

Enhancing teaching and learning in the ICU

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Editor's note: The intensive care unit (ICU) in a hospital is a busy and complex environment for patients, families, staff and learners. In this toolbox article, the authors consider the best ways to ensure that learning is promoted as the needs of critically ill patients are optimally met. There is a set of five practical and evidence-based strategies based on the literature and the authors' experiences of working in ICUs. The toolbox content is not all necessarily specific to the ICU but is also relevant for other clinical working and learning spaces. The strategies include: creating a positive learning environment through educator enthusiasm and a team approach; emphasising interprofessional and interspecialty learning; focusing on important topics in intensive care, including communication with staff and families or carers and involving family members in the teaching; applying evidence-based teaching, such as fostering critical thinking and the appropriate use of time and technology; and making best use of the 24-hour environment, including evening and night shifts. The authors include examples of a 1-minute preceptor activity and mini-chalk talks.

We identify practical, efficient and evidence-based strategies to enhance teaching

INTRODUCTION

In the USA, most medical trainees, independent of specialty, spend time in the intensive care unit (ICU) during residency.¹ For many of them, this occurs during their formative first postgraduate or intern year. Caring for critically ill patients in a fast-paced and

high-acuity setting in a multi-disciplinary team provides a unique atmosphere for learners, with the potential for rich educational experiences. This environment however, poses challenges for clinician-educators. All clinical teachers face time pressure, but in the ICU this pressure is magnified. Clinical teachers in the ICU

must balance caring for critically ill patients requiring time-sensitive clinical decisions with teaching in the midst of varying shift-work schedules for residents, fellows and faculty members.

In this toolbox article, we identify practical, efficient and evidence-based strategies to

enhance teaching and learning in the ICU setting. These were developed from a review of the literature, informed by our own experiences as trainees and educators in the ICU and revised based on iterative review. We highlight five strategies for ICU education, describe practical tools for each (summarised in Table 1) and share an example schedule of a day in the ICU focused on teaching moments (Box 1). Although we focus exclusively on the ICU, many of our recommendations can be applied to other clinical settings.

Create a positive learning environment

- Display enthusiasm for clinical reasoning
- Emphasise a team approach and model respect for all team members

As team leaders, ICU subspecialty trainees and attending physicians (or consultants) set the tone for the learning environment in the ICU. It is important that they demonstrate curiosity, encourage intellectual discourse and promote psychological safety (defined as ‘a shared belief that a team is a safe space for interpersonal risk taking’) to create a positive, cohesive and productive educational experience.² Trainees value specific behaviours of esteemed ICU educators, including displays of enthusiasm for the subject matter, explication of clinical reasoning, demonstration of compassion towards patients and families, and the practice of respect towards others.³ Emphasising the roles and contributions of all ICU team members will serve to cultivate mutual appreciation and a positive learning environment.⁴ In addition to modelling these

behaviours, ICU educators should explicitly identify education as a priority for the entire team, not just during rounds but throughout the entire day. This reinforces the potential for learning outside of the traditional rounds model and encourages team members to take advantage of unique teaching scenarios as they arise.

... ICU educators should explicitly identify education as a priority for the entire team ...

Champion opportunities for interprofessional teaching

- Recognise the expertise of all professionals within the multidisciplinary team
- Collaborate with physicians of other specialties

By virtue of providing advanced interprofessional patient care, the ICU team offers excellent opportunities for interprofessional education. We recommend leveraging the expertise of other ICU

Table 1. Five strategies for ICU teaching

Create a positive learning environment

- Display enthusiasm for clinical reasoning
- Emphasise team approach and model respect for all team members

Examples

- Demonstrate curiosity and promote interpersonal risk-taking
- Welcome input from all providers

Champion opportunities for interdisciplinary teaching

- Recognise expertise of all professionals within the multidisciplinary team
- Collaborate with physicians of other specialties

Examples

- Invite teachers from other specialties and professions to teach trainees
- Encourage teaching opportunities outside of rounds (e.g. night-time)

Focus on requisite ICU topics

- Integrate practical procedural and ultrasound teaching
- Prioritise training in high-stakes communication scenarios

