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ORIGINAL RESEARCH

Development of an Abbreviated Longitudinal Approach for Medical Student Learning in Perioperative Medicine: Teaching the Perioperative Surgical Home

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INTRODUCTION

Health care industry leaders continue to promote disruptive innovation, but little attention has been paid to how this change affects medical education.^{1,2} Clinical instructors are being asked to continuously adapt to evolving models of patient care even as they teach current, established care models. Educational resources are constrained by the need for more economic efficiency. Patients are increasingly encountered only in fast-paced ambulatory settings that are less conducive than the hospital setting to traditional group education. Compounding these constraints, today's students have been exposed to their own disruptive changes in education,³⁻⁷ and traditional teaching methods have been disfavored. It is imperative that our education system adapt to these new realities and adopt new teaching strategies if instructors wish to optimally prepare future clinicians and prevent medical-educator burnout.

Disruptive health care innovation affecting anesthesiology education is best exemplified by the emerging discipline of perioperative medicine (POM). Reimagining the traditional operating room role of anesthesiologists, Aronson, Grocott, and Mythen⁴ and Grocott et al⁸ have described a vision of anesthesiologists being involved in every aspect of a patient's surgical experience. These authors have demonstrated substantial improvements in quality and cost containment using a

new "longitudinal" model of patient care. The American Society of Anesthesiology has adopted and promoted this innovation in a national initiative titled the "Perioperative Surgical Home" (PSH).⁹ Anesthesiology department chairpersons and program directors at major academic centers have embraced the PSH and have overwhelmingly advocated teaching residents and medical students POM. In 2014, University of California-Irvine's anesthesiology department implemented a PSH curriculum for anesthesiology residents that spans all 4 years of training. Dedicating 4 weeks per year, interns begin with learning about the foundations of PSH and end with creating and implementing pathways as senior residents.¹⁰ However, consensus on how to teach POM is lacking.^{1,10-12}

Teaching in anesthesiology has traditionally been siloed in specialty clerkships. Fortunately, research has demonstrated that longitudinal learning following a patient over time through multiple facets of care, often via a Longitudinal Integrated Curriculum (LIC),¹³ is an excellent alternative to sequential, specialty-specific clerkships, which have been the mainstay of medical student education.^{14,15} We recognized an opportunity to pair changes in education with changes in the practice of anesthesiology.

At the request of our medical school leadership to increase departmental clerkship offerings, we developed a new

4-week elective for advanced medical students in POM with an emphasis on longitudinal learning. We hypothesized that creating a successful clerkship would require us to address 3 specific concerns: (1) Are medical students receptive to learning the evolving discipline of POM? (2) Can a longitudinal learning experience be introduced within the confines of a traditional 4-week clerkship? (3) Does our existing educational platform support advanced learning methodology in the preoperative assessment center (PAC) setting? We surveyed our medical student population, researched advanced learning theory, and incorporated key concepts into our online teaching platform. One year after introducing the clerkship, we interviewed participating students to evaluate areas of success and identify areas needing improvement. The purpose of this article is to describe the demand for this clerkship, principles behind its development, and students' perception of the educational experience.

METHODS AND MATERIALS

We followed Kern's 6-step approach to curriculum development while designing the clerkship (Figure 1).^{16,17} We paid special attention to the following aspects of curriculum design: (1) teaching the innovative constructs of POM; (2) incorporating new education methodology; (3) addressing unique features of current

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students' learning styles; (4) creating a longitudinal learning experience with both vertical and horizontal integration; (5) using the existing educational platform; and (6) addressing the logistical barriers present in our ambulatory care setting. Systematic integration of feedback from participants allowed for continuous improvement of the program. Each of these considerations was incorporated into the 6-step approach. This process and study were submitted to the University of Minnesota Institutional Review Board and were deemed to not be human research.

Step 1: Problem Identification and General Needs Assessment

Initial development of the program began September 2018 on the basis of an a priori assumption of need given the directive received. After piloting the program with a small pool of senior students in 2019–2020, we returned to this step with an assessment of learner need, interest and readiness for this clerkship, and interest in a longitudinal learning environment. This biphasic approach allowed us to confirm our a priori assumption of the need for this program with student input following a phased rollout of the program.

