

Integrated Critical Care Curriculum for the Third-Year Internal Medicine Clerkship

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Abstract

Introduction: A majority of residents provide care for critically ill patients, yet only a minority of medical schools require ICU rotations. Therefore, many medical students enter residency without prior ICU experience. The third-year internal medicine (IM) clerkship at our institution's Veterans Affairs Medical Center (VAMC) provided an opportunity for medical students to rotate through an open ICU as part of their inpatient ward rotation. Prior to March 2019, no structured critical care curriculum existed within the IM clerkship to prepare students for this experience. **Methods:** We created a seven-session ICU curriculum integrated within the VAMC IM clerkship addressing core critical care topics and skills including bedside presentations, shock, and respiratory failure. IM residents facilitated the curriculum's case-based, small-group discussions. We assessed curricular efficacy and impact with a pre- and posttest and end-of-curriculum survey. **Results:** Forty-one students participated in the curriculum from March to November 2019. As a result, students agreed that their overall clerkship experience improved (73% *strongly agree*, 24% *agree*). Students also reported increased comfort in their ability to participate in the management of critically ill patients (44% *strongly agree*, 51% *agree*). Objectively, student performance on a 15-question pre- and posttest improved from a precurricular average of 7.5 (50%) questions correct to a postcurricular average of 10.7 (71%) questions correct ($p < .0001$; CI 2.2-4.4). **Discussion:** Following implementation of our ICU curriculum, medical student attitudes regarding overall IM clerkship experience, self-perceived confidence in critically ill patient management, and medical knowledge all improved.

Keywords

ICU, Intensive Care Unit, Chalk Talk, Critical Care Medicine, Internal Medicine, Case-Based Learning

Educational Objectives

By the end of this activity, learners will be able to:

1. Apply a standardized approach to rounding presentations in the medical ICU.
2. Describe a physical exam-based approach for working through the differential diagnosis in an undifferentiated shock patient.
3. Describe the management for a patient with septic shock, including IV fluid resuscitation, appropriate antibiotics, and vasopressors.
4. Describe the management for a patient in cardiogenic shock, including inotropes, afterload reduction, and diuresis.
5. Describe the management for a patient with hemorrhagic shock from an acute gastrointestinal bleed, including volume resuscitation, blood transfusion thresholds, and adjunctive therapies utilized for patients with cirrhosis.
6. Identify patients with acute respiratory failure that may benefit from noninvasive positive pressure ventilation.
7. Identify indications for intubation and mechanical ventilation.

Introduction

As described by the core Entrustable Professional Activities (EPAs) outlined by the AAMC, a medical school graduate must be able to "recognize a patient requiring urgent or emergent care and initiate evaluation and management."¹ Included in the specific functions of this EPA are the abilities to "recognize normal vital signs and variations," "recognize severity of a patient's illness and indications for escalating care," and to "start initial care plan for the decompensating patient."¹ Despite this AAMC recommendation, formalized critical care education during medical school is limited. As of 2015, only 46 of

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136 (34%) surveyed medical schools required ICU rotations during a student's fourth year.² Furthermore, prior research in student decision-making regarding fourth-year course selection revealed significant fear and anxiety surrounding the choice to pursue an ICU rotation.³ Regardless of student participation in an ICU course during medical school, a majority of resident physicians are required to care for the critically ill by the ACGME. The six largest residency specialties (internal medicine, family medicine, pediatrics, general surgery, emergency medicine, and anesthesiology) all require residents to provide care for critically ill patients during their training.⁴⁻⁹ In total, the aforementioned groups encompass 64% of all currently practicing residents.¹⁰

At the University of Colorado, similar to the national landscape, there is significant variability in the exposure to formalized critical care education. The University of Colorado internal medicine (IM) third-year clerkship at the Rocky Mountain Regional Veterans Affairs Medical Center (VAMC) provided an opportunity for medical students to rotate through an ICU as part of an open-ICU staffing model. An open-ICU staffing model allows an inpatient medical team to care for patients simultaneously on the floor and in the ICU, as opposed to a closed-ICU model in which critically ill patients are managed exclusively by an intensivist and dedicated ICU service. Prior to March 2019, no structured critical care curriculum existed within the IM clerkship to prepare third-year students for this added ICU experience. Furthermore, a designated ICU course is not a clinical requirement for medical students at our institution. Many medical students miss the opportunity to develop the knowledge and skills necessary to care for the critically ill patient prior to graduation. As currently constructed, the VAMC IM clerkship may represent a student's only formal exposure to critical care medicine prior to residency training.