Examples

- Use high-fidelity mannequins and Just-In-Time teaching
- Practice and debrief important family-patient communication

Use evidence-based and efficient teaching strategies

- Employ the ‘one-minute preceptor’ and mini-chalk talks
- Foster critical thinking
- Use technology to reinforce learning

Examples

- Provide short, focused teaching points
- Ask ‘how’ and ‘why’ questions
- E-mail daily teaching points to team

Capitalise on the 24-hour teaching and learning environment

- Arrange for morning teaching sessions
- Incorporate bedside teaching
- Boost with night-time education

Examples

- Prepare mini-chalk talks
- Include ‘teaching point’ on rounds checklist

... developing interprofessional relationships may remove barriers to additional learning at the bedside, leading to improved teamwork and community building

Box 1. Example of daily ICU schedule with a focus on teaching opportunities



FROM SUNRISE TO STARRY SKY

Finding ways to teach all day

MORNING:

- Provide lecture for trainees about ARDS management
- Perform mini-chalk talk about measurement of pulmonary mechanics
- Elicit RT expertise regarding oesophageal balloon use
- Assign learner to investigate data about steroids in ARDS
- Prompt pharmacist to explain pharmacologic differences between paralytic agents

AFTERNOON:

- Subspecialty trainee leads bedside session on thoracic ultrasound
- Nurse explains and demonstrates how to monitor level of paralysis

EVENING:

- Resident trainee adds papers about ventilation strategies in ARDS to shared online repository
- Daytime attending sends e-mail to ICU team with learning points from the day
- Supervising overnight physician reviews patient list and discusses possible contingencies with trainee

OVERNIGHT:

- Supervising physician uses 'one-minute preceptor' when discussing new patient
- Resident reviews video of CVC placement with medical student prior to performing procedure



Abbreviations: ARDS = acute respiratory distress syndrome; CVC = central venous catheter, ICU = intensive care unit; RT = respiratory therapist.

practitioners, including nurses, pharmacists and respiratory therapists, to teach trainees. This can include teaching on rounds, at the bedside or during small group teaching sessions. On rounds, we suggest actively seeking out the opinion of other professions, as this explicitly models mutual respect and highlights the value added by team members.⁵ For example, when choosing antibiotics, the team may ask the ICU pharmacist for her opinion, as she is the expert in local susceptibility patterns.

Different professions and medical specialties can contribute to teaching in a variety of ways. At our institution, we routinely have physicians from specialties such as nephrology, oncology and maternal–fetal medicine give morning lectures. Pharmacists teach about sedation and analgesia, and respiratory therapists deliver a session on mechanical ventilation. Residents value these sessions because they are leaning from the 'expert'. As an added benefit, developing interprofessional relationships may remove barriers

to additional learning at the bedside, leading to improved teamwork and community building. Reinforcing this positive element of the informal curriculum, i.e. the value of high-quality multidisciplinary collaboration, can ultimately improve patient care.^{6,7}

Focus on key ICU topics

- Integrate practical procedural and ultrasound teaching
- Prioritise training in high-stakes communication scenarios

With dynamic physiology, high-level teamwork and complex patient–family interactions, there is a plethora of topics well suited for ICU curricula. In particular, these rotations are a prime opportunity to teach and reinforce procedural skills, including the placement of central lines, arterial lines and chest tubes, as well as the performance of lumbar puncture, paracentesis and thoracentesis. Procedural encounters should be selected according to the trainee's level of experience and, when feasible, after performing

repeated high-fidelity simulation until competence is achieved.^{8,9} When simulation experiences are not available, educators can employ the strategy of Just-In-Time teaching prior to performing a procedure.⁸ This approach involves reviewing the steps of a procedure together with the trainee just before the encounter begins, and can include viewing procedure videos (e.g. such as those from the *New England Journal of Medicine*).¹⁰ Although institutional requirements for supervision vary, trainees performing procedures are generally supervised by a more experienced operator. Survey-based studies have shown that resident-teachers are often inexperienced with procedures and are uncomfortable supervising them.^{11,12} We recommend that both supervisor and operator learning be considered. Indeed, if the attending physician (or consultant) oversees the senior resident supervising the learner, procedures can provide a multi-level teaching opportunity.

