Curriculum Providing Cognitive Knowledge and Problem-Solving Skills for Anesthesia Systems-Based Practice

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Abstract

Background Residency programs accredited by the ACGME are required to teach core competencies, including systems-based practice (SBP). Projects are important for satisfying this competency, but the level of knowledge and problem-solving skills required presupposes a basic understanding of the field. The responsibilities of anesthesiologists include the coordination of patient flow in the surgical suite. Familiarity with this topic is crucial for many improvement projects.

Intervention A course in operations research for surgical services was originally developed for hospital administration students. It satisfies 2 of the Institute of Medicine's core competencies for health professionals: evidence-based practice and work in interdisciplinary teams. The course lasts 3.5 days (eg, 2 weekends) and consists of 45 cognitive objectives taught using 7 published articles, 10 lectures, and 156 computer-assisted problem-solving exercises based on 17 case studies. We tested the hypothesis that the cognitive objectives of the curriculum provide the knowledge and problem-solving skills necessary to perform projects that satisfy the SBP competency. Standardized terminology was used to define each component of the SBP competency for the minimum level of knowledge needed. The 8 components of the competency were examined independently.

Findings Most cognitive objectives contributed to at least 4 of the 8 core components of the SBP competency. Each component of SBP is addressed at the minimum requirement level of *exemplify* by at least 6 objectives. There is at least 1 cognitive objective at the level of *summarize* for each SBP component.

Conclusions A curriculum in operating room management can provide the knowledge and problem-solving skills anesthesiologists need for participation in projects that satisfy the SBP competency.

Editor's Note: The online version of this article contains 3 supplemental TABLES providing additional details about the course material, as well as an APPENDIX of the 156 exercises in 17 cases that the students perform.

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Background

The Accreditation Council for Graduate Medical Education (ACGME) mandates that residency programs in all specialties teach and assess 6 general competencies, including systems-based practice (SBP).[1,2] The components of the SBP competency (TABLE 1) and functional definitions encompass content related to "cost effective practice," including "tools and techniques for controlling costs and allocating resources, understanding of financing and insurance structures, mock practice experiences/mock financials, and evaluating risk and benefit of costly prescribing."[3] Anesthesiologists engage in operating room (OR) management, essentially directing the surgical suite and ensuring smooth patient flow. Practitioners must be able to understand coordination of surgical suites and explain the principles to OR nurses, nursing directors, surgeons, surgical technologists, anesthesia technicians, postanesthesia care unit nurses, intensive care unit nurses, and administrators.[4,5] Among the 61 English language articles identified by searching "operating room

TABLE 1 **Functional Definitions of the Accreditation Council for Graduate Medical Education (ACGME) Competencies in Systems-Based Practice**[a]

Symbol Used in TABLES 4 and 5	Core Component of the ACGME Systems-Based Practice Competency	Functional Definition for *Minimum* Requirement of Curriculum Whose Cognitive Objectives Provide Resident With the Knowledge and Problem-Solving Skills Needed to Satisfy the Core Component of Competency
A	Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care	Exemplify relationships among 2 layers of a health care system: purchasers (payers), insurers, delivery systems (hospitals), anesthesia and surgical group practices, providers, and patients
B	Residents must demonstrate ability to call effectively on other resources in the system to provide optimal health care	Exemplify how analysts and/or publicly available government databases are used to forecast effectiveness of strategies to reduce cost or to care for more patients at same cost
C	Residents are expected to work effectively in various health care delivery settings and systems relevant to their clinical specialty	Exemplify impacts of timeliness of care and how fast clinicians work in different OR and non-OR anesthetizing locations on resulting efficiency, productivity, and utility of the health system
D	Residents are expected to coordinate patient care within the health care system relevant to their clinical specialty	Exemplify how to coordinate decisions among 2 layers of the perioperative health care system (eg, choice of date and scheduled start time of each case involves 1 layer of providers including surgeons and anesthesiologists and another layer of patients)
E	Residents are expected to incorporate considerations of cost awareness and risk-benefit analysis in patient and/or population-based care as appropriate	Exemplify how multiple clinical and managerial decisions made in the perioperative setting influence patient and health system costs and/or risks
F	Residents are expected to advocate for quality patient care and optimal patient care systems	Exemplify how to use evidence-based management literature to determine (1) optimal solutions, when they exist, and otherwise (2) validated methods to quantify and/or describe qualitatively balance between risk and cost
G	Residents are expected to work in interprofessional teams to enhance patient safety and improve patient care quality	Exemplify how to coordinate decisions between 2 layers of perioperative health care system that influence patient safety and/or patient perception of quality (eg, surgeon scheduling a case affects patient waiting time)
H	Residents are expected to participate in identifying system errors and implementing potential systems solutions	Exemplify how to use evidence-based management literature to determine optimal system performance, judging cost versus utility of improvement and steps for appropriate implementation

