NEW EDUCATIONAL METHOD

The Use of Hybrid Lumbar Puncture Simulation to Teach Entrustable Professional Activities During a Medical Student Neurology Clerkship [version 2]

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Abstract

This article was migrated. The article was marked as recommended.

Background: In 2014, the Association of American Medical Colleges (AAMC) published a list of 13 Entrustable Professional Activities (EPAs) that medical school graduates should be able to perform upon starting residency. The University of Pittsburgh School of Medicine (UPSOM) has surveyed our neurology clerkship students in regard to EPAs since 2017; according to this data we have been deficient in addressing EPAs 4 (enter and discuss orders/prescriptions), 11 (obtain informed consent for tests and/or procedures), and 12 (perform general procedures of a physician). We therefore developed a hybrid simulation experience encompassing these three skills, centered around lumbar puncture (LP).

Methods: We created a hybrid LP simulation for students on the neurology clerkship encompassing EPAs 4, 11, and 12. Students first obtained informed consent for LP from a Standardized Patient, then performed LP on a specialized manikin. They then entered orders on CSF into a simulated patient chart. Real-time feedback was provided for all three components. Students filled out surveys to assess their perceived confidence and skill with these activities both pre- and post-simulation.

Results: The percentage of students who increased their confidence with LP from minimal or less to average or more was 58.24%, 38.47%, and 26.38% for LP, informed consent, and order entry, respectively. The percentage of students who improved from not being able to perform/need significant supervision to being able to perform with...
minimal supervision/ independently was 25.27%, 47.25% and 28.58%, for LP, informed consent, and order entry, respectively. These differences were all statistically significant (p

Conclusions/Significance: Hybrid LP simulation was effective in increasing medical student confidence and perceived skill with EPAs 4, 11, and 12.

Keywords
hybrid simulation, lumbar puncture, Entrustable Professional Activity

Corresponding author: Claire Yanta (casperca2@upmc.edu)
Competing interests: No competing interests were disclosed.
Grant information: The author(s) declared that no grants were involved in supporting this work.
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How to cite this article: Yanta C, Knepper L, Van Deusen R and Ruppert K. The Use of Hybrid Lumbar Puncture Simulation to Teach Entrustable Professional Activities During a Medical Student Neurology Clerkship [version 2] MedEdPublish 2021, 9:266 https://doi.org/10.15694/mep.2020.000266.2
First published: 27 Nov 2020, 9:266 https://doi.org/10.15694/mep.2020.000266.1
Introduction

According to a 2016 survey, 57% of US medical school graduates do not perform a lumbar puncture—a crucial diagnostic procedure for neurological conditions—prior to graduation (Barr and Graffeo, 2016). Likewise, a 2019 survey of German medical students found that, out of 14 common medical procedures, the students endorsed the least confidence with performing a lumbar puncture (von Cranach, Backhaus and Brich, 2019). The Association of American Medical Colleges (AAMC) recognizes the importance of procedural skill in medical education, as reflected in its list of 13 Entrustable Professional Activities (EPAs) that students should be able to perform upon starting residency (AAMC, 2014).

In the 4-year United States (US) medical education system, schools require their students to complete clinical experiences involving direct patient care—known as clerkships—typically beginning in the students’ third year. At the University of Pittsburgh School of Medicine (UPSOM), we introduced the EPAs to our students on our required neurology clerkship in 2015 and have given the students yearly surveys to determine how well we teach these skills during the clerkship. Based on this survey data, we had previously developed a curriculum centered around note-writing to teach EPAs 1 (“Gather a history and perform a physical examination”), 2 (“Prioritize a differential diagnosis following a clinical encounter”), and 5 (“Document a clinical encounter in the patient record”). Since implementing this curriculum, the percentage of students who state that our clerkship teaches these activities has been 99-100% in all three activities. Our findings have been presented in poster form at the 2018 World Summit on Competency-Based Medical Education in Basel, Switzerland (Knepper et al. 2018).

According to our students, our neurology clerkship has remained deficient in addressing EPAs 4, 11, and 12, which are defined as follows:

- EPA 4: Enter and discuss orders/prescriptions
- EPA 11: Obtain informed consent for tests and/or procedures
- EPA 12: Perform general procedures of a physician

According to our survey data, 75% of our students reported having entered and discussed orders, 53% of our students reported participating in obtaining informed consent, and 78% reported performing “general procedures of a physician”. The number for LP, specifically, was not recorded.