Ultrasound training can be incorporated into ICU teaching using simple and focused

techniques.¹³ Providing short teaching sessions on one or two basic echocardiographic views with binary or qualitative assessments (e.g. Is the right ventricle enlarged or not?; Is the inferior vena cava collapsible or not?) are most successful and easily implemented. The availability of dynamic exam findings in critically ill patients allows trainees to solidify their ultrasound skills in a short period of time. At our institution, we have weekly ultrasound teaching before rounds. After a short didactic on foundational ultrasound topics we go to the bedside of a patient with instructive ultrasound findings, where all trainees can observe and practise ultrasound image acquisition with real-time hands-on feedback.

The ICU is also enriched with opportunities to cultivate skills in patient and family communication. Similar to medical procedures, using simulation scenarios to teach communication skills can improve both learner and patient and family outcomes.¹⁴ Simulation can be superior to lectures in teaching communication skills for challenging circumstances, such as talking about death and dying.¹⁴ Given the critical importance and broad applicability of teaching communication skills, we recommend including a comprehensive communication curriculum during ICU rotations. At our institution, medical interns are provided with a longitudinal curriculum on communication skills over their 4-week ICU rotation. This includes role-playing difficult conversations with family volunteers, with peer-led debriefing and feedback. This curriculum has led to improved family member satisfaction during direct observations of authentic resident-family communication.¹⁴ Outside such a formal curriculum, patients, visiting family members and caregivers can be valuable participants in teaching about

communication and decision making. ICU educators should seize the opportunity to assess trainees' communication skills during rounds, bedside teaching or family meetings, and elicit feedback from patients and families. Explicit debriefing encounters with patients and families also aids in education.

Use evidence-based and efficient teaching strategies

- Employ the 'one-minute preceptor' and mini-chalk talks
- Foster critical thinking
- Use technology to reinforce learning

When time is short, we recommend the deliberate use of time-tested and proven teaching strategies, such as the 'one-minute preceptor' or mini-chalk talks.^{15,16} The 'one-minute preceptor' is a technique based on five micro-skills of teaching: (i) get a commitment from the learner; (ii) probe for their understanding; (iii) teach a general rule; (iv) highlight positive behaviours; and (v) correct any errors. Although this technique has been studied primarily in the

outpatient setting, it can easily be used in real time during rounds (see Table 2) or when discussing a new admission one-on-one.

A mini-chalk talk is another efficient and effective tool for brief focused teaching in the ICU. Whether rounds are conducted at a table, at a computer or at the bedside, ICU teachers can employ this straightforward technique to enhance their clinical teaching. A readily available dry-erase marker on a whiteboard (either in the patient's room or in one's own room) or other glossy surface (such as the window or glass door) provides an easily visible and usable canvas for a mini-chalk talk. Mini-chalk talks work well for frequently encountered ICU topics such as respiratory system mechanics or haemodynamic calculations, where providing learners with a few focused teaching points and/or a framework is most valuable. An example is provided in Figure 1. One way to link pathophysiology to clinical presentation is to create concept and mechanism maps when giving a mini-chalk talk.¹⁷ An example is provided in Figure 2.

... patients, visiting family members and caregivers can be valuable participants in teaching about communication and decision making

Table 2. Example of a 1-minute preceptor technique in the ICU

Microskill	Teacher and student (italicised) exchange
1. Get a commitment	"Why do you think this patient is hypotensive?" "I think they are in cardiogenic shock"
2. Probe for supporting evidence	"What signs, symptoms and lab values support a diagnosis of cardiogenic shock?" "The CvO2 is low, the patient's extremities feel cold on exam, and they have acute kidney injury"
3. Teach a general rule	"Severe hypovolemic shock can also present with cool extremities and low CvO2. This is because oxygen delivery is reduced due to decreased effective circulating volume and not due to an intrinsic cardiac problem"
4. Reinforce what was done well	"You did a good job integrating the physical exam and labs into your proposed diagnosis"
5. Correct errors	"However, a low CvO2 is not always indicative of cardiogenic shock, so it's important to consider other causes of a low CvO2"

Abbreviation: CvO2 = central venous oxygen saturation.