Abbreviation: OR, operating room.

[a] The core components in column 2 are given (and listed identically) in TABLE 3 and TABLE 4. The first 2 components are specified in the ACGME preamble and the last 6 in the bulleted list.[1,2] The functional definitions in column 2 are minimum requirements because they refer only to illustrating a concept by example (ie, "exemplifying") (see TABLE 2). The description of systems-based practice as being based on multiple layers is from the ACGME explanation[22] and is used in rows A and D of column 3 of this TABLE 1. According to the ACGME,[22] at the heart of systems-based practice (SBP) is a focus on the broader context of patient care within the multiple layers of a health care system including purchasers (employers, government), insurers (commercial, Medicare, Medicaid), delivery systems (hospitals, physician networks, drug and technology companies, community resources), work group (local entity providing care such as a group practice, hospital service), providers (physicians, nurses, and others both as individuals and teams that provide direct care), and the users (patients and families). Awareness and effective use of these resources … include how national and local structures, systems, rules, and regulations contribute to the experience of a specific patient and populations of patients; who pays for care and why it matters to both patient and physician; and factors within the culture, organization, management, and financing of the local care system that impact care of individuals and populations.

management" in Web of Science, 74% were published in anesthesiology journals.

Three characteristics of hospital surgical suites cause coordination of surgical care to differ from SBP in other specialties. First, surgery is non-preemptive, meaning that once a surgical procedure is started, it must be completed. The patient cannot be moved out of the OR and replaced by another patient, with the surgery to be finished at a later time. All decisions concerning the scheduling of a case are therefore made before the case is started. Second, surgical cases with anesthesia have a large mean absolute error in predicted duration.[6] Third, variability in the daily numbers of scheduled cases affects the efficiency of use of OR time. Coordination of cases is therefore an important issue.

The mathematics of forecasting case durations is nonintuitive. For example, the time remaining in a case that is running late is the time until the end of surgery, plus a relative constant for irrigation, inspection, incision closure, awakening from anesthesia, and transport to recovery. If a case scheduled for 3 hours is still ongoing after 2.5 hours, the median expected time remaining is not 0.5 hour but longer, for example, 1.0 hour.[7] If still ongoing at 3.5 hours, the best estimate of the time remaining, and when the next case can begin, is still 1.0 hour.[7] These nonintuitive aspects of OR scheduling should be understood by anesthesiologists coordinating the perioperative team, as well as by anesthesiology residents embarking on an SPB project in OR management. The knowledge and problem-solving skills needed for OR management are generally not readily learned on the job but through formal study.[8] Innate psychological biases[9] and misconceptions[10] must be overcome.