Step 2: Targeted Needs Assessment

Stakeholders in the PAC clerkship included participating students, medical school clinical clerkship leaders, PAC faculty, and anesthesiology department education leaders. Operationally, our PAC model closely follows University of California–Irvine's structure.¹⁸ A literature search for longitudinal learning and innovative teaching techniques in medical education was used to evaluate the medical school's expectations for a novel educational experience. A separate literature search on teaching POM was used to assess the expectations of the anesthesiology department. Areas of high intersecting interest were identified and targeted for emphasis in the clerkship redesign. Stakeholders identified a desire to move to a longitudinal, patient-centered model of education.

Step 3: Goals and Objectives

Educational objectives for this clerkship were developed along a hierarchy (Figure

2). Our primary objective was for students to gain experience in using evidence-based, multidisciplinary, perioperative care. Benefits for both individual patients and entire populations would be emphasized. Secondary objectives included having learners acquire detailed knowledge of the basic components of POM: risk stratification, perioperative patient optimization, patient education, shared decision-making, multidisciplinary care organization, medication management, enhanced recovery pathways, pain management, and resource stewardship.^{14,19} Tertiary objectives included having students distinguish between disease-specific and surgery-specific interventions.

The Association of American Medical Colleges has organized medical education into 9 broad competency domains, each further subdivided into core competencies. Core competencies are fulfilled by learning and demonstrating discrete objectives. This common taxonomy allows for greater standardization of medical curriculums.²⁰ We aligned our objectives to the core competencies established by the association.¹⁷

Step 4: Educational Strategies

Our primary goal was to provide the student a patient-centric perspective of longitudinal care. This necessitated that the student follow the patient through all phases of perioperative care. A series of supervised clinical experiences (preoperative evaluation, provision of anesthesia, postoperative anesthesia care, postoperative ward care, and pain management) coupled with resident- and faculty-led teaching were used to facilitate this goal. For secondary objectives (components of POM), we used active learning principles organized on our institutional online learning platform: micromentoring, patient-centered teaching, and a multidisciplinary approach to patient care. Micromentoring describes brief episodes of mentoring and education that centers on a specific clinical topic. Though brief, the interaction allows for an experience that is both Socratic and clinically applicable. Students were assigned daily readings from contemporary literature, and optional podcasts and videos were made available.^{7,21,22} Formal daily problem-based learning discussions were scheduled with PAC faculty to expand on

assigned readings. Students also received frequent micromentoring from the faculty, given that multiple patients were reviewed each day with PAC advanced practitioners.

Third-tier goals were addressed with active online learning and a variant of the flipped classroom: Students were asked to research and present concise 1-page summaries on clinically relevant topics. In addition, students maintained a log for each patient they encountered and documented perioperative strategies, interventions, outcomes, and salient learning points. At the end of the clerkship, the students reviewed these logs with the attending physician as a reflection on the learning process.²³

Step 5: Implementation

The medical school provided access to the online learning platform (Canvas LMS, Salt Lake City, UT). The anesthesiology department supplied support personnel for creating the POM online modules. We supplied the course content. Modules and resources were created in alignment with the educational strategies listed in the previous section, Step 4: Educational Strategies. A course schedule was constructed to organize the student's experience and allow for natural progression of learning through the clerkship (Figure 3). Given the novelty of the clerkship and the limited resources, a phased introduction of the clerkship was planned. Prior to full implementation, the clerkship was piloted during the academic year 2019–2020 with limited enrollment of 7 students. The final version of the clerkship opened to full medical school access enrollment in September 2020.

Step 6: Evaluation and Feedback

Evaluation of the redesigned clerkship was completed in 2 phases. Phase 1 included qualitative interviews with participants in the pilot PAC clerkship in the academic year 2019–2020. The purpose of these interviews was to directly assess participants' experiences and to gauge whether they preferred the novel longitudinal clerkship to the traditional block clerkship.

Phase 2 included quantitative feedback from 44 of 70 senior medical students who completed a survey-based assessment in spring 2020. The purpose of phase 2

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was to more generally assess students' perception of the change in health care, their evaluation of their preparation for this change, exposure to longitudinal teaching, and desire to participate in a clerkship that provides a longitudinal teaching experience in the care of surgical patients (Appendix A).