By asking 'how' and 'why' questions, ICU educators can ascertain how trainees are thinking critically about a problem

Teaching sequence for connecting ventilator waveforms and pulmonary mechanics

- Measuring pulmonary compliance
- Perform inspiratory hold on ventilator
- Draw the tracing seen on ventilator
- Label the key pressures on the tracing
- Teach about the equation of motion for respiratory system
- Set equation to conditions during an inspiratory hold
- Use equation to calculate compliance

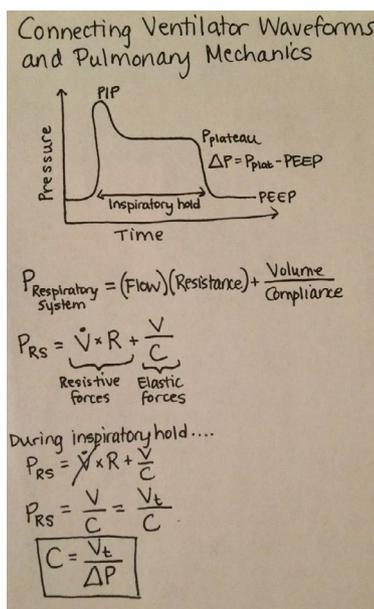


Figure 1. Example of a mini-chalk talk linking ventilator waveforms and static compliance. At the bedside, the educator can use the teaching sequence listed in the table to create the figure on the left. This demonstrates how to calculate static compliance by integrating the real-time ventilator waveform with pulmonary mechanics.

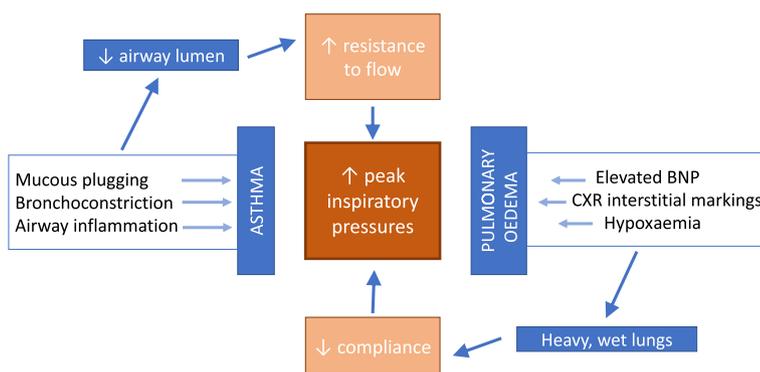


Figure 2. Mechanism map exploring how both pulmonary oedema and asthma could contribute to the finding of increased peak inspiratory pressure. Abbreviations: CXR = chest x-ray, BNP = brain natriuretic peptide. During a teaching session, a mechanism map can be generated by asking learners how a clinical finding, such as elevated peak inspiratory pressures, can be explained by underlying disease, such as pulmonary oedema and asthma. This approach utilises 'how' and 'why' questions to encourage critical thinking and links observation (e.g. elevated peak inspiratory pressure) to pathophysiology (e.g. mucous plugging in asthma).

In the process of teaching core ICU content, promoting curiosity and critical thinking, i.e. the ability to be deliberate about one's own thinking, is of the utmost importance to enhance cognitive skills.¹⁷ There are many techniques to improve critical thinking, including explaining and exploring one's thinking processes aloud and assessing the learner's critical thinking skills.¹⁷ We however, focus on three techniques, especially when time is short. The first is to identify cognitive biases. We do this by simply asking our team on rounds: 'Are we relying too heavily

on prior information when making our diagnosis? Is this clouding our judgement?' The second is to admit uncertainty. As teachers, we should model this (e.g. 'I'm not certain why this patient is hypotensive right now') and we should encourage our learners to admit their uncertainties. The third technique is to ask questions that promote critical thinking. Critical-thinking questions are the 'how' and 'why' questions, and require learners to work through a problem. The 'what' questions, such as 'what is the starting dose of this vasopressor', test memory, not thought

processes. By asking 'how' and 'why' questions, ICU educators can ascertain how trainees are thinking critically about a problem. Engaging learners with these three strategies will help promote their curiosity, strengthen their ability to maintain a broad differential diagnosis, avoid premature closure and provide them with a safe environment to use thinking tools that can be applied easily in other clinical settings.