TABLE 2 **Definitions of Standardized Vocabulary for the Knowledge and Skill Levels Attained for Each Competency and Cognitive Objective**[a]

Hierarchical Level of Knowledge and Problem-Solving Skills, Used to Fill in Columns 3 to 10 of TABLE 4, and Columns 3 to 6 of TABLE 6, and in the Header Row of Columns 3 to 8 of TABLE 5	Standardized Vocabulary: Verb Used as the First Word for Each of the 45 Objectives of TABLES 3, 4, and 6	Explanation	Similar Verbs That Provide Further Clarity
1	Remember	Locate and/or retrieve relevant knowledge in long-term memory with/without cues	Clarify, list, recognize, recall, state, translate, paraphrase
2	Exemplify	Illustrate a concept by example	Illustrate, construct
3	Summarize	Prepare a single statement that represents presented information or abstracts a general theme	Abstract
4	Explain	Construct a cause and effect model of a system and predict how a change in one part of a system will affect another	Infer, compare, predict, interpolate, extrapolate
5	Apply	Carry out or use a procedure in a given situation, both familiar and unfamiliar	Carry out, execute, implement

[a] The taxonomy of cognitive learning and the corresponding verbs are from references 12 and 13. The functional definitions in column 3 of TABLE 1 are minimal requirements because they refer only to illustrating concepts by example (ie, "exemplify" in row 2 column 2 of this TABLE 2).

In a previous study of teaching related to the SBP competency in anesthesiology, Delphin and Davidson[11] showed that resident team projects are effective. Although indispensable to satisfying the competency, the level of knowledge and problem-solving skills needed to select and conduct projects presupposes a basic level of understanding, such as exemplifying and summarizing principles according to higher levels of Bloom's taxonomy (TABLE 2).[12,13] Residents may not yet possess this knowledge. Delphin and Davidson's team-oriented approach is best applied once residents have acquired these basic skills.

Curriculum Design

To offer residents a basic understanding of the scientific principles of OR management as they relate to SBP, we developed a course in OR management originally designed for master's-level hospital administration students in the University of Iowa Department of Health Management & Policy. The 35-hour course is given over 3.5 days during 1 weekend or 2 successive weekends. The course teaches residents when statistical forecasting is necessary, ways to apply literature searches to choose among forecasting methods, and how to explain to analysts the needs of an anesthesia group.

Although the curriculum was designed for hospital administration students, participants to date have been anesthesiologists and a few perioperative analysts and OR nursing directors. Other hospitals send representatives to the course to learn principles of OR management for application at their own institutions. One hospital sent a contingent of anesthesiologists, OR nursing directors, and financial analysts to the course to lay a common foundation on which they could base their decisions. Thus, the course has been attended by a wide variety of personnel with varying backgrounds. As part of our needs assessment to apply for continuing medical education credit, we observed that the curriculum's cognitive objectives provide the knowledge and problem-solving skills necessary to satisfy the ACGME recommendations for teaching "an awareness of and responsiveness to the larger context and system of health care" and teaching cost-effective practice (supplemental online TABLES 4 through 6).

The curriculum includes 3 educational methods (TABLE 3 and supplemental online TABLE 5): 10 lectures and 156 exercises using 17 case studies (online APPENDIX). Our website (www.FranklinDexter.net/education.htm) contains all slides used in the lectures, 7 targeted articles relevant to SBP for anesthesiology residents,[14–21] and a link to "statistics for anesthesia," which is a review of required background material involving basic statistics up to the level of Student *t* test.[22] The lectures, slides, and review of statistics are all publicly available. Learners complete the 156 exercises using an Excel workbook tool that provides immediate, adaptive, elaborated feedback to numeric and short answer questions. The adaptive feedback is programmed without macros by the use of more than 4250 Excel spreadsheet formulae containing more than 8300 Excel functions. Variations of the curriculum have been given to groups of 7 to 50 students on 14 occasions.

TABLE 2 lists 5 hierarchical levels of knowledge from the review by Anderson and colleagues[13] of the revision of Bloom's taxonomy. TABLE 1 shows the ACGME's definitions of the components of SPB. *Remembering* a new concept is the minimum level of knowledge, followed by an ability to exemplify, summarize, explain, and apply that concept. We used this standardized vocabulary to formulate the 45 objectives of the curriculum and evaluate the extent to which each objective satisfies the core components of the SBP competency.

