Curriculum Innovations: A Podcast-Based Neurologic Emergency Flipped Classroom Curriculum for Neurology Residents

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Abstract

Introduction
Education on the management of neurologic emergencies is vital for neurology residents, and effective educational methods are needed. This study aims to implement and evaluate the impact of a podcast-based flipped classroom curriculum in neurologic emergencies. “Flipped classroom” instructional methods have been used in GME and informed by experiential learning theory.

Curriculum Objectives
The objectives of this curriculum were to (1) compare the clinical phenomena discussed in the neurologic emergencies podcast(s) with your own clinical experience; (2) discuss the pitfalls in the management of the neurologic emergencies discussed in the podcast(s); and (3) develop a management plan for the neurologic emergencies discussed in the podcast(s).

Methods
At 10 neurology residency programs, we implemented a 3-session flipped classroom curriculum covering topics in acute stroke, movement disorder emergencies, and status epilepticus. Each session consisted of a Neurology® podcast followed by content discussion with a clinical expert. Assessment of the curriculum included presession and postsession surveys focused on learners’ confidence and attitudes toward podcast-based education.

Results
Our data sample consisted of survey responses from residents, with response volumes ranging from 29-111 across all surveys. Podcasts are already highly used by neurology residents in their self-directed education. Confidence increased among learners in the management of movement disorder emergencies (18% confident before vs 79% confident after, \( p < 0.001 \)) and status epilepticus (72% confident before vs 91% confident after, \( p = 0.014 \)) among those who completed the curriculum. A change in confidence in acute stroke management was not found (\( p = 0.15 \)). Podcasts were consistently preferred over lectures and reading-based instructional methods while less preferred compared with simulation-based learning and case-based discussion with faculty. The podcast-based curriculum studied here showed high levels of enjoyment and perceived utility.

Conclusions
We present a 3-part curriculum to help build learners’ familiarity and confidence in 3 neurologic emergency categories. The educational impact is established in Level 1 of the Kirkpatrick paradigm. Future studies can explore a higher-level impact of this curriculum. Evolution in neurology education is shifting increasingly toward immediately accessible information via digital media. This curriculum can be useful to neurology educators who need to be increasingly agile and facile with multiple educational techniques to meet learners’ needs.
Supervised first-line management of neurologic emergencies is expected of neurology residents. Almost all neurology trainees are involved in managing acute stroke. Competency in managing status epilepticus is also essential; timely and appropriate treatment improves morbidity and mortality. Conversely, neurologic movement disorder emergencies are uncommon during the course of residency training. For all these scenarios, education innovation is valuable.

A “flipped classroom” (FC) teaching model pairs an instructional activity completed by learners ahead of an interactive educational session in which learners engage in problem-solving or exploring the nuance of a topic. Medical educators have urged the use of this methodology in medical schools to improve learning complex topics. The method has demonstrated favorable reception and more sustained knowledge retention among graduate medical education (GME) trainees. The use of FC methodology in neurology education at the undergraduate medical education (UME) or GME level is less common than in other medical specialties. FC methods using online modules have been used to teach neurologic emergencies to EM residents. The FC method is informed by student-centered learning theory, which has informed other instructional techniques (e.g., peer-assisted learning, problem-based learning). Others have placed the FC in the context of theories related to learning styles, in which the 2 components of the model cater to different steps in learning. For example, one can view FC instruction in the context of the Kolb cycle of experiential learning, in which learning occurs in discrete cyclic steps.

Podcasts represent a digital audio recording, typically distributed online, which can be played on almost any Internet-connected device with audio capabilities. Podcasts have been used across specialties in GME with outcomes ranging from increased learner satisfaction to changes in clinical practice, including topics in neurology. In education literature, podcasts have been discussed within the “Learning Object” framework as Audio Learning Objects. Learning objects represent “anything that has pedagogical value…so long as the object can be contextualized by individual learners.” The context is the “connections between the learning object and [the learner’s] experiences or knowledge.”