Finally, the role of technology in medical education cannot be overlooked. In the ICU, novel strategies such as incorporating audience-response systems via mobile phone apps into rounds or pre-round lectures can improve learner engagement and identify knowledge deficiencies.¹⁸ Drawing upon the principle of spaced learning from cognitive learning theory, using a shared repository for literature or summarising learning points via e-mail, Twitter or Google Docs may also promote learner retention.¹⁹

Capitalise on the 24-hour teaching and learning environment

- Arrange for morning teaching sessions
- Integrate bedside teaching
- Boost with night-time education

Most ICU teaching occurs via group lectures and at the bedside. Morning teaching sessions may have a positive impact on educational experiences without compromising patient care. Indeed, holding teaching sessions first thing in the morning, before rounds, can be associated with improved scores on an end-of-rotation exam compared with lectures after rounds, without any increase in ICU length of stay or hospital mortality.²⁰ Rounds are also ripe for bedside teaching opportunities.²¹ In the ICU, bedside education can be reinforced by the inclusion of a 'teaching point' as an

item in the ICU rounding checklist.²² One could argue that providing an identifiable teaching point for each patient should be an essential component (i.e. core measure) of rounding in a teaching hospital, thereby justifying the inclusion in a checklist.

As patient care occurs throughout the day and night, teaching can occur at all hours. This is increasingly relevant with the intensivist shift-work model employed by many ICUs, where overnight intensivists are impactful teachers for trainees during their ICU rotations.²³ Best practices for night-time teaching include the review of patient lists by faculty members to identify possible teaching opportunities, adding teachable moments when discussing patients (using the techniques described above) and follow-up with learners the next day, either in person or via electronic contact (i.e. e-mail).²⁴

CONCLUSIONS

In summary, the ICU is a rich educational environment well suited for meaningful learning opportunities through the use of specialised teaching strategies tailored to different clinical situations used throughout the day and night. We hope that with the above discussion we have highlighted both evidence and experience-based methods for improving ICU education.

REFERENCES

1. Accreditation Council for Graduate Medical Education. Common program requirements. ACGME, 2019. Available at <https://www.acgme.org/What-We-Do/Accreditation/Common-Program-Requirements>. Accessed on 24 March 2019.
2. Edmondson A. Psychological safety and learning behavior in work teams. *Adm Sci Q* 1999;**44**(2):350–383.
3. Santhosh L, Jain S, Brady A, Sharp M, Carlos WG. Intensive care unit educators: a multicenter evaluation of behaviors residents value in attending physicians. *Ann Am Thorac Soc* 2017;**14**(4):513–516.