There are many reasons for these low performance rates. For one, Pennsylvania state law mandates that informed consent must be obtained by a physician, thus students are not afforded real-life experience in obtaining informed consent on their own. In addition, there are multiple possible sites at which our students may have their clinical experiences; while we strive for site equivalence, there are certain services where lumbar puncture procedures are more commonly done than others. Finally, different services also have different degrees of involvement in order entry (primary neurology service vs consultation services, for example). These problems are not unique to our own institution but are experienced, to varying degrees, by neurology clerkship directors across the country (Safdieh et al., 2018).

Simulation-based training has been recommended by the American Academy of Neurology as a potential way to alleviate novice stress levels before and during lumbar puncture procedures (Henriksen et al., 2018). 53% of neurology clerkships have LP simulation exercises during their neurology clerkships (Safdieh et al., 2018). To date, there are few studies that looked at whether these simulations improved student confidence with performing LP. A 2017 study of 24 second- and third-year medical students who received simulation-based training on multiple procedural skills including lumbar puncture showed that student self-reported confidence and procedural performance scores significantly improved following their training sessions (Toy et al., 2017). Similarly, a 2018 study of 20 senior medical students who received small group simulation-based training in multiple clinical skills including lumbar puncture showed significant improvement in their skill performance as compared to PGY-1 (postgraduate year 1; i.e. first year following medical school graduation) historical controls (Wayne et al., 2018).

The results of these studies have been positive, though it is important to note that the outcomes reported here were based on skills assessments and survey data immediately following the simulation experiences. There is no data available as to whether these simulations advance skill and improve self-efficacy in real-world settings. Furthermore, to our knowledge, there are no other high-fidelity, comprehensive simulation experiences that also incorporate obtaining informed consent from standardized patients and entering orders into the electronic medical record (EMR). Hybrid simulation has, however, demonstrated to be both feasible and effective for medical student training of gynecologic procedures such as intrauterine device insertion and Papanicolaou tests as well as breast examinations (Amerjee et al., 2018; Seo et al.,...
We therefore developed a hybrid simulation experience encompassing all three of these crucial skills and centered around LP. It was our belief that this innovative hybrid simulation model would translate into improved student confidence and capability in a similar real-life scenario. Preliminary data was accepted for presentation in poster form at the Association for Medical Education in Europe 2020: The Virtual Experience (Yanta et al., 2020). We now present our final data.

Methods
This project was approved by the UPSOM Research on Medical Students Committee and University of Pittsburgh Institutional Review Board. At the beginning of the 2019-2020 academic year, we first distributed a survey to the rising MS-4 (fourth-year medical student) class to determine how often they participated in informed consent, electronic order entry, and lumbar puncture during their third-year clerkships (Supplementary File 1). We then incorporated our simulation into the clerkship curriculum. During the clerkship orientation, the students received a tutorial on obtaining informed consent and entering orders into the EMR from a faculty preceptor. Within the first four days of the clerkship, the students completed an online Likert-style survey assessing their level of confidence and perceived skill with these activities (Supplementary File 2). The design of this survey was based on previously published instruments (Dehmer et al., 2013; von Cranach, Backhaus and Brich, 2019).

On the fifth day of the 28-day clerkship, the students then gathered for the hybrid simulation experience. During this experience, they first simulated obtaining informed consent for a lumbar puncture from a standardized patient (SP) with a chief complaint of monocular vision loss concerning for optic neuritis. Feedback was immediately provided to the students based on an informed consent checklist provided to the SPs (Supplementary File 3). The students then received instruction from neurology faculty or senior resident preceptors on performing LP with the use of a specialized manikin. They were then able to practice the procedure with real-time feedback provided by preceptors. The students then entered orders on the “CSF” into a simulated EMR, again obtaining real-time feedback from preceptors.