Problem Statement

Given the importance of training neurology residents in the management of neurologic emergencies, a series of podcast-based FC sessions focused on these topics were developed. The study aims to deepen the understanding of FC methods on teaching neurologic emergencies as well as the impact of podcasts in that FC framework. We applied frameworks of experiential learning and learning objects to develop the curriculum. We aimed to explore whether this approach is enjoyable for neurology resident learners.

Curriculum Objectives

The objectives of this curriculum were as follows:

1. To compare the clinical phenomena discussed in the neurologic emergencies podcast(s) with your own clinical experience.
2. To discuss the pitfalls in the management of the neurologic emergencies discussed in the podcast(s).
3. To develop a management plan for the neurologic emergencies discussed in the podcast(s).

Methods and Curriculum Description

Participants

The learners were US neurology residents in their PGY2 to PGY4 years of training. Discussion session facilitators were fellowship trained in the respective neurologic subspecialties being discussed (vascular neurology, epilepsy, and movement disorders).

Curricular Implementation

Educational sessions and data collection occurred from July 2021 through May 2022 at 10 neurology residency programs. At the discretion of program directors, sessions could occur at any time and in any order over the course of the year in the context of their existing scheduled residency didactic curriculum. All applicable links and documents were provided to residency programs via email. Data on which sessions were administered at each program were attempted, but only 50% of programs responded to this survey.

Curricular Program

The Neurology Podcast is a weekly podcast produced and distributed by the journal Neurology. In 2020, a series of Neurology Recall episodes were produced, featuring interviews between 2 subspecialty experts discussing the management of neurologic emergencies (acute stroke, status epilepticus, and movement disorder emergencies).

The curriculum consisted of 3 individual sessions in which learners were assigned a specific podcast before a facilitated discussion. The podcasts are available at no cost via web browser or via podcast-aggregating applications (e.g., Apple Podcasts, Spotify, etc). The episodes ranged from 35 to 48 minutes.

During interactive sessions, residents participated in a discussion about the management of the assigned neurologic emergency with the subspecialty neurologist. Programs were
Table Resident Survey Participation

<table>
<thead>
<tr>
<th>Survey</th>
<th>PGY2 residents</th>
<th>PGY3 residents</th>
<th>PGY4 residents</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>Baseline survey</td>
<td>38</td>
<td>35</td>
<td>38</td>
<td>111</td>
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<td>Movement disorder emergencies</td>
<td>10</td>
<td>7</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Status epilepticus</td>
<td>11</td>
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<td>11</td>
<td>32</td>
</tr>
<tr>
<td>Acute stroke</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>41</td>
</tr>
<tr>
<td>Final survey</td>
<td>10</td>
<td>12</td>
<td>9</td>
<td>31</td>
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instructed to allot 60 minutes for each discussion. Discussion questions for the facilitator were provided. Questions were intended to (1) review the salient information conveyed in the podcast, (2) prompt consideration on how learners have managed similar emergencies, (3) review any clinical protocols at their own institution for that neurologic emergency, and (4) review the management of the emergency topic with the facilitator. There is no assessment or evaluation of learners as part of the curriculum. Educational materials required for the curriculum (Podcast information and Discussion Questions) are available in the Supplementary Material (links.lww.com/NE9/A34).

Curricular Assessment and Data Collection
The primary outcomes were learners’ reactions to the curriculum and changes in self-reported confidence using surveys distributed before and after the discussion sessions. Surveys were administered through the Qualtrics platform (Provo, UT). Surveys were anonymous and did not record any identifying information about the respondent, including their training program, age, or sex.

Five surveys were distributed (Supplementary Material, links.lww.com/NE9/A34). A baseline survey gathered information on year of training, confidence in managing the neurologic conditions to be taught, and learners’ experience and attitudes toward using podcasts for their neurology education. Three surveys were distributed, respectively, after completion of each educational session. Among those who had both listened to the podcast and attended the session, the surveys gathered information on learners’ level of training, confidence in managing the applicable topic, and attitudes on the use of podcasts to learn that topic. Confidence was measured using a 5-point Likert scale ranging from “1 = extremely confident” to “5 = extremely unconfident.” A final survey was distributed at the end of the study that evaluated attitudes toward podcasts as educational tools and opinions on which aspects of the podcast format respondents found useful and not useful.