Using the ACGME language in TABLE 1, we created functional definitions that would provide anesthesia residents with the knowledge and problem-solving skills needed to satisfy the component. Each definition is based only on *exemplifying* the material (ie, illustrating by example).

Implementation of the Curriculum

We assigned ratings (levels of knowledge using standardized verbs) to calculate the level at which each of the 45 objectives satisfied each of the core components of the competency (supplemental online TABLE 4) and the ACGME recommendations for implementation (supplemental online TABLE 6). Ratings were based on the depth of the lecture material presented to the students and the nature of the 156 exercises in the Excel workbook. The exercises are included as supplemental online APPENDIX. We use Objective 6 as an example to show how the educational materials and exercises were used to determine without ambiguity the appropriate verb from the standardized vocabulary. The number of core components satisfied by each objective is summed in TABLE 3 column 5. The number of cognitive objectives that satisfy each core component at each hierarchical level of knowledge is summed in TABLE 3. The number of cases, readings, and lectures associated with each component is also summed in TABLE 3.

For example, Objective 6 is to "Apply multiple methods of case duration prediction, including use of upper and lower prediction bounds, for making staff assignment and case scheduling decisions, with and without computer support." This objective refers to the frequent decision whether or not to insert a pending add-on case into a gap in the schedule. Assume the first case of the day was scheduled to last until noon but ended at 9 AM because the pathology was more extensive than anticipated. The next case was not scheduled to begin until 12:30 PM. Another surgeon had a 3-hour add-on case in a different OR and was hoping to start sooner than the scheduled noon start time. The OR manager should consider the 90% upper prediction bound for the duration of the add-on case when deciding whether it would fit into the schedule without disrupting later cases and extending the workday. In addition to using prediction bounds, the case requires students to calculate the economic savings by moving a case, revise case scheduling to reduce the probability of resource conflict over a surgical microscope, estimate the cost of time spent waiting for patients, determine optimal hours of staffing based on the standard deviation for the length of the workday, and examine the effects of nonsequential case scheduling on personnel needs. The case thus requires students to "apply" their knowledge.

The curriculum is taught using 17 cases, 10 lectures, and 7 readings (shown in supplemental online TABLE 5 last 3 columns). Each objective contributes to at least 1 of the 8 ACGME SBP core components, and most contribute to at least 4 of them (TABLE 3 last 3 columns). The objectives contributing to just 1 component enable understanding of objectives taught later and thus cannot be deleted.

Each component of SBP is addressed at the minimum requirement level of exemplify by at least 6 of the 45 specific objectives (TABLE 5 column 8). There is at least 1 cognitive objective at the level of summarize (level 3) for each component (TABLE 5 column 5).

Discussion and Conclusions

We designed a 35-hour curriculum to teach the basic principles of operations research for use in OR management. The curriculum consists of 10 lectures, 7 readings, and 17 case studies. We have shown that 45 cognitive objectives provide the knowledge and problem-solving skills needed for anesthesiology residents to perform projects that would satisfy the ACGME competency in SBP. The unique curriculum reflects anesthesiologists' responsibilities for coordinating OR care and the fundamental differences of hospital OR management from that of other medical specialties.

Our curriculum in operations research for surgical services provides the knowledge and problem-solving skills needed to satisfy all elements of the ACGME core competency in SBP. Examples illustrate the reliability and face validity of the objectives of the curriculum, the assignment of levels of knowledge using a standardized vocabulary, and the assessment of the extent to which each objective meets the 8 ACGME core components of SBP and the 4 elements for implementation.