Phase 1 Evaluation

Following the initial rollout of the redesigned PAC clerkship, we invited the 7 medical students who completed the clerkship to participate in an interview session to assess its efficacy (Appendix B). Invitations were sent via email. As an incentive, students who participated were entered for a \$50 Amazon gift-card drawing. Interviews were conducted on a university Zoom (San Jose, CA) account by the lead author (W.N.). Notes were recorded in real time. Students verbally consented to being recorded and understood that the interviews would be kept confidential. The audio recordings were downloaded to the lead author's secured computer and electronically transcribed using Otter.ai (Los Altos, CA). The transcripts were reviewed for accuracy and deidentified. The lead author then coded the data from the open-ended questions by deducing their answers to a summative attribute and then categorizing the answers into groups for tabulation.²⁴

Phase 2 Evaluation

Following our pilot of the redesigned clerkship, we also designed a questionnaire for advanced University of Minnesota medical students enrolled in spring 2020 (Appendix A). The survey was anonymous and participation was voluntary. Prior to distribution, items were reviewed by our Evaluations and Analytics team to ensure that instructions, scales, and anchors were clear.²⁵ In March 2020, using Qualtrics survey software (Salt Lake City, UT), our survey (Appendix A) was distributed as part of a medical school-wide survey. A total of 70 students, a statistical representation of the third- and fourth-year classes, were randomly sampled. The fielding period was 1 week.

Though not the focus, we compared responses to survey questions for LIC

students and non-LIC students. For Likert-scale questions, responses were aggregated into broader categories (eg, any level of agreement vs neutral/disagreement). Open-ended questions were coded as described in the previous section, Phase 1 Evaluation.²⁴ Students with incomplete responses were not included. Unadjusted comparisons between categorical data were made using the Fisher exact test to determine statistical significance set at $P < .05$. All analyses were completed using R version 3.6.3 (Vienna, Austria).

RESULTS

Interviews

Six of 7 fourth-year students responded to email requests and were interviewed. Interviews lasted from 20 to 35 minutes and were conducted from March 27–April 7, 2020. One woman and 5 men participated. In July 2020, three commenced anesthesiology residency and the other 3 commenced procedure-based specialties. None of the students participated in an LIC.

They said they took the PAC clerkship because they wanted more preoperative evaluation experience and had positive comments regarding the clerkship (Table 1). Of the students, 83.3% indicated that the most enjoyable aspect of the clerkship was following patients through the entire perioperative process. Two said they enjoyed the patients' reactions to seeing a "familiar face." Two enjoyed the opportunity to know patients better and interact with them and their families.

Four students indicated that the most memorable learning point they would incorporate into their practice was recognizing the importance of the preoperative assessment. Other key learning points included using care-pathway protocols, using algorithms to evaluate patients, ordering studies and labs judiciously, and the significance of communication and patient follow-up.

All students who went into anesthesiology noted the expansion of the anesthesiologist's role into POM. Two-thirds of these students expressed that they believed this was the future of anesthesiology.

Medical School Survey Results

A total of 44 students completed the survey (62.9% response rate). Of these,

24 students were third-year students and 20 were fourth-year students. Twenty-five respondents identified as men and 19 identified as women (Table 2). Twenty-one (51.2%) students were enrolled in an LIC. Overall, 79.5% ($n = 35$) of students indicated that they somewhat or strongly agreed that there was a shift in health care delivery, and 72.7% ($n = 32$) indicated that they were somewhat or strongly concerned about this shift (Table 2). However, only 54.5% ($n = 24$) and 61.4% ($n = 27$) of students somewhat or strongly agreed that they were taught about health care industry and population health, respectively (Table 2). Preferences regarding computer-based and in-person learning were evenly spread across the board (Figure 4).

It was not surprising that there was a statistically significant difference regarding the preference of a longitudinal experience among LIC students and non-LIC students (85.7% vs 17.4%; $P = .001$; Table 2). Otherwise, there were no other statistically significant differences in how LIC students and non-LIC students answered the survey questions (Table 2). However, the open-ended question regarding students' focus during the perioperative period revealed a trend wherein 42.9% ($n = 9$) of LIC students versus 17.4% ($n = 4$) of non-LIC students cited that the patient or something patient-related was the focus ($P = .099$). There was also a trend in which 38.1% ($n = 8$) of LIC students versus 17.4% ($n = 4$) of non-LIC students affirmed discussing cost considerations during plan formulation ($P = .179$; Table 2).

