization rates have resulted in gaming by certain surgeons. He would like your group to create a set of OR metrics that would be objective, applicable to all individuals in the OR, and serve to ensure the financial footing of the institution. List at least 5 metrics that would enable you to gather data and implement focused, directed changes in the perioperative process.

22. You perform anesthesia for an 89-year-old male undergoing an emergent acetabulum repair (CPT code 01173). The patient has a history of cardiac disease, chronic obstructive pulmonary disease, and diabetes mellitus. He has had coronary stents placed in the past and has been medically stable. Anesthesia start time is 09:07; the end time is 15:01. Please submit a bill for the number of base units, time units, and any patient modifiers.

23. You start an elective esophagectomy (CPT code 00500) on a 57-year-old female with esophageal cancer and concomitant severe pulmonary fibrosis. Anesthesia start time is 07:27. Your partner takes over the case at 12:04. The end time for the case is 14:03. Please submit a bill for the number of base units, time units, and any patient modifiers.

24. True or False: You and your partner can submit two separate bills for the anesthesia services provided in question.

25. You start an elective thoracotomy for a RUL wedge resection that requires one-lung ventilation in a 68-year-old female smoker. She has small cell carcinoma, and the cancer has metastasized to her liver and brain. You place an arterial line in the preoperative holding area and the anesthesia start time is 07:41. The end time for the case is 11:03.

    a. Please find the appropriate CPT codes for the radial line placement and the procedure.

    b. Please submit a bill for the number of base units, time units, and any patient modifiers.

    c. Does it matter whether the arterial line was placed before or after the anesthesia start time?

26. Unlike operative anesthesia, there is no single widely accepted method of accounting time for neuraxial labor anesthesia services. Professional charge and payment policies should reasonably reflect the costs of providing labor anesthesia services as well as the intensity and time involved in performing and monitoring any neuraxial procedures. Which methods for determining professional charges are appropriate for determining professional charges?

    a. Base units plus time units subject to a reasonable cap,

    b. Base units plus one unit per hour for neuraxial anesthesia service management plus direct patient contact time,

    c. Incremental time-based fees,

    d. Single fee,

    e. An inconsistent policy that submits a bill based upon the highest number of units utilizing the four accounting methods mentioned above,

27. Upon graduation from residency, you join a private practice group where your salary is dependent upon the number of units you generate. It is your turn to pick the type of cases you would like to perform the next day. You are on call and will be the last attending anesthesiologist relieved tomorrow. Please select from the following rooms:

    a. Pediatric otolaryngology. The surgeon has scheduled nine ear tube placements, four adenoidectomies, and four tonsillectomies. The day is expected to start at 07:30 and end at 16:00.

    b. Cardiothoracic. The cardiothoracic surgeon has scheduled one cardiac bypass. The case is expected to start at 07:00 and end at 11:30.

    c. General surgery. The general surgeon has scheduled three laparoscopic procedures. The day is scheduled to start at 07:00 and end at 14:00.