Anesthesiologists differ from physicians in other specialties in that their professional work involves the smooth flow of patients through the surgical suite. The literature on SBP projects for other disciplines focuses on quality improvement or reducing medical error, while our curriculum addresses the coordination of patient flow. Our curriculum is therefore useful for practicing anesthesiologists, nursing directors, analysts, and other OR staff. In addition, the curriculum addresses 2 of the 5 Institute of Medicine core competencies for health professionals—evidence-based practice and work in interdisciplinary teams.[21] Evidence-based practice is addressed by almost all of the cases and lectures. Participation of nursing directors, certified registered nurse

TABLE 3 **The Teaching of Cognitive Objectives and the Contribution of Each Objective to Accreditation Council for Graduate Medical Education Components**

Cognitive Objective	Description Using the Bloom's Taxonomy (Verbs), Listed in Sequence of Presentation in the Course	Enables Understanding of Objective(s) Taught Later	Educational Method(s) to Teach Objective (Readings 1–7 are References 15–21)	Contributes to How Many of the 8 Components (ie, Columns) of TABLE 4
1	Exemplify importance for health system of clinicians basing operational decisions on ordered priorities	2, 7, 8, 25, 26	Cases 1, 6 Lectures 1, 3 Readings 1, 2	7
2	Apply principles to judge quality of operational decisions on day of surgery based on impact on OR efficiency and tardiness of case start times	4, 6, 9, 25, 26, 38	Cases 2, 3, 5, 6 Lecture 1 Reading 1	8
3	Summarize differences among perioperative staffing, staff scheduling, and staff assignment decisions	36	Case 11 Lectures 1, 8	6
4	Remember use of offline bin packing for scheduling of cases on day of surgery to increase OR efficiency and exemplify why, in contrast, first-come first-served scheduling cannot be used for that purpose	26, 28, 29	Lecture 1	6
5	Exemplify reduction in OR efficiency from decisions to reduce percentage of delayed starts	28, 29	Case 4 Lecture 1	7
6	Apply multiple methods of case duration prediction, including use of upper and lower prediction bounds, for making staff assignment and case scheduling decisions, with and without computer support	11, 38	Cases 2–5 Lecture 2 Reading 1	7
7	Apply use of search protocols for relevant scientific articles based on knowledge of the vocabulary of operations research and OR management	8, 17, 19, 27, 28, 29	Cases 3, 4, 7, 12 Lecture 1 Readings 1, 3	3
8	Explain differences between block time for tactical decisions and allocated time for staffing decisions, including impact on patients and ICUs	11, 25, 26	Cases 7, 8 Lectures 3, 4 Readings 2, 3	6
9	Explain impact of open access to OR time on patients and surgeons and its facilitation by capital equipment purchasing	21, 25, 26	Case 9 Lecture 3 Readings 2, 3	5
10	Summarize the principle and value of creating scenarios customized for each facility for educational purposes	38	Case 2 Lecture 3	4
11	Apply statistical methods to allocate OR time based on maximizing OR efficiency to reduce labor costs	38	Cases 6, 15 Lectures 3, 8, 9 Reading 2	7
12	Remember when and how to incorporate seasonal variation and trends over time in staffing analyses	34	Lectures 3, 8 Reading 2	2
13	Exemplify definitions of fixed costs, variable costs, contribution margin, and profit in budgetary decisions	15	Cases 8, 10, 13 Lecture 4 Reading 3	5
14	Remember that tactical decisions to increase OR utilization differ from those to reduce numbers of patients on waiting lists or average patient waiting times	22	Lecture 4 Reading 3	8