Analysis of Data
Descriptive statistics were used to explore participants’ level of training and attitudes about podcast learning. Attitudes about podcast learning vs other teaching methods were assessed via the χ² analysis. Confidence scales were assessed via the Mann-Whitney U test. Using the Spearman rho, a post hoc analysis evaluated confidence ratings over time to explore whether confidence increased with accrued residency experience, using days since July 1 as the measure of time. Quantitative analysis was completed with IBM SPSS v.26 and MS Excel 2016. Narrative feedback about the advantages and disadvantages of podcast learning were also reported.

Research Ethics, Informed Consent, and Data Availability
This study was determined exempted by the University of Utah IRB. Signed consent was not obtained; the recruitment email inviting residents’ participation was reviewed and approved by the IRB. Participants were informed of their right to refuse participation in data collection without any impact on their ability to participate in the educational sessions themselves. Anonymized data not published within this article will be made available by request.

Results
Demographic Data
Curricular materials and surveys were distributed to 10 neurology residency programs across 10 different states representing multiple US Census geographic divisions. The average size of the residency programs (PGY2-PGY4) was 22.6 residents (range 9–32).

Baseline Data
The Table summarizes the baseline surveys that were completed by 111 respondents (38 PGY2, 35 PGY3, and 38 PGY4). At baseline, 78% of respondents had previously used a podcast to learn neurology and 86% reported they were likely to use podcasts to learn neurology. For learning neurology, participants reported they preferred podcasts over lectures (54% preferred podcasts), review articles (65% preferred podcasts), and textbooks (80% preferred podcasts). Podcasts were not preferred over simulation (20% preferred podcasts) nor case discussions with faculty (18% preferred podcasts).

Movement Disorder Emergency Session
Twenty-nine participants completed surveys on the movement disorder session (10 PGY2, 7 PGY3, and 12 PGY4). Among participants, 72.4% enjoyed the session, 24.1% were neutral, and 3.4% did not enjoy the session. Regarding the podcast, 89.7% felt the podcast was appropriate to their level, 10.3% felt the podcast was overly simple, and 0% felt the podcast was overly complex.

For learning movement disorder emergencies, participants preferred podcasts over lectures (51% preferred podcasts), review articles (79% preferred podcasts), and textbooks (72% preferred podcasts). Podcasts were less preferred when compared with simulation (38% preferred podcasts) and case discussion (28% preferred podcasts).
Reported confidence in managing movement disorder emergencies was higher after the education session (median [Mdn] = 2.0, mean [M] = 2.1) compared with baseline (Mdn = 4.0, M = 3.5), U(Npre = 111, Npost = 29) = 423.00, z = −6.33, p < 0.001).

Subgroup analysis demonstrated the same pattern in PGY2 residents (Mdn = 4.0 pre vs 2.0 post; M = 4.3 pre vs 2.3 post; U[Npre = 38, Npost = 10] = 4.50, z = −5.00, p < 0.001); PGY3 residents (Mdn = 3.0 pre vs 2.0 post; M = 3.2 pre vs 2.3 post; U[Npre = 35, Npost = 7] = 50.0, z = −2.57, p = 0.011); and PGY4 residents (Mdn = 3.0 pre vs 2.0 post; M = 3.1 pre vs 1.9 post; U[Npre = 38, Npost = 12] = 73.0, z = −3.73, p < 0.001). See Figure 1.