A needs assessment of students, residents, and faculty at our institution identified a need for increased education in core critical care topics and skills for third-year students during the VAMC IM rotation. Specifically, our assessment highlighted existing skill deficiencies surrounding bedside presentations during ICU teaching rounds, and knowledge gaps regarding support devices, shock, and respiratory failure. Furthermore, there is a paucity of literature describing educational strategies aimed at developing knowledge and skills in critical care targeted toward the third-year medical student. A review of existing resources on *MedEdPORTAL* utilizing the search terms "critical care" or "ICU" returned 16 results, of which only four resources pertained to medical student education. Three of these student-targeted curricula focused on pediatric critical care,¹¹ preparation

for surgical residency,¹² and palliative care.¹³ The most relevant resource published by Luks et al in 2011 described a 10-week course offered to second-year medical students during the preclinical training period.¹⁴ A review of Ovid MEDLINE utilizing the terms "critical care" or "ICU" and "medical student" and "curriculum" yielded no relevant results. To our knowledge, there are no critical care curricula or resources specifically designed for third-year clerkship students available in *MedEdPORTAL* or in the broader literature.

To address this local and national gap in critical care education, we created an integrated critical care curriculum within the third-year IM clerkship at the VAMC. Our curriculum represents the first integrated critical care resource designed for third-year learners rotating through an IM clerkship with an open ICU. We designed the curriculum as a series of small-group, case-based chalk talks. A chalk talk is an educational format in which an instructor utilizes a whiteboard to convey learning objectives in real time by diagramming key concepts and writing high-yield points. Our primary goal was to improve the student experience during the IM clerkship. Secondary goals included improving attitudes regarding self-perceived confidence in critically ill patient management and objective knowledge of core critical care topics.

Methods

Curricular Context

We integrated our curriculum within the third-year IM clerkship at the VAMC site. Third-year medical students rotated at the VAMC for 4-week periods during their IM clerkship. Similar to other VAMCs, our institution's VAMC utilized an open-ICU staffing model. Due to this open-ICU model, the VAMC is the only IM clerkship site at the University of Colorado at which third-year students provided care for critically ill patients.

Implementation

We constructed a seven-session curriculum, delivered twice per week during the first 3 weeks of the students' VAMC rotation, and once during the fourth and final week. Existing educational commitments limited student availability to 3 afternoons per week during the first 3 weeks, and 2 afternoons during the final week. Consequently, we developed a seven-session curriculum to comply with student availability. We selected topics based on our institution's needs assessment and review of the existing Clerkship Directors in Internal Medicine IM clerkship educational objectives, which required students to care for patients with gastrointestinal (GI) bleeding, heart failure, chronic obstructive pulmonary disease, and sepsis.¹⁵ Our group developed critical

care-focused content as a natural extension of these existing objectives. Curriculum sessions occurred in a conference room with a whiteboard and lasted approximately 30 minutes. Second- and third-year IM residents and pulmonary and critical care medicine (PCCM) fellows led curricular sessions. Our curriculum specifically prioritized the participation of residents and fellows as educators in order to increase availability of small-group teaching opportunities during their training.

To ensure facilitator availability for every session, we emailed the dates of teaching sessions to all second- and third-year IM residents rotating at the VAMC 1 week prior to the start of their VAMC rotation. If facilitator spots remained open following this inquiry, we queried IM residents within our institution's clinician-educator pathway or the PCCM fellow at the VAMC. We encouraged facilitators to lead multiple sessions if interested. Notably, this process ensured complete staffing of all sessions throughout the implementation process and created the opportunity for a total of seven different facilitators to participate over a 4-week rotation.

Following the scheduling period, we sent all facilitators the facilitator guide (Appendix A). Our group developed this guide in response to student feedback following preliminary implementation to assist facilitators in the creation of their chalk talks while ensuring delivery of key curricular content. The facilitator guide provided a step-by-step walkthrough of each session's educational objectives along with corresponding definitions, clinical examples, and teaching ideas for various learning points. We encouraged facilitators to utilize the guide when preparing for each session.