TABLE 3 **Continued**

Cognitive Objective	Description Using the Bloom's Taxonomy (Verbs), Listed in Sequence of Presentation in the Course	Enables Understanding of Objective(s) Taught Later	Educational Method(s) to Teach Objective (Readings 1–7 are References 15–21)	Contributes to How Many of the 8 Components (ie, Columns) of TABLE 4
15	Explain when tactical decisions to increase OR utilization and contribution margin result in differential increases in block time for subspecialties	23, 29, 31, 40	Cases 8, 10 Lectures 4, 5 Readings 3, 4	4
16	Remember that changes in group and/or hospital contract(s) with insurers can have different impacts on OR utilization and profit	19	Lecture 4 Reading 3	6
17	Explain when tactical decisions to increase OR utilization can reduce surgeons' flexibility to grow practices (eg, when clinics or ICUs are relatively full)	23, 29	Cases 7, 10 Lecture 4 Reading 3	5
18	Remember that subspecialties have markedly different variable costs per OR hour, overall variable costs are highly disproportional to OR utilization	21	Lecture 4 Reading 3	3
19	Summarize based on quality control charts why OR utilization cannot be estimated accurately for individual subspecialties as needed for tactical decisions	41	Case 7 Lecture 4 Reading 3	5
20	Apply methods of perioperative managerial cost accounting for budgetary decisions	21, 23	Cases 8, 10 Lectures 5, 7 Readings 3, 5	3
21	Remember that tactical (contribution margin) analysis can assess financial impact of growth for groups and/or hospitals with fixed global budgets		Lecture 5 Reading 3	3
22	Remember that strategic objectives can be included in tactical analysis for increases in block time	31, 43, 45	Lecture 5 Reading 3	1
23	Exemplify need to use linear programming to incorporate constraints such as limited ICU beds when analyzing suitability of recruiting a new surgeon	38	Case 10 Lecture 5 Reading 4	5
24	Exemplify need to use quadratic programming (portfolio analysis) to prevent decisions based on spurious cost and revenue data	33	Cases 10, 13 Lecture 5 Reading 4	2
25	Explain appropriate increases in block time for surgeons based on the impact of operational decisions on tactical decisions	41	Cases 8, 10 Lecture 5 Reading 4	6
26	Exemplify appropriate operational decisions resulting in anesthesia groups' costs being insensitive to poor tactical decisions from politics and/or inaccurate forecasts of subspecialties' potential for growth	38	Cases 10, 15 Lecture 5	3
27	Remember definitions of turnover time, non–value added time, lean method, six sigma, and benchmarking	28	Cases 11, 12 Lecture 6	2
28	Explain relative impact of reducing anesthesia times and turnover times for specific surgeons and specialties on OR efficiency and costs	38	Cases 11, 12, 15 Lecture 6 Reading 2	6

TABLE 3 **CONTINUED**

Cognitive Objective	Description Using the Bloom's Taxonomy (Verbs), Listed in Sequence of Presentation in the Course	Enables Understanding of Objective(s) Taught Later	Educational Method(s) to Teach Objective (Readings 1–7 are References 15–21)	Contributes to How Many of the 8 Components (ie, Columns) of TABLE 4
29	Summarize economic and psychological arguments for reducing turnover times	38	Case 12 Lecture 6	6
30	Remember that interventions to reduce prolonged turnovers focus on time of day with most prolonged turnovers	38	Lecture 6 Reading 2	6
31	Exemplify differences in results of strategic financial analyses between hospital versus anesthesia and surgical groups	38	Cases 13, 16 Lecture 7 Reading 5	5
32	Exemplify impact of length of stay on diagnosis related groups reimbursement for common and uncommon procedures	45	Case 8 Lecture 7 Reading 5	3
33	Summarize use of publically available databases to benchmark length of stay, payer mix, contribution margin, and/or profit data for perioperative financial analyses		Cases 9, 14, 16 Lecture 7 Reading 5	3
34	Exemplify importance of calculating empirically the maximum number of ORs that can be run for each specialty		Cases 1, 10 Lectures 1, 8 Reading 6	4
35	Remember that afternoon and evening anesthesia staffing is based equivalently on increasing group productivity and reducing its labor costs	36	Lecture 8	1
36	Explain difference between staff being regularly scheduled to work late versus being scheduled on-call to work late if necessary	37	Cases 11, 15 Lecture 8	2
37	Remember how to provide information to anesthesia providers on work hours for different shifts		Lecture 8	2
38	Remember managerial roles of anesthesia providers when there is substantial underutilized OR time		Lectures 8, 9 Reading 6	4
39	Remember that salary guarantee for regularly scheduled but underutilized OR time establishes precedent for other specialties		Lecture 9 Reading 6	2
40	Explain appropriateness of financial support from hospital to anesthesia group and its effect on financial impact of growth in OR workload		Case 8 Lecture 9 Reading 6	5
41	Summarize difference between surgeon block time for surgeon convenience versus to grow practices		Cases 10, 15 Lecture 9	4
42	Remember the following scientifically distinct terms: case, discharge, patient, procedure, surgery, and visit	43, 44, 45	Cases 9, 16, 17 Lectures 10 Readings 5, 7	3
43	Exemplify interests of different stakeholders (eg, surgeons vs politicians) when performing strategic analyses of diversity of procedures		Case 17 Lecture 10 Reading 7	4