Following the simulation exercise, the students filled out a similar Likert-style survey to assess their confidence and perceived skill with these three activities (Supplementary File 4). At the end of the four-week clerkship, the students filled out an additional survey to determine how many of them had live-patient experiences with these skills (Supplementary File 5). Those students who performed these skills on live patients identified the clinical preceptors who supervised them. Those supervisors, in turn, were asked to submit an evaluation of the students’ roles in those crucial skills (Supplementary File 6). All this data was then de-identified and analyzed in aggregate, stratified by time of academic year (block 1-5 vs block 6 onward). P values were calculated using Fisher’s exact test. At the end of the academic year, this same cohort of students was then asked to complete an identical online survey to that of the previous rising senior class (Supplementary File 1). These results were compared to the survey results of the prior rising senior class.

Results
Of the 128 students who completed the neurology clerkship during the 2019-2020 academic year, 84 completed the pre-simulation survey, 70 completed the post-simulation survey and 49 completed the end of clerkship survey.

Confidence and Perceived Skill with Lumbar Puncture
In the pre-simulation survey, the percentage of students who endorsed average or better confidence with LP was 5.95%. Following the simulation, this percentage improved to 90%. The proportion of students who endorsed average confidence increased by a net 55.48 percentage points, above average confidence increased by 27.14 percentage points, and maximal confidence increased by 1.43 percentage points (Table 1). When broken down by respondent, the percentage of students whose confidence with LP improved from nil/minimal to average or better was 58.24%. This increase was statistically significant (p < 0.0001).

In addition to self-confidence, we also asked the students to rate their perceived skill with LP both before and following the simulation. In the pre-simulation survey, the percentage of students who endorsed average or better confidence with LP was 5.95%. Following the simulation, this percentage improved to 90%. The proportion of students who endorsed requiring minimal supervision for LP improved by a net 38.57 percentage points (Table 2). When we looked at individual respondents, the percentage of students whose confidence with LP improved from not being able to perform/need significant supervision to being able to perform with minimal supervision or independently was 25.27%. This increase was statistically significant (p < 0.0001).

Confidence and Perceived Skill with Obtaining Informed Consent
In the pre-simulation survey, the percentage of students who endorsed average or better confidence with obtaining informed consent was 46.43%. Following the simulation, this percentage improved to 97.14%. Above average
confidence with obtaining informed consent increased by 46.90 percentage points, and maximal confidence increased by 5.95 percentage points (Table 1). When broken down by respondent, the percentage of students whose confidence with obtaining informed consent improved from nil/minimal to average or better was 38.47%. This increase was statistically significant (p < 0.0001).

In the pre-simulation survey, the percentage of students who reported that they were able to obtain informed consent with minimal or no assistance was 30.95%. Following the simulation, this percentage improved to 95.71%. The proportion of students who reported requiring minimal supervision with obtaining informed consent increased by 41.43 percentage points, and the proportion of students who felt able to perform this skill independently increased by 23.33 percentage points (Table 2). When we looked at individual respondents, the percentage of students whose perceived skill with obtaining informed consent improved from not being able to perform/need significant supervision to being able to perform with minimal supervision or independently was 47.25%. This increase was statistically significant (p < 0.0001).

Confidence and Perceived Skill with Electronic Order Entry

In the pre-simulation survey, the percentage of students who endorsed average or better confidence with electronic order entry was 55.95%. Following the simulation, this percentage improved to 90%. The proportion of students who reported average confidence with electronic order entry increased by 11.91 percentage points, above average confidence increased by 20.00 percentage points, and maximal confidence increased by 2.14 percentage points (Table 1). When broken down by respondent, the percentage of students whose confidence with electronic order entry improved from nil/minimal to average or better was 26.38%. This increase was statistically significant (p < 0.0001).

In the pre-simulation survey, the percentage of students who reported that they were able to perform electronic order entry with minimal or no assistance was 51.19%. Following the simulation, this percentage improved to 90%. The proportion

