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## Utilizing the Flipped Classroom, Simulation-Based Mastery Learning and Group Learning to Teach and Evaluate Lumbar Puncture Skills

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### ABSTRACT:

**Audience:** This lumbar puncture curriculum was developed and implemented to educate and evaluate incoming intern emergency medicine (EM) residents. This curriculum can also be used to educate and evaluate senior medical students and senior residents.

**Introduction:** Procedural competency is an important component of healthcare education. With the implementation of milestones, the need for valid assessment tools to determine procedural competency has increased. Simulation-based mastery learning (SBML) with the incorporation of deliberate practice has been shown to be an effective way to teach and evaluate procedural skills.<sup>1-8</sup> These studies, however, highlight one of the major barriers to successful integration of SBML into existing medical curricula: they require a significant investment of time. One reason for this is the performance of the pre-test evaluation of the learners' procedure skills prior to commencement of training. Although necessary for research endeavors to evaluate curricula effectiveness, the need for pre-testing specifically on studies where the goal of the curricula is procedural competency, as measured by learners' performance on the post-testing, has not been described. Consequently, we decided a more effective use of limited time was to allow our learners the opportunity for deliberate practice and conducting the post-test. Since the ultimate goal of our educational endeavors is to ensure that our learners achieve defined standards of performance, evaluation of their performance prior to training may not be necessary. Another reason for the significant time investment for SBML curricula is the utilization of individualized instruction with one facilitator providing corrective feedback to one learner. Although Cohen et al. reference the use of groups of learners for procedure training<sup>9</sup>, it is not explicitly delineated how the group instruction is conducted. In other disciplines, training team protocols such as dyad training (pair of learners), where learners practice a task in teams in order to achieve the goal of performing the task individually, has been shown as an effective strategy to teach motor skills.<sup>10-12</sup> This type of learning consists of a learner performing the procedure while the other learners actively observe,

# SMALLgroups



then alternate roles. In addition, recent studies have illustrated the improved efficiency with utilization of a flipped classroom with online educational materials when implementing mastery learning curriculums<sup>8,13</sup>. We designed a curriculum that utilizes a flipped classroom and a group learning protocol to improve the efficiency and ease of integration of a SBML lumbar puncture (LP) curriculum.

**Objectives:** The goal of the curriculum is to teach and evaluate senior medical students / emergency medicine residents on the performance of a lumbar puncture using a group learning protocol. At the completion of the training session, learners should be able to: 1) Demonstrate how to perform a LP on an adult patient by achieving the minimum passing standard on the checklist, 2) state the indications and contraindications of performing a LP, and 3) state the potential complications that can occur after performing a LP.

**Methods:** Small group session

**Topics:** Lumbar puncture, group learning, flipped classroom, mastery learning, simulation.



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## Learner Audience:

Medical students, interns, junior residents, senior residents

## Time Required for Implementation:

The time required to implement each session would be dependent on two factors:

1. The number of learners in each group
2. If pre-testing of the learners' LP skills prior to the procedure training is included. In our experience, when dividing our Emergency Medicine interns into groups of 2 or 3 interns and eliminating the pre-testing, 2 hours were needed to implement the session (procedure training and post-testing).

For our groups of 2 interns, the session typically lasted 90 minutes, while for our groups of 3 interns the session typically lasted 2 hours. If pre-testing is included, an additional hour would be needed to be included to the session time.

## Recommended Number of Learners per Instructor:

3 learners per instructor

## Topics:

Lumbar puncture, group learning, flipped classroom, mastery learning, simulation.