DISCUSSION

Development of a de novo medical student clerkship in POM provided us the opportunity to creatively match innovative changes in education with transformative changes in anesthesiology. The common unifying theme for our program was adoption of a longitudinal approach to teaching. Within anesthesiology, Grocott and Mythen²⁶ described POM as "the practice of patient-centered, multidisciplinary, and integrated medical care of patients from the moment of contemplation of surgery until full recovery." Within medical student education, Poncelet

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et al¹³ identified continuity of patient care across multiple disciplines as a core principle of LICs. We successfully matched the complementary nature of longitudinal learning to the longitudinal care of surgical patients as assessed by student evaluations.

Improving the quality of medical care while simultaneously reducing cost is the embodiment of health care innovation. It is widely recognized that this is best achieved by transitioning from a series of isolated episodes of patient care to a well-orchestrated, cohesive, multidisciplinary plan of care.^{27,28} Anesthesiology has been an early adopter of this strategy with the PSH.⁹ Having anesthesiologists involved in all phases of perioperative care and in charge of coordination of care is a departure from the traditional role of the anesthesiologist. Academic anesthesiology departments are addressing this problem with significant redesigns of their residency programs to provide education in POM.¹⁰ Educating medical students in POM has been described less,²⁹ but would theoretically offer the same benefit for future physicians.

Our results suggest that LIC-students reaffirmed that they preferred having a longitudinal experience versus a traditional block schedule (Table 2). LICs that allow students to follow patients through multiple episodes of care have been shown to be better or equal to traditional curriculums in teaching clinical skills.^{3,13,14,22} These curriculums have been demonstrated to improve student and patient satisfaction.^{13,30} There have been calls to incorporate anesthesiology clerkships into LICs for medical students,³ though few outcomes have been reported thus far.

We were able to create an elective 4-week advanced clerkship structure that allowed students to follow patients from the PAC to the operating room, to the ward, and ultimately to home. Our program has demonstrated the feasibility of embedding LIC principles within the current medical student anesthesiology education system. We offer an elective 2-week introductory anesthesiology clerkship for students who have completed either the core medicine or surgery clerkship. At other sites, it is offered as a 2-week subspecialty during the core surgery clerkship. It is encouraged,

but not mandatory, that students take the introductory anesthesiology clerkship prior to taking the PAC clerkship. During the PAC clerkship, students are able to obtain letters to support their residency applications. Other clerkship offerings include 4-week advanced anesthesiology, 2-week pain medicine, 2 to 8 week research, and 4-week cardiac intensive care unit electives.

It is interesting that none of the participating students were planning on becoming a primary care physician, and currently these physicians provide the majority of preoperative assessments. In addition, 1 of the students indicated that LICs were not attractive to students interested in procedural specialties due to constraints of exposure to procedural specialties. We theorize that the PAC clerkship could fill 2 needs: educating students in perioperative care and allowing students less likely to participate in an LIC to benefit from the educational principles in following patients longitudinally.

It is important to note that incorporating advanced learning techniques into the clerkship design allowed for creation of a new medical student experience with limited additional resources. No additional clinic space, time for student-patient encounters, or dedicated teaching time was made available. Participating staff had little increase in their daily work, yet students universally reported appreciation for POM and the role of patient-centered care. Students not intending to specialize in anesthesiology reported new appreciation for the role of the anesthesiologist.

The report is primarily observational and thus has several limitations. The small study size (N = 6) that skewed towards men versus women is a consequence of the pilot rollout. Staged implementation was planned to assess the effect of the rotation on clinic operations. Larger numbers will be available for assessment in the future now that proof of concept has been established. During the subsequent academic year, 4 women and 4 men completed the clerkship. The reported results are subjective. More structured preclerkship and postclerkship testing is planned in the future to improve objective assessment of students' understanding of the principles of POM.

Future research direction includes examining which perioperative practices were incorporated into the practices of students who completed the clerkship and examining the practices of anesthesiology residents who took the clerkship versus those who did not.

CONCLUSIONS

We have described the successful implementation of a longitudinal learning experience in POM for advanced medical students that emulates and promotes the PSH. Further research will be needed to verify its applicability on a larger scale.