| Table 1: Student Confidence Pre- vs Post-Simulation (%) |
|---------------------------------|----------------|-------------|---------|---------|---------|---------|----------------|---------|-------------|---------|
|                                 | LP: Pre | LP: Post | Net Δ   | Informed Consent: Pre | Informed Consent: Post | Net Δ   | Electronic Order Entry: Pre | Electronic Order Entry: Post | Net Δ   |
| No confidence                   | 63.10   | 0.00     | -63.10  | 11.90   | 1.43    | -10.47 | 13.1   | 0.00     | -13.10  |
| Minimal Confidence              | 30.95   | 10.00    | -20.95  | 41.67   | 1.43    | -40.24 | 30.95  | 10.00    | -20.95  |
| Average Confidence              | 5.95    | 61.43    | +55.48  | 32.14   | 30.00   | -2.14  | 30.95  | 42.86    | +11.91  |
| Above Average Confidence        | 0.00    | 27.14    | +27.14  | 13.10   | 60.00   | +46.90 | 21.43  | 41.43    | +20.00  |
| Maximal Confidence              | 0.00    | 1.43     | +1.43   | 1.19    | 7.14    | +5.95  | 3.57   | 5.71     | +2.14   |

| Table 2: Student Perceived Skill Pre- vs Post-Simulation (%) |
|---------------------------------|----------------|-------------|---------|---------|---------|---------|----------------|---------|-------------|---------|
|                                 | LP: Pre | LP: Post | Net Δ   | Informed Consent: Pre | Informed Consent: Post | Net Δ   | Electronic Order Entry: Pre | Electronic Order Entry: Post | Net Δ   |
| Unable to Perform               | 45.74   | 0.00     | -45.74  | 5.95    | 0.00    | -5.95  | 4.76   | 0.00     | -4.76   |
| Requires Significant Supervision| 54.76   | 61.43    | +6.67   | 63.10   | 4.29    | -58.81 | 44.05  | 10.00    | -34.05  |
| Requires Minimal Supervision    | 0.00    | 38.57    | +38.57  | 28.57   | 70.00   | +41.43 | 41.67  | 71.43    | +29.76  |
| Can Perform Independently       | 0.00    | 0.00     | 0.00    | 2.38    | 25.71   | +23.33 | 9.52   | 18.57    | +9.05   |
of students who felt that they required minimal supervision for electronic order entry increased by 29.76 percentage points, and the proportion of students who felt able to perform the skill independently increased by 9.05 percentage points (Table 2). When we looked at individual respondents, the percentage of students whose perceived skill with electronic order entry improved from not being able to perform/ needing significant supervision to being able to perform with minimal supervision or independently was 28.58%. This increase was statistically significant (p < 0.0001).

Effect of Clerkship Timing within Academic Year on Results
To determine whether the students’ cumulative clinical experience in other clerkships affected the utility of the simulation, we stratified the survey results based on when in the academic year they rotated through the neurology clerkship (first half of the academic year vs second half). Between these groups, there was no statistically significant difference in the degree of improvement following the simulation regarding confidence and perceived skill with LP or informed consent (p values 0.13 - 1). There was, however, a significant difference between these two groups regarding confidence and skill with electronic order entry. The percentage of students whose confidence in electronic order entry improved from nil/minimal to average or more was 48.15% in the early group and 19.29% in the late group (p = 0.0266). The percentage of students whose perceived skill with electronic order entry improved from not being able to perform/ needing significant supervision to being able to perform with minimal supervision or independently was 55.56% in the early group and 19.29% in the late group (p = 0.0052).

Preceptor Evaluation of Student Skills with Live Patients
Out of 49 respondents to the end-of-clerkship survey, 27 (55%) reported participating in at least one LP, and 2 (4%) reported participating in 3 or more. 18 (37%) respondents reported participating in at least one informed consent discussion, and 2 (4%) reported participating in 3 or more. 15 (31%) respondents reported participating in at least one electronic order entry, and 6 (12%) reported participating in 3 or more. Regarding LP performance, seven clinical preceptors responded to the student performance evaluation request, with two preceptors declining to score their students on the basis that the students only observed the procedure and did not actively participate. Of the five remaining evaluations, three of them gave their students a score of 2 (able to perform with significant supervision), and two of them gave their students a score of 3 (able to perform with minimal supervision). Regarding informed consent performance, six clinical preceptors responded to the student performance evaluation request, with two preceptors declining to score their students. Of the remaining three, two of them gave their students a score of 4 (able to perform independently). The other preceptor, while not providing a numerical score, wrote that "[the student] was thorough and completed the consent verbiage without assistance". Regarding order entry, six clinical preceptors responded to the student performance evaluation request; three of these preceptors declined to score their students. Of the remaining three preceptors, one gave their student a score of 2, one gave their student a score of 3, and one gave their student a score of 4.