## Objectives:

### Primary Objective:

At the completion of the training session, learners should be able to:

1. Demonstrate how to perform a LP on an adult patient by achieving the minimum passing standard on the checklist

### Secondary Objectives:

At the completion of the training session, learners should be able to:

1. State the indications and contraindications of performing a LP
2. State the potential complications that can occur after performing a LP

## Linked objectives and methods:

The educational strategies used in this curriculum include:

1. Online educational module – an online module was created to meet the cognitive objectives of the curriculum. The module will replace an in-person lecture (flipped classroom) and will address the indications and contraindications of the procedures, the complications to avoid, the equipment needed to perform the procedures, step-wise descriptions of how to perform the procedures with a PowerPoint presentation and a video demonstrating how to perform a LP. The module is provided to the learners prior to the procedure training sessions. The learners could view the modules an infinite number of times before attending the procedure training sessions.
2. Procedure training sessions – the procedure training sessions are conducted to meet the psychomotor objectives of the curriculum. The sessions are conducted with the use of the Simulab® adult LP task trainer or any other commercial adult LP task trainer. The learners are separated into groups of 2-3 learners and the learners will have the opportunity to alternate performing a LP while receiving corrective feedback from a faculty facilitator. The learners at the conclusion of the session are tested using a validated checklist to determine if they meet the minimum passing standard of performance of a LP.

## Recommended pre-reading for instructor:

- Prior to the session the instructor should review the group learning protocol (Figure 1) to familiarize themselves with the structure of the session and also the online materials provided to the learners – LP PowerPoint presentation and video link for NEJM LP instructional video.<sup>14</sup>
  - <http://www.nejm.org/doi/full/10.1056/NEJMc054952>

## Learner responsible content (LRC):

Prior to the training session the learners should review:

- PowerPoint presentation describing how to perform the adult lumbar puncture (see attached)
- NEJM Adult lumbar puncture procedure video<sup>14</sup>
  - <http://www.nejm.org/doi/full/10.1056/NEJMc054952>

## Results and tips for successful implementation:

- The study was implemented during the two-week emergency medicine intern boot camp using the Simulab® adult LP task trainer. One of the main characteristics of a mastery learning curriculum is the performance of a pre-test. The time constraints of the



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EM intern boot camp curriculum made it logistically impossible to include a pretest of every interns' LP skills. We decided a more effective use of limited time was to allow each intern to have the opportunity for deliberate practice and conducting the post-test. Also, since we did not trial group sizes greater than 3 learners, we are not able to recommend group sizes larger than groups of 2 or 3 learners.

## Content:

- Figure 1 – Diagram describing format of training session
- Lumbar Puncture Procedure Checklist
- Lumbar Puncture PowerPoint Presentation

## Stations:

A Simulab® adult LP task trainer was used during the training sessions. The 21-item checklist with a minimum passing standard of 85% developed in previous research was used during the training sessions.<sup>4</sup> Prior to the in-person training sessions, the interns were provided with access to a LP PowerPoint presentation and the NEJM LP instructional video<sup>15</sup>. Each SBML LP training session was designed to have 1 faculty facilitator, 1 adult LP task trainer and a group of two or three learners.

At the beginning of the training session, the faculty facilitator demonstrated the steps of performing a LP. The 1<sup>st</sup> intern (Learner A) would attempt the LP while the other intern(s) (Learner B and Learner C (if a group of 3 learners) observed. The faculty facilitator provided corrective feedback while Learner A attempted the LP. When Learner A completed his/her first attempt, the interns alternated roles and Learner B began his/her first attempt while the other intern(s) observed. The interns continued to alternate until each intern either felt comfortable performing the procedure or the session time limit was reached. During the training sessions when assuming the role of procedure observer, the interns were permitted to interact with the intern performing the procedure. Immediately after, a posttest was then conducted individually with each intern by a different faculty facilitator to determine if they had achieved the minimum passing standard (Figure 1).

## Pearls:

- At the conclusion of this session, the learners should be able to demonstrate how to perform an adult LP on an adult LP task trainer. A copy of the LP checklist (attached) can be provided to the learners at the completion of the session. The learners can also have continued access to the online module provided to them prior to the training session.