4. Lingard L, Espin S, Evans C, Hawryluck L. The rules of the game: interprofessional collaboration on the intensive care unit team. *Crit Care* 2004;**8**(6):R403–R408.
5. Kassutto S, Seam N, Carlos WG, Kelm D, Kaul V, Stewart NH, Hinkle L. Twelve tips for conducting successful interprofessional teaching rounds. *Med Teach* 2019. <https://doi.org/10.1080/0142159X.2018.1545086>. [Epub ahead of print]
6. Kim MM, Barnato AE, Angus DC, Fleisher LF, Kahn JM. The effect of multidisciplinary care teams on intensive care unit mortality. *Arch Intern Med* 2010;**170**(4):369–376.
7. Urisman T, Garcia A, Harris HW. Impact of surgical intensive care unit interdisciplinary rounds on interprofessional collaboration and quality of care: mixed qualitative–quantitative study. *Intensive Crit Care Nurs* 2018;**44**:18–23.
8. Joyce MF, Berg S, Bittner EA. Practical strategies for increasing efficiency and effectiveness in critical care education. *World J Crit Care Med* 2017;**6**(1):1.
9. Huang GC, McSparron JI, Balk EM, Richards JB, Smith CC, Whelan JS, Newman LR, Smetana GW. Procedural instruction in invasive bedside procedures: a systematic review and meta-analysis of effective teaching approaches. *BMJ Qual Saf* 2016;**25**(4):281–294.
10. Kleinpell R, Ely EW, Williams G, Liolios A, Ward N, Tisherman SA. Web-based resources for critical care education. *Crit Care Med* 2011;**39**(3):541–553.
11. Mourad M, Kohlwes J, Maselli J, Auerbach AD. Supervising the supervisors – procedural training and supervision in internal medicine residency. *J Gen Intern Med* 2010;**25**(4):351–356.
12. Huang GC, Smith CC, Gordon CE, Feller-Kopman DJ, Davis RB, Phillips RS, Weingart SN. Beyond the comfort zone: residents assess their comfort performing inpatient medical procedures. *Am J Med* 2006;**119**(1):71.e17–71.e24.
13. Kanji HD, Mccallum JL, Bhagirath KM, Neitzel AS. Curriculum development and evaluation of a hemodynamic critical care ultrasound: a systematic review of the literature. *Crit Care Med* 2016;**44**(8):e742–e750.
14. Sullivan AM, Rock LK, Gadmer NM, Norwich DE, Schwartzstein RM. The impact of resident training on communication with families in the intensive care unit resident and family outcomes. *Ann Am Thorac Soc* 2016;**13**(4):512–521.
15. Aagaard E, Teherani A, Irby DM. Effectiveness of the one-minute preceptor model for diagnosing the patient and the learner: proof of concept. *Acad Med* 2004;**79**(1):42–49.
16. Pitt MB, Orlander JD. Bringing mini-chalk talks to the bedside to enhance clinical teaching. *Med Educ Online* 2017;**22**(1):1–7.
17. Hayes MM, Chatterjee S, Schwartzstein RM. Critical thinking in critical care: five strategies to improve teaching and learning in the intensive care unit. *Ann Am Thorac Soc* 2017;**14**(4):569–575.
18. Chung H, Kallay T, Anas N, Bruno D, Decamps J, Evans D, Vilasagar N, Mink RB. Using an Audience Response System Smartphone App to Improve Resident Education in the Pediatric Intensive Care Unit. *J Med Educ Curric Dev* 2018;**5**:238212051877067.
19. Matos J, Petri CR, Mukamal KJ, Vanka A. Spaced education in medical residents: an electronic intervention to improve competency and retention of medical knowledge. *PLoS One* 2017;**12**(7):e0181418.
20. Lim KG, Dunn WF, Klarich KW, Afessa B. Internal medicine resident education in the medical intensive care unit: the impact on education and patient care of a scheduling change for didactic sessions. *Crit Care Med* 2005;**33**(7):1534–1537.
21. Carlos WG, Kritek PA, Clay AS, Luks AM, Thomson CC. Teaching at the bedside: maximal impact in minimal time. *Ann Am Thorac Soc* 2016;**13**(4):545–548.
22. Cao V, Tan LD, Horn F, et al. Patient-centered structured interdisciplinary bedside rounds in the medical ICU. *Crit Care Med* 2018;**46**(1):85–92.
23. Petri CR, Ranchoff BL, Cohen AP, Sullivan M, Schwartzstein RM, Hayes MM. An exploratory study of overnight education in the medical intensive care unit. *International Journal of Critical Care and Emergency Medicine* 2019;**5**:063.
24. Richards JB, Wilcox SR, Roberts DH, Schwartzstein RM. Twelve tips for overnight teaching. *Med Teach* 2014;**36**(3):196–200.

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Author contributions

CRP contributed to the design, drafting and revision of the work. AA contributed to the design and revision of the work. RMS contributed to the design and revision of the work. MMH contributed to the design and revision of the work. All authors (CRP, AA, RMS and MMH) provided final approval to the submitted work and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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