We introduced the curriculum and provided the syllabus to students via email 1 week prior to the start of their VAMC rotation (Appendices B and C). The first session of the curriculum, entitled Introduction to the ICU, occurred on the second day of the 4-week rotation. This session described services provided by the ICU, reviewed illnesses requiring ICU-level care, and demonstrated a systematic approach to bedside ICU rounding presentations. At the conclusion of the session, we provided students a pocket-sized laminated placard entitled ICU Presentation Template (Appendix D). The placard served as a quick reference guide for the remainder of the clerkship. At the conclusion of the initial session, students also received the ICU Student Handout, a comprehensive handout with high-yield learning points outlining future sessions (Appendix E). We designed the handout as both a reference tool and note-taking template based on student feedback following preliminary implementation.

The second session covered IV access, central venous catheters (CVC), and endotracheal tubes (ETT). During this session, students practiced pushing fluids through peripheral IVs and CVCs to demonstrate Poiseuille's Law. Students also reviewed the parts of an ETT and practiced inflating the cuff of the ETT. The third session defined acute respiratory failure and reviewed indications for noninvasive positive pressure ventilation (NIPPV). During this session, students also reviewed contraindications to NIPPV and indications for endotracheal intubation. The fourth session, entitled Introduction to Shock, defined shock, described clinical manifestations of shock, and provided students with the SHOCK+AWE physical exam-based approach to the undifferentiated shock patient (Appendix E, page 4). Utilizing the SHOCK+AWE framework, the remainder of the curriculum covered principles of management of septic shock (fifth session), hemorrhagic shock in the context of acute gastrointestinal bleed (sixth session), and cardiogenic shock (seventh session). Facilitators taught all curricular sessions as small-group, case-based chalk talks using the information provided in the facilitator guide (Appendix A).

Facilitators and students participated on a voluntary basis. Student participation in our curriculum did not affect clinical grade determination. Our curriculum did not meet the definition for human subject research and, thus, did not require approval by the University of Colorado Institutional Review Board.

Evaluation

We assessed curricular efficacy with regard to medical student attitudes with a novel 13-question end-of-curriculum survey (Appendix F). Ten questions assessed level of agreement on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*), while three questions allowed for open-ended responses. We constructed the survey to focus on respondent attitudes regarding overall clerkship experience, confidence in critically ill patient management, likelihood of pursuing critical care in the future, and the logistics of curriculum delivery. Following development, we reviewed survey content with medical students that had previously completed the VAMC IM clerkship rotation to determine if questions aligned with student experience and if respondent interpretation of items matched expectations. Educators with experience in curriculum development reviewed the final version of the survey prior to dissemination. Following the final session, students completed the end-of-curriculum survey via Qualtrics, an online survey tool.

Beginning in July 2019, we incorporated pre- and posttests into the curriculum to assess objective knowledge gains of core critical care topics. The 15-question pre- and posttests consisted

of nine resident-level questions from the Medical Knowledge Self-Assessment Program and six student-level questions from *IM Essentials*.^{16,17} We selected previously published and expert-reviewed content-specific questions to ensure evaluation accuracy. Students completed the pretest on the first day of their rotation following the initial VAMC site orientation. Students completed the posttest following the final curriculum session during the fourth week of their rotation.

Results

Fifty-six third-year medical students rotated through the VAMC from March 2019 to November 2019. An average of five students participated in our curriculum per 4-week clerkship rotation. From July to November 2019, we collected data regarding the total number of curriculum sessions attended by each student. During this time period, 56% of students attended six or seven sessions, 37% attended four or five sessions, and 7% attended two or three sessions. IM residents taught 95% of curriculum sessions. PCCM fellows taught 5% of sessions.