Comparison of Real-World Experience of Simulation Cohort vs. No-Simulation Cohort
To determine whether or not the simulation experience enabled the students to better participate in these skills in real-world settings, we compared the results of the survey sent to the MS-4s at the beginning of the 2019-2020 academic year (i.e. students who did not participate in the simulation) to the results of the same survey sent to rising MS-4s at the beginning of the 2020-2021 academic year. 25 students completed the 2019-2020 survey, and 17 students completed the 2020-2021 survey. One respondent to the 2019-2020 survey reported not yet completing the neurology clerkship. Of the 25 students who completed the 2019-2020 survey, 13 (52%) reported participating in at least one LP, 20 students (80%) reported participating in at least one informed consent discussion, and 21 students (84%) reported participating in at least one electronic order entry. By comparison, of the 17 students who completed the 2020-2021 survey, 11 (65%) reported participating in at least one LP, 16 students (94%) reported participating in at least one informed consent discussion, and 17 students (100%) reported participating in at least one electronic order entry (Tables 3 and 4).

Discussion
Our data demonstrate that our hybrid lumbar puncture simulation was effective at improving students’ confidence and perceived skill with obtaining informed consent, performing LP, and entering orders into the EMR. These effects were

Table 3: MS-4 Survey Responses 2019-2020 (n=25) (%)

|       | LP       | Informed Consent | Electronic Order Entry |
|-------|----------|-----------------|------------------------|
| 0     | 12 (48.00) | 5 (20.00)       | 4 (16.00)              |
| 1-2   | 13 (52.00) | 11 (44.00)      | 4 (16.00)              |
| 3+    | 0 (0.00)  | 9 (36.00)       | 17 (68.00)             |
seen independent of the clinical experience of the students as measured by the time of academic year they had their clerkship, particularly regarding obtaining informed consent and in performing LP. There was a statistically significant attrition in the improvement in confidence and perceived skill with electronic order entry in the late group as opposed to the early group. This finding is likely explained by the fact that rising fourth-year students reported more experience with order entry during their third-year clinical curriculum than they did with LP or with informed consent discussions. Correspondingly, students who rotated through the neurology clerkship later in the year had higher pre-simulation confidence and perceived skill scores than their earlier counterparts. Still, even in later groups, 19.29% of students had significant improvement in their confidence and perceived skill following our simulation.

Our data regarding improved real-world improvement following the simulation was hampered by low survey response rate. Only 49 students completed the end-of-clerkship survey, as opposed to the 84 who filled out the pre-simulation survey and 70 who filled out the post-simulation survey. Likewise, very few clinical preceptors responded to the student performance evaluation request (7 responses out of 27 student reports for LP, 6 responses out of 19 student reports for informed consent, and 6 responses out of 16 student reports for order entry), and relatively few students completed the class-wide surveys sent at the beginning of academic years 2019-2020 and 2020-2021. When taken descriptively, however, it can at least be said that the students were observed as being able to complete these skills with varying degrees of supervision, and rising MS-4s who participated in the simulation reported more real-world experience with these skills than their counterparts who did not participate in the simulation.

In conclusion, we have demonstrated that hybrid LP simulation is a feasible and effective way to teach lumbar puncture, informed consent, and electronic order entry. This simulation improves confidence and perceived skill with all three of these activities regardless of the clinical experience of the student. Furthermore, there is some suggestion from our data that this simulation also promotes competency with these skills in real-world settings.

**Take Home Messages**

- Lumbar puncture is currently underperformed by medical students prior to graduation.
- Lumbar puncture, informed consent discussions, and electronic order entry are three skills that medical school graduates should be able to perform upon entry into residency.
- Hybrid lumbar puncture simulation is feasible and effective in teaching medical students how to perform lumbar puncture, obtain informed consent, and enter orders into the electronic medical record.

**Notes On Contributors**

**Claire Yanta**, MD: Dr. Yanta is an Assistant Professor of Neurology at the University of Pittsburgh School of Medicine in Pittsburgh, PA, USA. She is the Director of the UPSOM MS-1 Neuroscience Course and is the Assistant Director of the UPSOM Neurology Clerkship.

