

# A Mastery Learning Module on Sterile Technique to Prepare Graduating Medical Students for Internship

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## Abstract

**Introduction:** Sterile technique is a basic technical skill used for a number of bedside procedures. Proper use of sterile technique improves patient safety by reducing infection risk. **Methods:** We applied the principles of mastery learning to develop a simulation-based mastery learning module for sterile technique that was used as part of a 2-week internship preparatory course for fourth-year medical students. Forty-one medical students entering surgical or emergency medicine internships completed the module. Learners demonstrated baseline skills with a pretest, watched a didactic online video, participated in supervised deliberate practice sessions, and then completed a posttest. Physicians evaluated performance using a nine-item mastery checklist validated by a multispecialty panel of board-certified physicians. Learners who did not demonstrate mastery by correctly performing all nine checklist items received formative feedback and repeated the posttest as needed until mastery was achieved. **Results:** No learners demonstrated mastery of sterile technique during pretesting. A total of 100% of learners demonstrated mastery of sterile technique during either their first or second attempt of the posttest. The learners reported statistically significantly higher levels of confidence at the end of the module. **Discussion:** Our module highlights the skills gap that exists in the transition from undergraduate to graduate medical education and offers a cheap, effective, and easily reproducible curriculum for sterile technique that could be widely adopted for many learner populations.

## Keywords

Sterile Technique, Aseptic Technique, Simulation-Based Mastery Learning, Internship Preparation, Clinical/Procedural Skills Training, Curriculum Development, Simulation

## Educational Objectives

By the end of this activity, learners will be able to demonstrate mastery of creating and maintaining a sterile field for a bedside procedure with assistance only with gown tying.

## Introduction

Sterile technique is a basic technical skill that is used in all disciplines of medicine. It is a foundational skill necessary for performing any sterile procedure, such as a laceration repair or a central line placement. As outlined in the AAMC Core Entrustable Professional Activities for Entering Residency, all medical students are expected to be competent in sterile technique by graduation.<sup>1</sup> Interns could be expected to create and maintain a

sterile field without supervision even if they require supervision for the procedure itself. Proper use of sterile technique reduces infection by preventing contamination from disease causing microorganisms.

Many curricula for skills that require proper use of sterile technique have been published, but curricula for graduating medical students specifically on the key foundational skill of sterile technique are scarce. This may be because sterile technique is assumed to be a basic skill in which students are already competent. The University of Michigan implemented an assessment for sterile technique as one of 14 necessary competencies for all incoming interns.<sup>2</sup> That model does not include a curriculum, only an assessment. Students did not complete additional attempts if they were found to be not competent. It was also resource intensive, requiring standardized patients and nurses to play the role of assistants.

Sterile technique is a basic, foundational skill for interns across specialties. A cost-effective, stand-alone curriculum using

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evidence-based educational methods is needed and could be adopted widely. We have designed a simulation-based module for graduating medical students on sterile technique to fill this gap. Our module is cheap and effective and utilizes the evidence-based educational method of mastery learning to ensure competency in this important skill.<sup>3</sup>

Our module was developed using the tenets of simulation-based mastery learning (SBML). SBML is a rigorous educational method for high-achieving learner populations. SBML is different than traditional teaching methods because the endpoint of the module is that all learners achieve a predetermined mastery standard with as much supervised deliberate practice and remediation as needed.<sup>4</sup> Learners first perform a pretest so that evaluators may assess baseline knowledge and learners can be primed for learning. Next, learners engage in didactics and deliberate practice. Learners then take a posttest. If learners do not achieve the predetermined mastery standard on the posttest, they are given feedback and return to supervised deliberate practice. They are then allowed to reattempt the posttest as needed until they achieve the mastery standard. Because learners are allowed additional attempts until they meet the standard, they can be held to a higher standard than in traditional teaching methods. SBML has been shown to be an effective method to help medical students and residents achieve level-appropriate skills in a safe, simulated setting, as well as benefit patient safety.<sup>5-9</sup> We have previously described a module on chest tube insertion appropriate for the skills level of graduating medical students who have matched into surgical residencies using SBML.<sup>10</sup>

## Methods

### Curricular Context

Our mastery learning sterile technique module was offered as part of a required 2-week internship preparatory course (IPC) and was administered to all graduating fourth-year medical students at the University of Wisconsin School of Medicine and Public Health (UWSPH) in April 2017. All students had completed their core third-year rotations and fourth-year electives and were within weeks of graduation. The course included lectures, skills-based workshops, and simulation modules. All students had completed an extensive simulation-based clinical education on physical exam skills during their first year of medical school as part of the medical school's curriculum. All students had also previously attended a suturing workshop immediately prior to starting third-year rotations that included learning simulated suturing and sterile technique, as well as supervised practice.