Overall, 41 students (73%) completed the end-of-curriculum survey. Students agreed that their overall clerkship experience improved as a result of our curriculum (73% *strongly agree*, 24% *agree*; Table). With regard to attitudes, students reported increased comfort in their ability to participate in the management of critically ill patients (44% *strongly agree*, 51% *agree*) as well as increased comfort presenting a patient during teaching rounds in the ICU (41% *strongly agree*, 41% *agree*). Students also reported an increased likelihood of applying for an ICU subinternship during their fourth year of medical school (24% *strongly agree*,

32% *agree*) and a higher likelihood of pursuing a specialty in which they could practice critical care medicine (20% *strongly agree*, 32% *agree*). From a curriculum delivery perspective, students found session topics applicable to their clerkship experience (71% *strongly agree*, 27% *agree*), appropriate in duration (68% *strongly agree*, 27% *agree*), and appropriate for their level of training (73% *strongly agree*, 24% *agree*). Overall, students found protected educational time for our curriculum a valuable part of their clerkship experience (66% *strongly agree*, 32% *agree*).

A thematic analysis of the open-ended response portion of the end-of-curriculum survey revealed the following themes:

- The benefits of early exposure to critical care medicine:
 - “This material isn’t taught anywhere else and it provided a brief review, built on what we know as a framework, and ultimately taught us an outline and approach to management of ICU patients.”
 - “Exposure to topics that are not well-covered in medical school didactics.”
 - “It was helpful and concise. Explained a lot of concepts I would have otherwise never learned.”
 - “Really helped to clarify topics that were frequently confused previously; very helpful for the shelf and moving forward.”
- The advantages of small-group, case-based chalk talks:
 - “The small-group, chalk talk nature. I thought there was a good flow to the series and that each talk built off each other.”

Table. End-of-Curriculum Survey Results (N = 41)

Statement	Strongly Agree (%) ^a	Agree (%) ^a	Neither Agree Nor Disagree (%) ^a	Disagree (%) ^a	Strongly Disagree (%) ^a	M (SD) ^b
The critical care curriculum improved my overall VA internal medicine clerkship experience.	73	24	0	2	0	4.7 (0.6)
As a result of the critical care curriculum:						
I am more comfortable presenting a patient during teaching rounds in the MICU.	41	41	15	2	0	4.2 (0.8)
I am more comfortable participating in the medical management of critically ill patients.	44	51	2	2	0	4.4 (0.7)
I am more likely to apply for a MICU sub-internship during my fourth year of medical school.	24	32	34	7	2	3.7 (1.0)
I am more likely to select a specialty in which I can practice critical care medicine.	20	32	39	7	2	3.6 (1.0)
I am inspired to create my own chalk talks for future teaching opportunities.	42	29	24	2	2	4.1 (1.0)
The session topics were applicable to my clerkship experience.	71	27	2	0	0	4.7 (0.5)
The duration of the sessions was appropriate.	68	27	2	2	0	4.6 (0.7)
Protected time for the critical care curriculum was a valuable part of my VA internal medicine clerkship experience.	66	32	0	2	0	4.6 (0.5)
The material was presented in a manner that was appropriate for my level of training.	73	24	2	0	0	4.7 (0.5)

Abbreviations: VA, veterans affairs; MICU, medical intensive care unit.

^aPercentages may not total 100% due to rounding.

^bLevel of agreement assessed on 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

- “The case-based approach was a useful framework for each session.”
- “The small-group nature of the sessions made asking questions comfortable.”
- “Intimate, structured Q&A feel.”
- “I really enjoyed the content and being able to think through concepts as a group.”
- The importance of residents as educators:
 - “Excellent teachers; able to connect with [residents] and ask questions without the pressure of rounds/patient care.”
 - “I loved the one-on-one interaction with residents ...in a low-pressure environment.”
 - “Being taught by the residents was great.”
- The necessity of developing an organized, efficient curriculum:
 - “Short presentations but very high-yield topics. Loved coming to these sessions.”
 - “I enjoyed how efficient these sessions were. They were informative but also quite quick, which made for a great learning opportunity.”
 - “Succinct and clear explanations; handouts were fantastic and presented in an easy-to-consume way.”
 - “The brevity but clarity was perfect.”
 - “Material laid out in a format that helped me organize topics in my mind and was not too in depth or overwhelming.”
 - “The organized teaching to our level with diagnosis and management outlines.”

Between July and November 2019, we offered our curriculum to all 32 students that rotated through the VAMC. All 32 students completed the pretest and, of these, 27 (84%) completed the posttest. We utilized posttest completion as a marker of curriculum participation during this time period. Overall, student testing performance improved from a precurricular average of 7.5 (50%) questions correct to a postcurricular average of 10.7 (71%) questions correct (mean improvement of 3.2 questions correct, 21%, $p < .0001$, CI 2.2-4.4).