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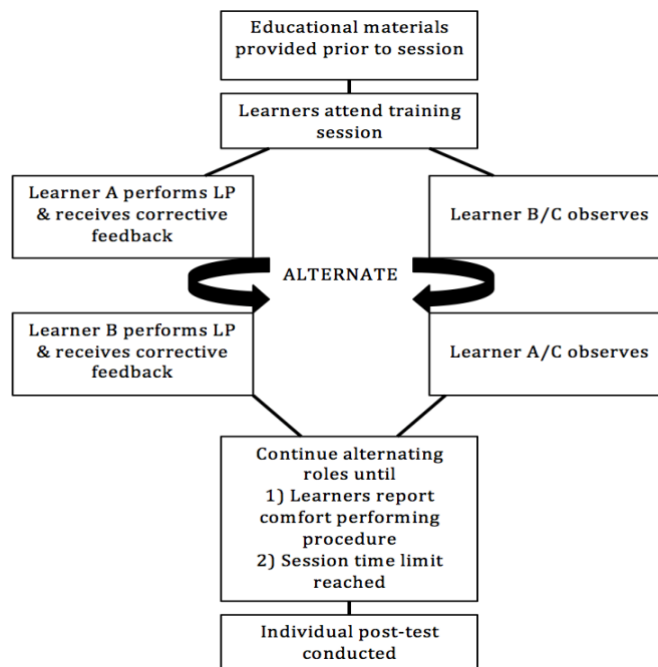
# DIDACTICS AND HANDS-ON CURRICULUM

Topic	Recommended Educational Strategy	Educational Content	Objectives	Learners	Timing, resources Needed (Space, Instructors, Equipment, citations of JETem pubs or other literature)	Recommended Assessment, Milestones Addressed
<i>Lumbar Puncture</i>	<p>1. Online materials – Description of how to perform a LP and video demonstrating how to perform a LP</p> <p>2. Hands on sessions for learners to receive simulation-based mastery learning education</p>	<p>-Indications and contraindications of performing a LP</p> <p>-Equipment needed to perform a LP</p> <p>-Complications that can occur as a result of a LP</p> <p>-Technique of how to perform a LP</p>	<p>The learner will demonstrate the ability to perform a LP by achieving the minimum passing standard on the post-test checklist</p>	<i>PGY-1</i>	<p>Asynchronous online materials</p> <p>90 minutes (hands-on session)</p> <p>Instructors: 1 per 3 learners</p> <p>Equipment: 1 adult LP task trainer</p> <p>30 minutes</p> <p>Post-testing</p>	<p>Milestone: PC9</p> <p>Assessment (Hands-on): Post-test evaluating learners ability to perform LP</p>



# INSTRUCTOR MATERIALS

## Figure 1: Design of Observational Group Learning SBML LP Training Sessions







# LUMBAR PUNCTURE CHECKLIST

Resident:

Year:   PGY-1           PGY-2           PGY-3           PGY-4

Exam Performed:

Date:

Checklist Item	Performed Correctly	Not Performed
Informed consent obtained Benefits Risks Consent given		
Wash hands		
Call "time out"		
Properly position the patient		
Demonstrate knowledge of correct anatomic location for procedure		
Put on sterile gloves		
Properly set up equipment Manometer Tubes		
Clean the skin with Betadine x 3		
Drape the patient		
Use 1% lidocaine to form a wheal at intended site		
Anesthetize deeper structures (larger needle)		
Insert spinal needle advancing toward umbilicus		
Bevel must be in correct direction		
Slowly advance the needle with periodic checking for cerebrospinal fluid (removal of stylet until space entered)		
Measure opening pressure		
Collect fluid in proper tubes		
Remove the needle after the stylet is replaced		
Place dressing		
Dispose of sharps in designated container		
Notify nurse procedure is done; give post-procedure orders (patient to lay flat)		
List routine tests to be ordered (glucose, cell count, protein, gram stain, culture)		