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**Kristine Ruppert**, DrPH: Dr. Ruppert is an Assistant Professor of Epidemiology at the University of Pittsburgh Graduate School of Public Health. She also works with the University of Pittsburgh Clinical and Translational Science Institute to facilitate research within the health sciences at the University of Pittsburgh.

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**Table 4: MS-4 Survey Responses 2020-2021 (n=17) (%)**

|        | LP (n=17) (%) | Informed Consent (n=17) (%) | Electronic Order Entry (n=17) (%) |
|--------|--------------|-----------------------------|----------------------------------|
| 0      | 6 (35.29)    | 1 (5.88)                    | 0 (0.00)                         |
| 1-2    | 10 (58.82)   | 10 (58.82)                  | 6 (35.29)                        |
| 3+     | 1 (5.88)     | 6 (35.29)                   | 11 (64.71)                       |
Declarations
The author has declared that there are no conflicts of interest.

Ethics Statement
Approved by University of Pittsburgh Institutional Review Board on August 27, 2019 - Reference: STUDY19060286.

External Funding
The project described was supported by the National Institutes of Health through Grant Number UL1TR001857.

Supplementary Files
Supplementary file 1 - Supplementary File 1.pdf
Supplementary file 2 - Supplementary File 2.pdf
Supplementary file 3 - Supplementary File 3.pdf
Supplementary file 4 - Supplementary File 4.pdf
Supplementary file 5 - Supplementary File 5.pdf
Supplementary file 6 - Supplementary File 6.pdf
Supplementary file 7 - LP Sim Paper-MedEd Publish version 2(1).docx

Acknowledgments
We would like to thank our education coordinator Renee Craig and the staff and Standardized Patients at the Standardized Patient Program for their hard work and inestimable contribution to the success of this project. We would also like to thank our medical students for their participation in this project.

The project described was supported by the National Institutes of Health through Grant Number UL1TR001857.

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Open Peer Review

Migrated Content

Reviewer Report 07 October 2021

https://doi.org/10.21956/mep.20286.r31500

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Dimitri Parra
The Hospital for Sick Children

This review has been migrated. The reviewer awarded 4 stars out of 5

The authors present their experience with hybrid lumbar puncture simulation to teach EPA to medical students. Very interesting article. The review has significantly improved the paper. This work contributes to the field by showing creative alternatives to work with deficiencies in EPAs at different stages in medical education. I believe that this will also be useful in postgraduate education. I think the study design is adequate and I hope in future publications the portion based on the real-life experiences and assessment has more evidence. I think that is the key as, even though is valid, the student's self-assessment has limitations, and demonstrating quality improvement and decrease of health-related costs is the way to go to demonstrate the health care administrators that it is needed to include more simulated experiences to improve patients' outcomes and organizational efficiency. Congrats for the paper and I hope that the authors continue doing research in similar areas.

Competing Interests: No conflicts of interest were disclosed.

Reviewer Report 14 September 2021

https://doi.org/10.21956/mep.20286.r31498

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Ken Masters
Sultan Qaboos University
This review has been migrated. The reviewer awarded 5 stars out of 5

The authors have responded well to my comments on Version 1 of the paper (most of my comments dealt with layout and flow). The paper is now much easier to read and follow, and is a useful contribution to the field. Thank you.

**Competing Interests:** No conflicts of interest were disclosed.

Reviewer Report 07 September 2021

https://doi.org/10.21956/mep.20286.r31499

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BALAJI ARUMUGAM
TAGORE MEDICAL COLLEGE AND HOSPITAL

This review has been migrated. The reviewer awarded 4 stars out of 5

Simulation based medical education is defined as any educational activity that utilizes simulation aides to replicate clinical scenarios. Simulation tools serve as an alternative to real patients. A trainee can make mistakes and learn from them without the fear of harming the patient. But Hybrid simulation defined as the use of two or more simulation modalities within the same simulation session. An Entrustable Professional Activity is a key task of a discipline (i.e. specialty or subspecialty) that an individual can be trusted to perform in a given health care context, once sufficient competence has been demonstrated. The study was conducted and well handled using an educational tool (hybrid Simulation) to assess the learning among the fourth year medical students. The EPAs of 4, 11 and 12 but the sequence of EPAs assessed in this simulation is obtaining the informed consent (11), performing a procedure (12) and entering the orders (4). This Hybrid Simulation included three EPA competencies included as a single simulation scenarios for which the before and after surveys of the medical students on perceptions of confidence and performance of skill was obtained. Of the 128 students who completed the neurology clerkship during the 2019-2020 academic year, 84 completed the pre-simulation survey, 70 completed the post-simulation survey and 49 completed the end of clerkship survey. The attrition seems to be high. Question arises as the reviewer in this portion? At the end of the academic year, this same cohort of students was then asked to complete an identical online survey to that of the previous rising senior class (Supplementary File 1). These results were compared to the survey results of the prior rising senior class. This result is not within the objective of this study.