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Abstract

Introduction: Leaders in anesthesiology are promoting increased involvement of anesthesiologists in perioperative medicine (POM). Academic leaders are calling

for a corresponding increase in resident and medical student education in this evolving medical discipline. Formalized POM programs are new to most academic anesthesiology programs, and very little has been written about development of these programs for anesthesiology residents or medical students. We describe the creation of a longitudinal medical student clerkship in POM using established curriculum design methods with minimal capital resources.

Methods: This is a descriptive account of the process of clerkship design. It includes a qualitative analysis of participants' satisfaction with the novel clerkship.

Results: Design and implementation of a new, advanced medical student clerkship in POM using no additional capital resources was successful. Medical students indicated appreciation for the unique longitudinal design. Students also demonstrated understanding of the expanding role of anesthesiology in perioperative care of patients, a primary goal of the educational process.

Conclusions: The principles of the American Society of Anesthesiology's Perioperative Surgical Home can be taught systematically and successfully to advanced medical students with little additional expenditure of departmental resources.

Keywords: Perioperative medicine, anesthesiology, medical student, curriculum, longitudinal

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Appendixes

Appendix A. Longitudinal approach for medical student learning in the perioperative setting

Indicate your level of agreement with the following statements.

	<i>Strongly disagree</i>	<i>Somewhat disagree</i>	<i>Neither agree nor disagree</i>	<i>Somewhat agree</i>	<i>Strongly agree</i>
The delivery of health care is undergoing significant changes.					
I am concerned about the future of health care delivery.					
My clinical educators are teaching me about the health care industry.					
My clinical educators are teaching me about population health.					

When caring for patients during your clerkships so far, how often:

	<i>Never</i>	<i>Sometimes</i>	<i>About half the time</i>	<i>Most of the time</i>	<i>Always</i>
Is the cost of care considered during the formulation of the care plan?					
Do you have more than 1 encounter with the same patient?					

For the next set of questions, please consider your experiences during a surgery rotation.

Please indicate the extent to which you agree with the following statements.

	<i>Strongly disagree</i>	<i>Somewhat disagree</i>	<i>Neither agree nor disagree</i>	<i>Somewhat agree</i>	<i>Strongly agree</i>	<i>N/A I haven't had a surgery rotation</i>
I prefer longitudinal experiences over block rotations.						
I prefer didactic sessions on a computer-based learning platform over attending in person.						
I prefer frequent, brief discussions with an attending over shadowing experiences.						

In your experience, what were the primary factors taken into consideration when creating a care plan for surgical patients?

While on rotation, what was the primary focus of care you were taught when caring for a surgical patient?