Subgroup analysis showed increased confidence in PGY2 residents (Mdn = 3.5 pre vs 2.0 post; M = 3.3 pre vs 1.9 post; U[Npre = 38, Npost = 10] = 4.50, z = −5.00, p < 0.001).}

Bars to the left of 0% represent participants indicating confidence as less than neutral (somewhat or extremely unconfident), while bars to the right represent participants indicating a confidence level of neutral, somewhat, or extremely confident. Confidence assessments before the FC session (pre, N = 111) are on top, while assessments from after the FC session (post, N = 29) are below. The 4 groups represent all participants (top) as well as by ascending PGY level (top to bottom). *p < 0.05, ns = not significant.

**Status Epilepticus Session**

Thirty-two learners completed the survey after the status epilepticus management session (11 PGY2, 10 PGY3, and 11 PGY4). Among them, 72% enjoyed the session, 28% were neutral, and 0% did not enjoy the session. Regarding the podcast, 91% felt the podcast was appropriate to their level, 9% felt the podcast was overly simple, and 0% felt it was overly complex.

For learning status epilepticus management, participants preferred podcasts over lectures (75% preferred podcasts), review articles (84% preferred podcasts), and textbooks (89% preferred podcasts). Podcasts were less preferred when compared with simulation (38% preferred podcasts) and case discussion with faculty (28% preferred podcasts).

Confidence in managing status epilepticus was higher after completion of the education session (Mdn = 2.0, M = 1.7) compared with baseline data (Mdn = 2.0, M = 2.2) as analyzed via the Mann–Whitney U test (Npre = 111, Npost = 32) = 1,301, z = −2.45, p = 0.014).

Subgroup analysis showed increased confidence in PGY2 residents (Mdn = 3.5 pre vs 2.0 post; M = 3.3 pre vs 1.9 post; U[Npre = 38, Npost = 10] = 4.50, z = −5.00, p < 0.001).
There was no effect in PGY3 (Mdn = 2.0 pre vs 1.5 post; M = 1.8 pre and post; U[Npre = 35, Npost = 10] = 141.5, z = −1.07, p = 0.28) or PGY4 residents (Mdn = 1.0 pre vs 1.0 post; M = 1.6 pre vs 1.5 post; U[Npre = 38, Npost = 11] = 181.0, z = −0.776, p = 0.438). See Figure 2.

**Acute Stroke Session**

Forty-one learners completed the survey after the session on the management of acute stroke (14 PGY2, 13 PGY3, and 14 PGY4). Among participants, 71% enjoyed the session, 24% were neutral, and 5% did not enjoy it. Regarding the podcast, 85% felt the discussion was appropriate to their level, 12% felt the podcast was overly simple, and 2% felt it was overly complex.

For learning acute stroke, participants preferred podcasts over lectures (76% preferred podcasts), review articles (81% preferred podcasts), and textbooks (90% preferred podcasts). Podcasts were less preferred when compared with simulation (27% preferred podcasts) and case discussion with faculty (15% preferred podcasts).

Confidence in managing acute stroke was not increased after the education session (Mdn = 2.0, M = 1.8) when compared with baseline data (Mdn = 2.0, M = 2.0) via the Mann-Whitney U test (U[Npre = 111, Npost = 32] = 1957.5, z = −1.42, p = 0.154).

There were no changes in confidence among PGY2 residents (Mdn = 2.0 pre vs 2.0 post; M = 2.6 pre vs 2.5 post; U[Npre = 38, Npost = 14] = 252.5, z = −0.301, p = 0.763) or PGY4 residents (Mdn = 1.0 pre vs 1.0 post; M = 1.4 pre vs 1.5 post; U[Npre = 38, Npost = 14] = 236.5, z = −0.729, p = 0.466). There was a reduction in confidence among PGY3 residents (Mdn = 1.0 pre vs 2.0 post; M = 1.5 pre vs 1.9 post; U[Npre = 35, Npost = 13] = 146.0, z = −2.15, p = 0.03). See Figure 3.

**Final Survey Analysis**

Thirty-one learners completed the final survey (10 PGY2, 12 PGY3, and 9 PGY4): 74% had attended the movement...
disorder emergencies session, 61% had attended the status epilepticus session, and 74% had attended the acute stroke session.