TABLE 3 **Continued**

Cognitive Objective	Description Using the Bloom's Taxonomy (Verbs), Listed in Sequence of Presentation in the Course	Enables Understanding of Objective(s) Taught Later	Educational Method(s) to Teach Objective (Readings 1–7 are References 15–21)	Contributes to How Many of the 8 Components (ie, Columns) of TABLE 4
44	Summarize utility of potential data sources and its use for assessing similarity of a hospital's procedures to those of other hospitals		Cases 16, 17 Lecture 10 Reading 7	2
45	Remember financial and marketing implications of tertiary facilities having large percentages of its physiologically complex procedures being rare		Lectures 7, 10 Readings 5, 7	2

Abbreviations: OR, operating room; ICU, intensive care unit.

anesthetists, operations managers, financial officers, and others enhances understanding on the part of anesthesia personnel of the viewpoint of others, satisfying the Institute of Medicine's competency of "work in interdisciplinary teams."[23]

Anesthesiologists, OR nursing directors, industrial engineers, analysts, and administrators report that the curriculum is useful. All 17 students enrolled in the most recent course presentation submitted evaluation forms. They were asked to agree or disagree with various statements on a 5-point scale, with 4 being "agree" and 5 being "strongly agree." All students scored the course a 4 or 5 with respect to "class increased my trust in applying evidence-based statistical methods and analytic reports in health care management decisions," "class enhanced my ability to analyze managerial questions critically and solve the problems in a logical, evidence-based manner," "course was well planned and content was organized logically," and "cases and readings aided in learning the material." However, we have no such formative assessments from anesthesiology residents. Future work is needed to evaluate the curriculum to determine the extent to which it aids anesthesiology residents in developing projects for SBP.

References

1 Accreditation Council for Graduate Medical Education (ACGME), 2006. Available at: http://www.ACGME.org/outcome/e-learn/FacManual_module2.pdf. Accessed June 1, 2010.

2 Accreditation Council for Graduate Medical Education (ACGME). Educational program, curriculum components, ACGME competencies, systems-based practice, common program requirement, 2008. Available at: www.ACGME.org/acWebsite/navPages/commonpr_documents/IVA5f_EducationalProgram_ACGMECompetencies_SBP_Explanation.pdf. Accessed June 1, 2010.

3 Joyce B. Practical implementation of the competencies. Accreditation Council for Graduate Medical Education (ACGME), 2006. Available at: http://www.ACGME.org/outcome/e-learn/redir_module2.asp. Accessed June 1, 2010.

4 Marjamaa RA, Kirvela OA. Who is responsible for operating room management and how do we measure how well we do it. *Acta Anaesthesiol Scand*. 2007;51:809–814.

5 Larsson J, Holmström I, Rosenqvist U. Professional artist, good Samaritan, servant and co-ordinator: four ways of understanding the anaesthetist's work. *Acta Anaesthesiol Scand*. 2003;47:787–793.