### Assessment Development

A team of five faculty physicians from various medical and surgical specialties at the University of Wisconsin developed a nine-item checklist (Appendix A) based on a checklist for sterile field preparation from a national surgical IPC curriculum.<sup>11</sup> Each checklist item had three options: *not done*, *done incorrectly*, or *done correctly*. The faculty panel determined by consensus that correct completion of all nine checklist items was required as the minimum passing standard since that is the level of mastery that would be expected of an intern. The checklist was next successfully trialed on a group of surgical resident trainees.

### Faculty orientation

Prior to the session, all evaluators underwent an instructor orientation (Appendix B) to understand mastery learning and how to score learners using the checklist.

### Module Implementation

For this module, students prepped a low-cost, high-fidelity simulator consisting of a cardboard copy paper box with a 2-inch by 4-inch rectangle of tape on top marking the clinical field of interest. The testing room contained all the necessary equipment laid out for learners to select from, including chlorhexidine prep sticks; surgical gloves, hats, and masks; eye protection; various pieces of packaged sterile equipment (e.g., 10cc syringes); sterile towels with sterile overwrap; and sterile gowns with sterile overwrap. Learners were instructed to gather the necessary equipment and prepare for a sterile procedure (e.g., a laceration repair or a chest tube insertion) including prepping, gowning, gloving, and draping. The learners were instructed to prepare the sterile field around the rectangle of tape on the box. They were also asked to open individually wrapped equipment (e.g., a syringe) onto the field to demonstrate sterile opening.

The module began with a pretest to assess the baseline skill of the learners. During the pretest, learners were asked to complete the task before they had received any didactics as part of the mastery learning sterile technique module. Learners were observed by an attending physician who did not provide any verbal feedback. The observer did not offer any assistance other than tying the learners' sterile gowns. After the pretest, learners were given verbal feedback but were not offered a retest. Next, learners were asked to review the video on sterile field preparation (Appendix C). The video included a demonstration of how to properly prep a sterile field for a procedure. Learners also viewed a video that explained the next steps of the module would be deliberate practice over the next week followed by a posttest with additional attempts as necessary until the mastery standard was met. The video concluded with an orientation

to the cardboard box simulator with specific instructions on how to demonstrate proper sterile technique for the course (Appendix D).

Over the next week, learners participated in scheduled peer-and/or faculty-moderated deliberate practice sessions during which they practiced sterile technique skills in a room set up exactly like the pretest and posttest room.

After the week of deliberate practice (approximately 8-10 days after the pretest), learners took the posttest. Failure to achieve mastery on the posttest resulted in mandatory additional attempts. These additional attempts included immediate feedback and supervised deliberate practice followed by repetition of the posttest until the learner met the mastery standard. All learners were evaluated by one course faculty member.

#### Course Evaluation

We measured the effectiveness of the course based on the percentage of learners able to achieve mastery by the end of the module. Learners provided written feedback about the course and also rated their confidence after both the pretest and posttest using a survey adapted from the Cato Confidence scale (Appendix E).<sup>12</sup> We used paired *t* tests to analyze differences in learner confidence from the pretest to the posttest.

This study was granted an exempt status by the University of Wisconsin School of Medicine and Public Health Institutional Review Board.

## Results

The mastery learning sterile technique module was offered to a group of 41 students who had matched into either an ACGME-accredited surgical specialty or emergency medicine (Table 1). Learners were evaluated by one of four faculty physicians (two trauma surgeons, one endocrine surgeon, and one dermatologist).

#### Mastery Achievement

None of the 41 learners achieved mastery on the pretest. Twenty-seven (66%) learners achieved the mastery standard on their first

Table 1. Participant Demographics

Specialty	No.	Male	Female	Average Age
Emergency medicine	11	6	5	29
Orthopedics	8	4	4	28
OB/GYN	9	1	8	27
General surgery (categorical)	5	4	1	30
General surgery (preliminary)	8	8	0	28
Total	41	23	18	28

attempt of the posttest. The remaining 14 (33%) learners who did not achieve mastery on the posttest received feedback and supervised deliberate practice from their faculty evaluator. All 14 learners who required additional attempts achieved mastery on their second posttest attempt.

The median number of checklist items that learners either incorrectly performed or did not perform on the pretest was three out of nine items, with a minimum of one item and a maximum of six items. Table 2 shows which checklist items learners missed during the pretest.

During the posttest, the most common checklist items the 14 (33%) learners who required additional attempts missed were performing a time-out (nine of the 14 learners), confirming availability of necessary equipment (six of the 14 learners), and demonstrating proper gloving (four of the 14 learners).