For learning neurology, 74% reported being more likely to use podcasts, 23% reported being equally likely, and 3% reported being less likely. Compared with baseline, the proportion of learners reporting they were likely to use podcasts to learn neurology was not significantly different (86% pre vs 77% post; \(X^2[1, N = 142] = 1.19, p = 0.275\)). Regarding utility in neurology education, 94% reported that podcasts were useful. In comparing podcasts with other teaching methods after completing the curriculum, there was no difference in preferring podcasts over lectures (54% vs 45%, \(X^2[1, N = 116] = 0.730, p = 0.39\)), review articles (65% vs 58%, \(X^2[1, N = 116] = 0.429, p = 0.51\)), textbooks (80% vs 84%, \(X^2[1, N = 116] = 0.221, p = 0.64\)), or case discussions (18% vs 16%, \(X^2[1, N = 116] = 0.037, p = 0.85\)). There was an increased proportion of respondents preferring podcasts over simulation (20% vs 42%, \(X^2[1, N = 116] = 5.70, p = 0.02\)). See Figure 4.

Confidence Over Time

The baseline survey was completed an average of 132 days into the academic year (range 27–324). At baseline, residents’ confidence weakly correlated with the days since July 1 for managing acute stroke (\(r = 0.30, p = 0.001\)) and movement disorder emergencies (\(r = 0.23, p = 0.015\)) while non-significant for status epilepticus (\(r = 0.18, p = 0.050\)). Among PGY2 residents, baseline confidence was weakly correlated with days for status epilepticus (\(r = 0.38, p = 0.02\)) and moderately for acute stroke (\(r = 0.57, p < 0.001\)) but not for movement disorder emergencies (\(r = 0.24, p = 0.15\)). For PGY3 respondents, confidence was moderately correlated with days for status epilepticus (\(r = 0.44, p = 0.009\)) and for acute stroke (\(r = 0.65, p < 0.001\)) but not movement disorder emergencies (\(r = 0.11, p = 0.54\)). In the PGY4 cohort, none of the baseline confidence reports correlated with time: status

Bars to the left of 0% represent participants indicating confidence as less than neutral (somewhat or extremely unconfident), while bars to the right represent participants indicating a confidence level of neutral, somewhat, or extremely confident. Confidence assessments before the FC session (pre, \(N = 111\)) are on top, while assessments from after the FC session (post, \(N = 41\)) are below. The 4 groups represent all participants (top) as well as by ascending PGY level (top to bottom). *\(p < 0.05\), NS = not significant.
epilepticus ($r = -0.007, p = 0.97$); acute stroke ($r = -0.10, p = 0.57$); or movement disorder emergencies ($r = 0.29, p = 0.08$).

The postdiscussion surveys were submitted an average of 107 days (range 62–314) after July 1 for the acute stroke session, 131 days (range 34–314) for status epilepticus, and 160 days (range 106–334) for movement disorder emergencies. In the postsession surveys, there was no correlation between the number of days since July 1 and confidence in status epilepticus ($r = -0.16, p = 0.40$), acute stroke ($r = -0.06, p = 0.69$), or movement disorder emergencies ($r = 0.01, p = 0.94$). In PGY2 respondents, there was a trend toward significance in status epilepticus management correlating with time ($r = 0.52, p = 0.099$) but no correlation in acute stroke ($r = 0.21, p = 0.46$) or movement disorder emergencies ($r = 0.11, p = 0.75$). Among PGY3 residents, there was no correlation for status epilepticus ($r = -0.44, p = 0.20$), acute stroke ($r = -0.22, p = 0.47$), or movement disorder emergencies ($r = -0.32, p = 0.49$). For the PGY4 cohort, a correlation was not found in status epilepticus ($r = -0.40, p = 0.22$), acute stroke ($r = -0.21, p = 0.45$), nor movement disorder emergencies ($r = 0.03, p = 0.92$).