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Appendixes continued

Appendix B: Interview Questions

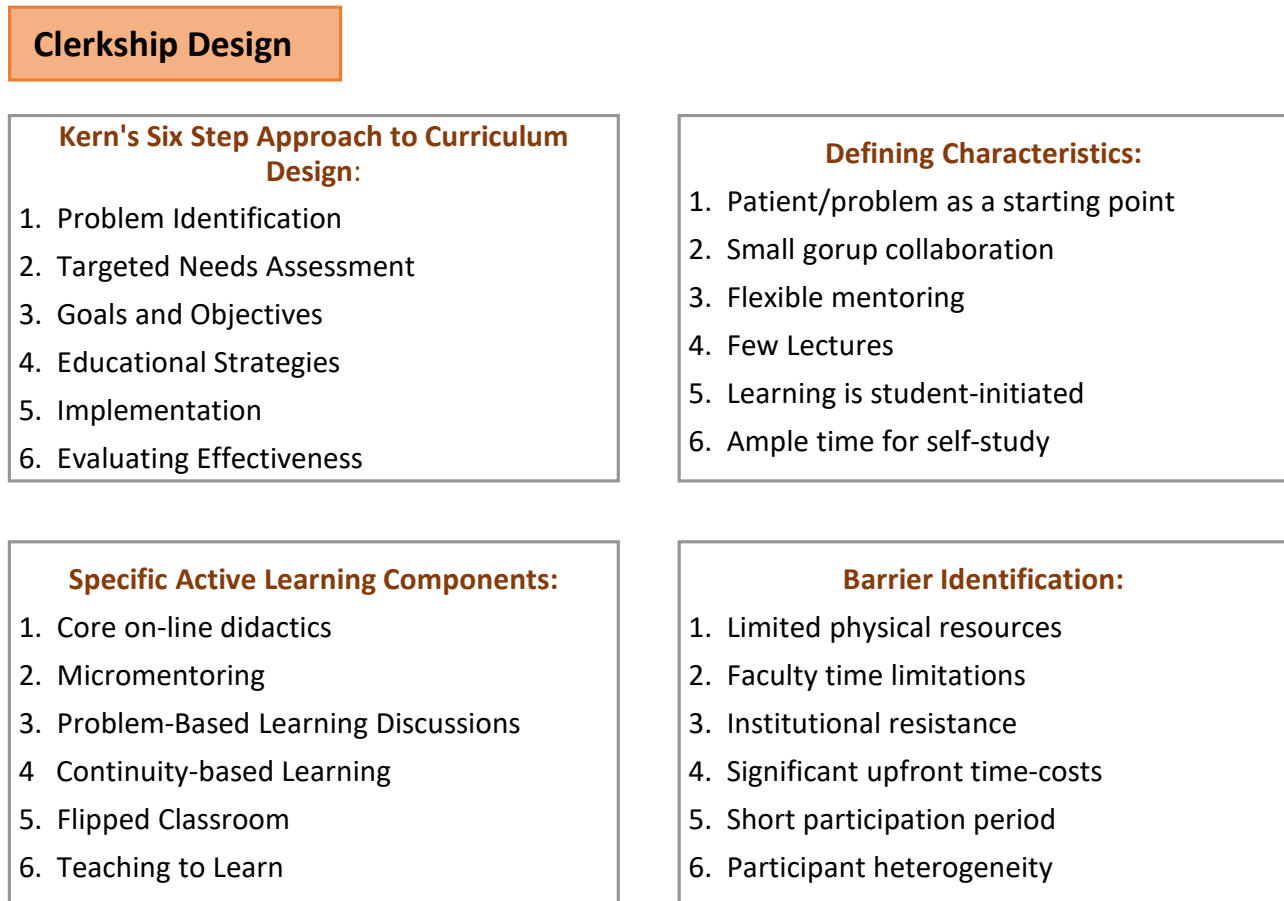
1. What makes a clerkship a “good” experience?
2. What makes a clerkship a “bad” experience?
3. What changes in health care do you think will take place in the next 6 months? 5 years?
4. Why did you choose to take ANES [Anesthesiology] 7187?
5. What did you like most about the clerkship?
6. What did you think the clerkship could improve?
7. Most memorable experience?
8. What was it like to follow your patient throughout their whole perioperative course?
9. What were the biggest learning points from this clerkship?
10. How has this clerkship shaped the way you will practice?

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Figures

Figure 1. Components of clerkship design.