6 Stepaniak PS, Heij C, Mannaerts GH, de Quelerij M, de Vries G. Modeling procedure and surgical times for current procedural terminology-anesthesia-surgeon combinations and evaluation in terms of case-duration prediction and operating room efficiency: a multicenter study. *Anesth Analg*. 2009;109:1232–1245.

7 Dexter F, Epstein RH, Lee JD, Ledolter J. Automatic updating of times remaining in surgical cases using Bayesian analysis of historical case duration data and instant messaging updates from anesthesia providers. *Anesth Analg*. 2009;108:929–940.

8 Dexter EU, Dexter F, Masursky D, Garver MP, Nussmeier NA. Both bias and lack of knowledge influence organizational focus on first case of the day starts. *Anesth Analg*. 2009;108:1257–1261.

9 Dexter F, Lee JD, Dow AJ, Lubarsky DA. A psychological basis for anesthesiologists' operating room managerial decision-making on the day of surgery. *Anesth Analg*. 2007;105:430–434.

10 Brown DE. Using examples and analogies to remediate misconceptions in physics: factors influencing conceptual change. *J Res Sci Teach*. 1992;29:17–34.

11 Delphin E, Davidson M. Teaching and evaluating group competency in systems-based practice in anesthesiology. *Anesth Analg*. 2008;106:1837–1843.

12 Thomas PA. Step 3, goals and objectives, focusing the curriculum. In: Kern DE, Thomas PA, Hughes MT, eds. *Curriculum Development for Medical Education, a Six-Step Approach*. 2nd ed. Baltimore, MD: Johns Hopkins University Press; 2009:45, 46, 49.

13 Anderson LW, Krathwohl DR, Airasian PW, et al. *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Abridged ed. New York, NY: Longman; 2001:31, 67–69, 73–79.

14 Commission on Accreditation of Healthcare Management Education. Self study handbook appendix A–a glossary of curriculum content areas, section III.B.5 Operations assessment and improvement, 2008, pp. ii. Available at: http://www.cahme.org/Resources/Appendix%20A%20-%20Glossary%20of%20Curriculum%20Content%20Areas.pdf. Accessed June 1, 2010.

15 McIntosh C, Dexter F, Epstein RH. Impact of service-specific staffing, case scheduling, turnovers, and first-case starts on anesthesia group and operating room productivity: tutorial using data from an Australian hospital. *Anesth Analg*. 2006;103:1499–1516.

16 Dexter F, Epstein RD, Traub RD, Xiao Y. Making management decisions on the day of surgery based on operating room efficiency and patient waiting times. *Anesthesiology*. 2004;101:1444–1453.

17 Wachtel RE, Dexter F. Tactical increases in operating room block time for capacity planning should not be based on utilization. *Anesth Analg*. 2009;106:215–226.

18 Dexter F, Ledolter J, Wachtel RE. Tactical decision making for selective expansion of operating room resources incorporating financial criteria and uncertainty in sub-specialties' future workloads. *Anesth Analg*. 2005;100:1425–1432.

19 Wachtel RE, Dexter F, Lubarsky DA. Financial implications of a hospital's specialization in rare physiologically complex surgical procedures. *Anesthesiology.* 2005;103:161–167.
20 Dexter F, Epstein RH. Calculating institutional support that benefits both the anesthesia group and hospital. *Anesth Analg.* 2008;106:544–553.
21 Wachtel RE, Dexter F. Differentiating among hospitals performing physiologically complex operative procedures in the elderly. *Anesthesiology.* 2004;100:1552–1561.
22 Dexter F, Masursky D, Wachtel RE, Nussmeier NA. Application of an online reference for reviewing basic statistical principles of operating room management. *J Stat Educ* 2010;18(3).
23 Committee on the Health Professions Education Summit, Greiner AC, Knebel E. *Health Professions Education: A Bridge to Quality.* Washington, DC: Institute of Medicine, The National Academy, 54, 56, 57, 62, 63. Available at: http://www.nap.edu/openbook.php?record_id=10681. Accessed November 3, 2010.