**Narrative Feedback**

The final survey asked participants to comment on the advantages and disadvantages of podcast-based learning. Regarding advantages, one learner identified podcast-based learning as “Convenient; was able to listen during daily commute and did not have to take additional time out of my day.” The ability to self-pace was also appreciated, one learner noting “I cannot pause/rewind an in-person lecture. My hands are also free for notes and I can look things up/type them up without having to focus on a PowerPoint.”

The lack of multimodal learning with both audio and video was noted as a disadvantage. One resident commented that it was “Hard to picture concepts that have lots of definitions of...
less commonly seen pathologies or terms, like abnormal movements that a video might be better for.” The passive nature of listening to audio was not appreciated by one learner, reporting “Sometimes I find my mind wandering when I don’t have visual stimulation while learning.” The amount of preparation needed for the discussion session was also reported as a disadvantage.

**Discussion**

We present an FC curriculum for neurology residents on 3 emergency neurology topics featuring podcast-based instruction followed by expert-led discussion on clinical topics. The primary impact reported focuses on residents’ reaction and changes in confidence. These results demonstrate preliminary findings of a positive impact of the curriculum and establish a rationale for further, more rigorous, assessment of this curriculum’s impact on residents’ knowledge or clinical skills.

Using the Kirkpatrick framework to evaluate educational interventions, the curricular sessions’ impact was positive on residents’ reaction and confidence (Kirkpatrick Level 1). Level 1 impact is demonstrated via learners’ responses or attitudes toward the session. Level 2 impact gauges knowledge, skills, and confidence, typically via measuring knowledge and skill improvement. While some studies have used self-reported confidence to demonstrate Level 2 impact, these reports of confidence often pertain to specific topics covered by the curriculum rather than overarching confidence.

Participants’ reported confidence increased after completing the sessions on status epilepticus and movement disorder emergencies (Figures 1 and 2). This effect was not found for acute stroke management (Figure 3). Baseline confidence ratings in acute stroke management were high, perhaps due to high volume of acute stroke management in neurology training. Thus, improvement in confidence may be limited by a ceiling effect.

Based on subgroup analysis, we suspect that actual experience in managing these neurologic emergencies modifies the sessions’ effect. The session on movement disorder emergencies was associated with positive shifts (some large) in confidence across training levels. Movement disorder emergencies are estimated to be encountered only 1–2 times in the course of residency training. This lack of experience may result in a more robust change in confidence after education.

In further support of this finding, confidence gains in managing status epilepticus were seen in subgroup analysis only among more experienced PGY3 and PGY4 residents in managing status epilepticus. The acute stroke session was associated with decreased confidence in PGY3 residents, though it is worth noting that no PGY3 participants reported feeling somewhat or extremely unconfident before or after the session. Further evaluation is needed, but we speculate that the more rare and nuanced clinical decisions discussed in the acute stroke podcast (e.g., thrombolysis in pregnancy or retinal artery occlusion) may have been humbling, emphasizing experience or knowledge gaps among PGY3 residents, which resulted in a mild reduction in confidence. We take caution in drawing excessive conclusions from a small sample, but this could be an area of further study.

In addition to gains in confidence, enjoyment of the curriculum was high. Baseline data demonstrated that podcasts are already popular for learning neurology. At the end of the curriculum, most residents reported that podcasts were helpful in their education (94%) and that they were more likely to use podcasts in the future compared with their recollection before the curriculum (74%). However, the percent of residents reporting they are likely to use podcasts for neurology on the initial survey was 86% compared with 77% on the final survey. While this difference was not significant, the decrease from before to after curricular implementation contradicts the former figure and creates some uncertainty in these results. This may be potentially attributed to noise in the data from the differences in sample size between the baseline and final surveys; future studies could examine actual learning practices via surveys or metadata of podcast downloads/streams.

Preference data in this study repeatedly showed that podcasts are preferred over lectures and reading of text, while less preferred compared with simulation and case-based discussion. One comparison indicated that this curriculum was able to increase the preference of podcasts compared with medical simulation; however, this result fails to remain significant if correcting for multiple comparisons.