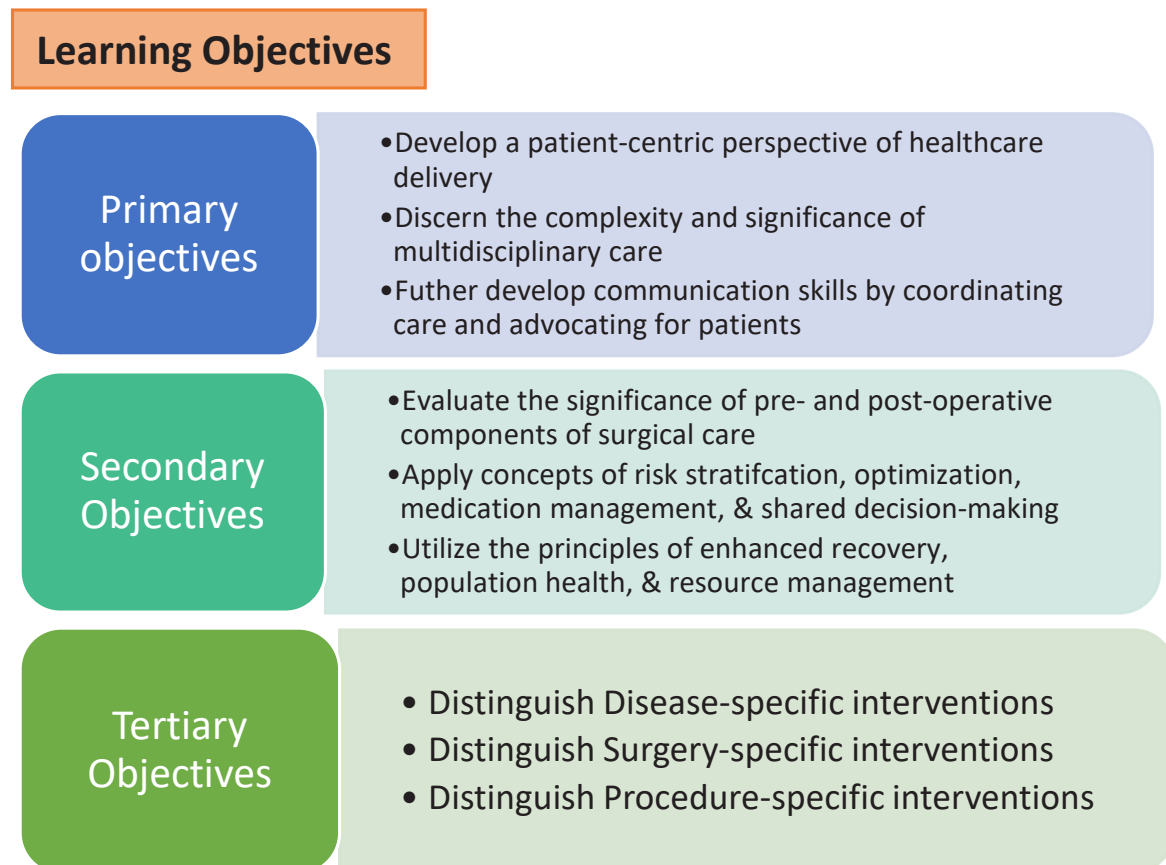


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Figure 2. Preoperative assessment center (PAC) clerkship objectives.



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Figure 3. Implementation timeline of clerkship.

Implementation

Learning Platform Development:

1. University-endorsed learning management platform utilized to create a digital learning environment
2. Directed reading curriculum developed from current literature covering 11 key topics
3. Formed a catalog of Problem-Based Learning Discussions for easy accessibility
4. Assembled multimedia collection of relevant podcasts, videos, and PowerPoint presentations
5. Individualized learner database established to allow learners to track patient interactions
6. Creation of Pre- and Post-tests

Week One:

- Take Pre-test
- Learn fundamentals of risk assessment & optimization
- Daily interaction with PAC patients & mentoring faculty

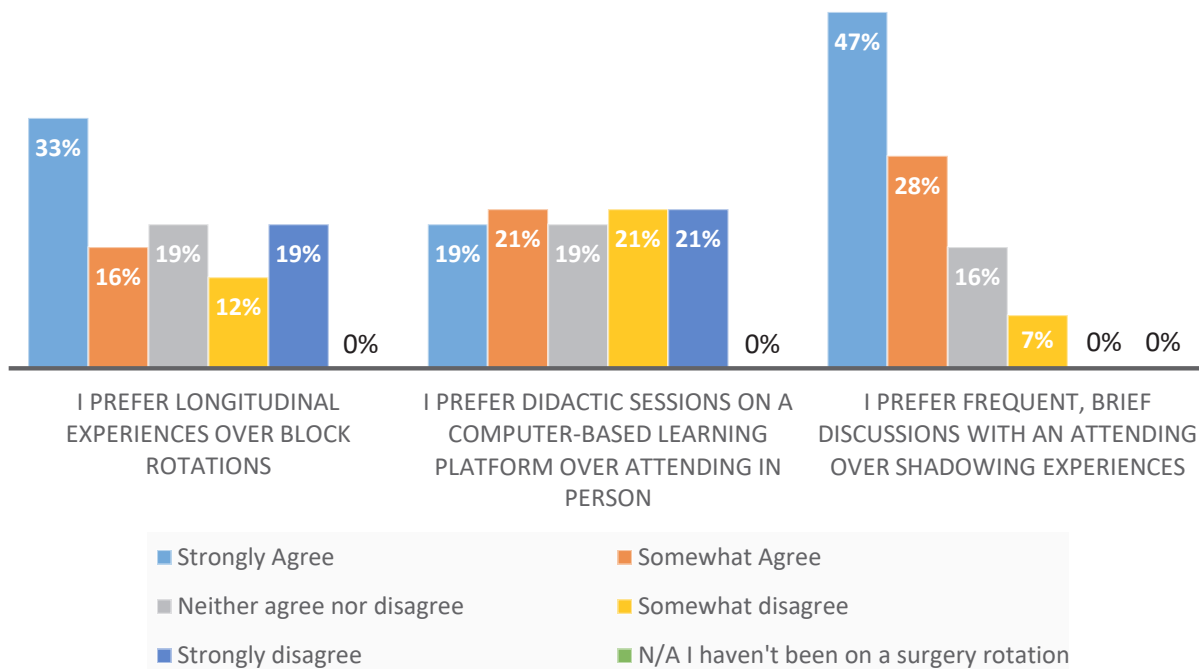
Weeks Two to Four:

- Follow previously seen PAC patients to OR
- Follow patients post-operatively until discharge
- Follow-up call to discharged patients
- Return to PAC daily to discuss experience with faculty and see new PAC patients

Final Day:

- Take Post-test
- Debrief and give feedback with primary faculty mentor

Figure 4. Medical students' preferences in learning experiences.



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Tables

Table 1. Notable Medical Student Comments Regarding the Perioperative Medicine Clerkship

Student's Anticipated Specialty	Comments From the Post Hoc Interview
Anesthesiology	"Anesthesiologists think the role of anesthesia is evolving ... (into) more of a perioperative physician."
	"Seeing where the future of anesthesia is, more like a perioperative field I wanted ... more experience in that."
	"Expansion of responsibilities and the role of anesthesiology ... that is something I would never have anticipated saying ... at the beginning of medical school."
Procedure-based Specialty	"I enjoyed it ... because on a lot of my rotations thus far, you met with the patient on the day of the procedure and hardly got a chance to get to know them. It just made it more of a personal experience and I actually felt like I was ... an attending in some ways because I had a list of my patients that I was following, rounding on individually and that was a really unique experience that I hadn't gotten..."
	"We got to optimize patients in the perioperative care clinic ... the one thing I think about is I want to be operating on the ideal patients and want the best outcomes possible."
	"I feel like sometimes when we have all these different rotations, we kind of go from one place to another and then you don't really see how the patient got to where they are. So I would say that's ... one of the highlights for that rotation."

Table 2. PAC Survey Results Comparing UMN Third- and Fourth-year Students Who Participated in an LIC Versus Those Who Did Not

Covariate	Overall	No LIC	LIC	P Value
	(N = 44), n (%)	(n = 23), n (%)	(n = 21), n (%)	
MS year 4	20 (45.5)	9 (39.1)	11 (52.4)	.545
Male	25 (56.8)	13 (56.5)	12 (57.1)	1.000
Age, y (SD)	27.6 (2.29)	27.9 (2.32)	27.4 (2.29)	.487
1. Health care delivery undergoing significant changes	35 (79.5)	18 (78.3)	17 (81.0)	1.000
2. Concerned about future of health care delivery	32 (72.7)	15 (65.2)	17 (81.0)	.318
3. Clinical educators teach about health care industry	24 (54.5)	13 (56.5)	11 (52.4)	1.000
4. Clinical educators teach about population health	27 (61.4)	14 (60.9)	13 (61.9)	1.000
5. Cost of care considered during care plan formulation	12 (27.3)	4 (17.4)	8 (38.1)	.179
6. Have multiple encounters with same patient	18 (40.9)	8 (34.8)	10 (47.6)	.541
7. Prefer longitudinal experience over block rotations	22 (50.0)	4 (17.4)	18 (85.7)	<.001
8. Prefer didactic session on computer-based learning platform (agree vs neither/disagree)	18 (40.9)	7 (30.4)	11 (52.4)	.220
9. Prefer frequent, brief discussions over shadowing experiences (any level of agreement vs neutral/disagreement pertaining to 1-9)	33 (75.0)	16 (69.6)	17 (81.0)	.494
10. Focus during caring for surgical patient: patient-related comments	13 (29.5)	4 (17.4)	9 (42.9)	.099

Abbreviations: LIC, longitudinal integrated curriculum; MS, medical school; SD, Standard Deviation; UMN, University of Minnesota.