#### Course Feedback

Narrative course feedback was anonymously collected from students on what helped them feel confident during their posttest. Twenty students provided narrative comments. These narrative comments were able to be divided into one or more of the categories below, with representative example comments included:

- Familiarity with the setup due to the pretest and/or the video (seven of 20 students):
  - “Familiarity with the materials. The room was set up well, very organized.”
  - “Having had a pretest experience.”
  - “Watching video to know that I will be expected to drape a box as my ‘patient.’”
- Practice session (seven of 20 students):
  - “Practice session; knew exactly what to do this time.”
  - “Having both practiced before and seen the instructional video made this station much easier.”

Table 2. Missed Checklist Items During Pretesting

Checklist Item	No. (%) Not Done	No. (%) Done Incorrectly
Stating handwashing	12 (29)	0 (0)
Confirming availability of necessary equipment	6 (15)	8 (20)
Performing time-out	40 (98)	0 (0)
Laying out all necessary equipment and donning personal protective equipment (hat and mask)	2 (5)	4 (10)
Opening of one piece of sterile equipment	7 (17)	2 (5)
Prepping	3 (7)	5 (12)
Gowning	0 (0)	7 (17)
Gloving	0 (0)	20 (49)
Draping	0 (0)	22 (54)

- Faculty that made them feel comfortable (five of 20 students):
  - “Friendly, non-intimidating faculty.”
- Previous experience with the task (three of 20 students):
  - “Previous experience.”

#### Confidence

Comparing the pretest to the posttest, learner confidence increased ( $M = 2.96, SD = .71$ , vs.  $M = 3.32, SD = .78$ ;  $p < .001$ ).

## Discussion

To address the lack of published curricula on the basic foundational skill of sterile technique, we developed a mastery learning–based module on sterile technique for graduating medical students. The module was cheap, easily reproduced, and effective, with all learners achieving mastery of sterile technique. The need for this type of didactic was evidenced by the fact that none of the medical students were able to demonstrate mastery in sterile technique during the pretest. All learners were able to achieve mastery on the first or second attempt during the posttesting.

It was surprising that none of the 41 learners demonstrated mastery in sterile technique during the pretest. The learner population consisted of graduating fourth-year medical students who had previously had didactics on sterile technique and had completed all of their core clerkships. The items learners did not demonstrate competency in during the pretest were nontrivial; the majority of learners (88%) made errors in gowning, gloving, and/or draping during the pretest. Forty of the 41 learners also did not perform a time-out during the pretest. This learner population’s inability to correctly demonstrate sterile technique during baseline skills testing may have been due to infrequent use of these skills during clerkships coupled with a traditional learning module during the third-year clerkship that did not facilitate durable learning of this skill.

After didactics and deliberate practice, the majority of students achieved mastery on their first attempt of the posttest. All of the learners who required additional attempts achieved mastery on their second attempt. The majority of students who required additional attempts forgot to perform a time-out rather than committing errors in gowning, gloving, or draping technique, which are skills that are more technical. This could be addressed by having a more explicit and standardized framing statement for the students, such as a setup in which a learner performs a chest tube at a patient’s bedside until the time point. While the practice sessions may have benefited from having faculty and/or trainees always present, this did not seem necessary

since learners commented practice with peers was helpful and all learners improved from pretest to posttest.

Our module was found to improve learner confidence in the skill of sterile technique, and the comments learners made suggested that the overall flow of the module with the pretest and the deliberate practice made them feel more comfortable and familiar with the simulation model.

Limitations of this study include no interrater reliability of faculty checklist evaluators, a small sample size at a single institution, and a lack of long-term follow-up data regarding the resulting durability of this intervention since students were graduating and moving on to their intern year. The module also required a significant amount of coordination and faculty time, as a trained attending physician was present to evaluate each learner during both the pretest and the posttest. To reduce the burden on faculty, physician assistants or other providers could possibly be trained to assess students using the mastery checklist.

We have demonstrated the effectiveness of a mastery learning module for sterile technique for graduating medical students about to start internships in emergency medicine or surgical specialties. Our module was cheap and easily reproducible and resulted in all learners achieving mastery in sterile technique. Sterile technique is a basic foundational skill that is broadly relevant outside of the context of internship preparation, and this module could be adapted for many different learner populations. This module could be useful as a prerequisite to other modules for procedures that require proper use of sterile technique and could also be used by residency programs to help onboard matriculating interns during their transition to residency.

## Appendices

- A. Sterile Technique Mastery Checklist.docx
- B. Facilitator Guide.docx
- C. Instructional Video.mp4
- D. Model Video.mp4
- E. Student Cato Confidence 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

University of Wisconsin School of Medicine and Public Health Institutional Review Board granted an exemption.

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