**Competing Interests:** No conflicts of interest were disclosed.
This review has been migrated. The reviewer awarded 4 stars out of 5

Thank you for submitting this manuscript for MedEdPublish. I enjoyed reading this paper. It is good to see this paper in the current context of Competency-based Medical Education (CBME) and Entrustable Professional Activities (EPAs). The authors presented the problem statement and the literature gap. The research methodology and data analysis are appropriate. The conclusions drawn were coherent with the results presented. But it could have been better, especially with long paragraphs, and readers might require to go back and forth. I am also skeptical of the transferability of knowledge from the simulation world to the real world, which could be an issue for any kind of simulation. And also, there is a drop in survey response rate at the end of the clerkship, which the authors also mentioned.

**Competing Interests:** No conflicts of interest were disclosed.

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This review has been migrated. The reviewer awarded 3 stars out of 5

An interesting paper on the use of hybrid lumbar puncture simulation to teach EPAs during a medical student neurology clerkship. The authors begin by clearly identifying a problem that they need to solve, namely that three EPAs are not being adequately addressed in their current training. Although there are good reasons for this, some of which are beyond their control, it remains a problem to be solved. They
then go on to describe a simulation training that has led to positive results. The main issue with the paper, however, is in the presentation, and I elaborate on this below:

• Some of the paragraphs are really long, and the reader is met with a wall of text. It would be preferable if these longer paragraphs could be broken into smaller paragraphs. This is important in the opening paragraphs, but also the paragraphs in the Results, where the reader is met with ideas and numbers that seem to flow into each other. These paragraphs can also benefit from sub-headings, to guide the reader through the text. The authors should bear in mind that they have conducted a study with multiple dimensions and results, and the aim is to ensure that the readers understand exactly what happened, and what the results were. Otherwise, the numbers get lost in a blur.
• It also does not help that the text in the Results refers to the EPAs by their names, but the headings in Table 1 and 2 refers to them by their number (even though there is a key at the bottom). It would be useful to be consistent in the convention, so I recommend that the table headings (can be split across two columns) give the name so that readers can more easily match what is being said in the text to what is being displayed in the table.
• Similarly, it would help the reader if the authors reported the results in the same order. In the text, they are displayed in LP, informed consent, order entry. In Table 1 and 2, they run order entry, informed consent and LP. Table 3 and 4 uses names, and runs: LP, informed consent, order entry, but also introduces EMR into the heading. A reader would now ask themselves if these are somehow different from the other order entries. Or might just stop reading.
• Other issues (again, of clarity) have been raised by the previous reviewer, so there is no need to repeat them here.

So, the study appears to be worth-while and has been well-conducted. The presentation of the paper, however, makes it difficult to read, and I can imagine most readers’ eyes glazing over and not completing the paper. I would like to see Version 2 of the paper, in which the authors address the issue of presentation, perhaps asking colleagues who are not familiar with the project to pre-screen it.

**Competing Interests:** No conflicts of interest were disclosed.

Reviewer Report 01 December 2020

https://doi.org/10.21956/mep.19144.r27678

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Mary Higgins
University College Dublin, National Maternity Hospital

This review has been migrated. The reviewer awarded 3 stars out of 5

Thank you for this interesting study. I am fascinated by the preceptor who signed off a students as being able to perform this independently. While you report that 54% of students had done at least one LP, what was the range? Can you also clarify the following for an international audience: PGY-1 (postgraduate year
one? first year post graduation?) Clerkships (clinical year student?) MS-4 (fourth year student?) In the introduction what are EPAs 1, 2, 5? How many EPAs are there?

**Competing Interests:** No conflicts of interest were disclosed.