The curriculum is likely easy to implement, using a freely available podcast as instructional material. While our discussion sessions featured subspecialty experts in movement disorders, epilepsy, and vascular neurology, programs could potentially use nonfellowship-trained faculty if they feel equipped to discuss the neurologic emergency topics. The curriculum is presented as a 3-part series; however, each session can be implemented in isolation.

The curriculum is not without disadvantages. Residents spent more than 30 minutes before the discussion in podcast listening. Some respondents noted an advantage of podcast listening was the ability to take notes or to rewind and relisten, which requires time and can be difficult to do while multitasking. When coupled with the 60-minute discussion session, the time devoted to the topic may total more than 90 minutes, which educators may find inefficient or residents may consider burdensome. Future research could experiment with
protecting 30 minutes of resident time for listening followed by a 30-minute discussion with an assessment of educational impact. In an era of busy clinical services and emphasis on work-life balance, the time commitments of these sessions should be considered.28

The curriculum’s impact on learning should not be overstated. While a growth in resident confidence may reflect a desired impact, further evaluation of knowledge or clinical skill development is needed. Future research could develop tests or other knowledge assessments for before and after the curriculum. Simulations of the neurologic emergencies taught could be developed to assess learners’ skills in managing these clinical scenarios.

In describing changes in confidence, changes in proportions of learners reporting confidence had varying magnitudes. Some showed seemingly large magnitudes such as the 61% increase among those who participated in the movement disorder emergencies session where others were more modest such as the 19% increase within status epilepticus management. Ultimately, knowing whether any of these changes are meaningful is challenging. As mentioned earlier, future studies that better define educational impact through changes in clinical behavior or performance would better capture the impact of an educational intervention. For example, if 19% more trainees could achieve competence on a validated stroke simulation protocol, educators could likely be more confident in the meaningful impact their curriculum conferred.

We are cautious in deducing that an increase in confidence begets increased clinical competence. In status epilepticus, a simulation-based assessment of neurology residents demonstrated that, despite high levels of self-reported confidence and experience in recognizing and managing status epilepticus, standards of competence were difficult to achieve.2 Other studies show that self-assessment of skill correlates poorly with objective measures of clinical abilities.29 Future educational interventions could study the implementation of similar teaching methods for other neurologic emergencies (e.g., cerebral herniation) or for nonemergent clinical syndromes (e.g., headache). One could also look at residents’ actual clinical practice changes to assess for higher-level impact.

This was an uncontrolled comparison among learners; everyone was exposed to the educational curriculum, and no control group was formed. Thus, it is possible that learners’ confidence increased by experience over time rather than due to our intervention. Our post hoc analysis suggests that the timing of the baseline survey correlates with participants’ reported confidence, with confidence growing over time. However these correlation coefficients were typically weak. Significant correlation was not found with postsession surveys, which suggests the effect on confidence seen was not only due to elapsed time but could be attributed to the curriculum intervention. We also acknowledge that the postsession subgroups are small and thus poorly powered such that we may have failed to detect a significant correlation that is actually present.

Survey participation was low at baseline and waned with subsequent survey administration. With 10 programs averaging 22 trainees per program, the baseline survey number of 110 indicates a relatively low response rate. Subsequent postsession response numbers may only represent approximately 10% of eligible residents. Given this sample size attrition, the confidence and attitudes of the remaining 90% of eligible but not surveyed residents may differ from those who responded. Attitudes toward podcast learning vs other modalities (lecture, simulation, etc.) may be misrepresented among those who completed data collection when compared with those who did not. Data on education session administration were not collected, so the total number of participants exposed to the curriculum is not known. Quantitative data to explain this drop are not available. The first survey was not associated with session attendance, while subsequent surveys were. Attendance numbers at each session were not recorded. We have previously discussed that attendance at GME didactics can be challenging in the current training environment.28,36 It is possible that residents who missed a session were less likely to open the survey link, reducing completion rates. Furthermore, while attendance at all sessions was not a requirement for completion of the final survey, some participants may have erroneously thought as much and thus not opened the final survey. Anecdotally, participating educators described other challenges to study and curricular execution. The impact of SARS-CoV-2 (COVID) on GME education has been well described.31-34 Over the course of this study, surges in cases with COVID required rescheduling and reformating of scheduled resident didactic sessions. Other sites commented that distributing the survey in the final minutes of the discussion session itself yielded higher response rates; however, this practice was not required and likely not applied across all sites.