Discussion

An integrated ICU curriculum within the third-year IM clerkship improved the overall clerkship experience for students while providing foundational training and exposure to core topics in critical care medicine. Following curriculum implementation, we observed an improvement in medical student attitudes regarding self-perceived confidence in critically ill patient management, heightened interest in further ICU training, as well as improved

objective knowledge. Students found that the small group, chalk talk nature of our curriculum provided the opportunity to learn in a relatively informal, low-pressure situation compared to typical bedside ICU teaching rounds. In addition, students consistently and overwhelmingly agreed that our curriculum provided applicable, efficient, and appropriate content for their level of training. Ultimately, our novel curriculum demonstrated that it was both feasible and beneficial to provide students with an early introduction to critical care medicine while rotating through an IM clerkship site that utilizes an open-ICU staffing model.

Students emphasized the importance of residents as educators during the IM clerkship. Our curriculum created seven unique teaching opportunities per 4-week rotation for IM residents and PCCM fellows to practice chalk talk delivery, develop small-group facilitation skills, and gain experience as educators. In addition, our curriculum allowed residents in our institution's clinician-educator pathway to gain valuable, hands-on teaching experience.

Scheduling of sessions and facilitators proved to be one of the more difficult aspects of implementation. After trialing several time slots, we found session attendance highest on Monday and Tuesday afternoons. We also found greater success scheduling facilitators if we reached out 1 week prior to the first curriculum session. Ultimately, many facilitators expressed interest in leading multiple sessions, which improved rapport and engagement with students. For future groups interested in implementing our curriculum, we recommend establishing a curriculum coordinator role for one to three IM residents. Coordinator responsibilities would include facilitator scheduling, communicating with students, and collecting evaluation materials.

Our curriculum had several limitations. The curriculum was designed for incorporation into IM clerkships with access to an open ICU. We recognize that the majority of academic medical centers employ a closed-ICU model that typically precludes ICU exposure for third-year students on non-ICU rotations. A significant number of medical schools utilize VAMCs as a clinical site for at least part of the IM clerkship. VAMCs commonly employ an open-ICU staffing model offering the opportunity for the widespread application of our curriculum. The subject content and educational strategies of our curriculum could similarly be applied during a dedicated ICU rotation. Our curriculum objectives focused on knowledge acquisition of core critical care topics and development of skills to improve bedside rounding presentations. Our evaluation methods predominantly captured attitudes and perceptions of the learner. We created the pre- and

posttest to address this limitation, but only applied the testing component to students who participated in the curriculum from July to November 2019. As currently constructed, we cannot determine whether the benefits of our curriculum translated to student performance improvement during the IM clerkship, as our evaluation methods focused solely on attitudes and knowledge. We intend to address this limitation by modifying our current evaluation strategy to include direct observation of bedside presentations and simulation performance. Improvements in medical student attitudes and knowledge may be confounded by the maturation effect associated with rotating through an open ICU for a 4-week period. This limitation could be addressed in the future by utilizing a control group at an IM clerkship site without ICU exposure. Finally, our knowledge assessment tool utilized previously published questions, limiting the generalizability due to copyright protections.

Since implementation in March 2019, we fully incorporated our curriculum into the framework of the third-year IM clerkship rotation at the VAMC site. Our curriculum improved the overall clerkship experience while positively impacting both attitudes and knowledge of critical care medicine. Future directions include utilizing the chalk talks as primers for high-fidelity simulation scenarios, as well as creating electronic learning content such as videos to promote wider dissemination and a flipped classroom approach. We also intend to collect data from prior student participants to determine whether our curriculum ultimately affected decisions to pursue ICU rotations during their fourth-year or impacted their choice of career specialty. Overall, our integrated critical care curriculum is the first resource specifically designed to maximize the benefits of an open ICU for third-year learners and represents one possible avenue for addressing both local and national gaps in critical care education prior to residency training.

Appendices

- A. Facilitator Guide.docx
- B. Student Welcome Email.docx
- C. ICU Curriculum Syllabus.docx
- D. ICU Presentation Template.pdf
- E. ICU Student Handout.pdf
- F. End-of-Curriculum Survey.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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Prior Presentations

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Ethical Approval

Reported as not applicable.

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