Statistical inferences must be interpreted with caution. Resident participants were not tracked with unique identifiers; thus statistical tests for independent samples were used. In performing so, statistical power is lost when compared with a paired-participant design with comparisons for dependent samples. In addition, there may be bias in residents’ decisions to complete the postsession surveys that could influence the postsession data. For example, attendance and survey participation may have been higher in residents with preexisting interest or confidence in the topics discussed, skewing the postsession results toward showing high confidence impact. Finally, the subgroups used in analyzing these sessions are small. Some of these subgroups still differed from one another at a significant level (e.g., analysis of confidence in movement disorder emergency management) indicating that power in these groups was adequate. However, among those analyses without statistical significance, inadequate power leading to Type II error is certainly possible. Power analysis was not performed before the study.

The theoretical background for the use of podcasts in an FC method is guided by the notion of a podcast as a Learning
The Learning Object is often conceptualized as a building block in a greater curriculum, analogous to Lego bricks; they can be reused or fit together with other learning objects to build curricula.35 Typically, learning objects are described as a component of E-Learning in digital learning materials. This aligns well with the podcast, given its portable, reusable, and digital qualities.

Inherent in the definition of Learning Object is the need for context for the learner. To provide that context, the FC instructional method was used. Kolb experiential learning theory informs the use of FC-based instruction. In our model, the podcast/learning object serves as the concrete experience to deliver knowledge, while the discussion facilitates the reflective observation, abstract conceptualization, or even active experimentation components of Kolb cycle.15,30 Of interest, some evidence indicates that dialog podcasts may begin to facilitate cognitive integration, where discussion between 2 people role models knowledge application.36,37 While our survey indicated residents appreciated the dialog format, our study is not equipped to assess our podcast compared with a monolog format.

As discussed earlier, while Kolb theory points to experiential learning, the primary outcome measured in this study was confidence, which is an inadequate corollary. To further solidify the use of podcast-based FC instructional methods and to better integrate the Podcast as a Learning Object in this paradigm, future work should assess learning via measured knowledge or even clinical skill acquisition.

Resident educators and neurology learners have various teaching and learning methods at their disposal. Because residency programs find that attendance at in-person didactic sessions wanes, engaging self-directed educational material becomes increasingly valuable.28,30 Neurology education experts advocate for “together time” as a vital educational component for learners to integrate the complexity of the material.30,38

In conclusion, this study adds to a growing set of data on the use of podcasts in resident education, contextualized by theoretical frameworks surrounding learning objects and experiential learning. Future studies are needed to measure the educational impact of this or other podcast-based curricula via controlled comparison studies with objective assessment of skills or knowledge.

In GME, learners are shifting increasingly toward immediately accessible digital information.39-41 Educators need to be increasingly agile and facile with educational techniques and methods that simultaneously fit into the learners’ clinical schedule and maintain attention and engagement, while helping trainees master complex neurologic topics. Podcast-based FC education may have a role in this educational paradigm shift.

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J. Ratliff serves as the Deputy Section Editor for Podcasts for the journal Neurology and Deputy Editor of the Neurology Minute Daily Briefing from the AAN. S. Clardy serves as the Section Editor for Podcasts for the journal Neurology and Editor of the Neurology Minute Daily Briefing from the AAN. F. Nascimento serves as the Deputy Editor for the Neurology Minute Daily Briefing from the AAN. Go to Neurology.org/NE for full disclosures.

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