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An Emergency Medicine Milestone-Based Simulation Curriculum: Acute Ischemic Stroke

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Appendices

A. CVA Scenario Template .docx
B. CVA History and Physical .doc
C. CVA Triage.doc
D. CVA Radiographs and ECG .docx
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All appendices are peer reviewed as integral parts of the Original Publication.

Abstract

Introduction: The emergency medicine (EM) resident's ability to make independent decisions in the setting of acute ischemic stroke has been reduced as a result of the involvement of multidisciplinary teams. This simulation was created to give EM residents the opportunity to independently manage the early stages of ischemic stroke and its complications. **Methods:** A solo learner was presented with a 55-year-old male with complaints consistent with an acute stroke. The resident had to calculate stroke severity; coordinate hospital resources; discuss risks, benefits, and alternatives to thrombolysis; and deal with subsequent complications. The learner had to keep a broad differential for sudden change in mental status and consider alternative interventions. Strategies to decrease intracranial pressure needed to be implemented while obtaining neurosurgical consultation. Debriefing included discussion of expected actions in the context of the Accreditation Council for Graduate Medical Education (ACGME) milestones. Residents' review of their video performance added additional self-reflection. **Results:** A total of 69 PGY 3 EM residents independently participated in this simulation over a 5-year period. Thirty-two completed a postsimulation evaluation. Nearly all learners felt that this case reflected an actual patient encounter and increased their confidence in managing stroke. The milestone-based feedback tool was completed with all learners. Anticipated actions linked to Level 1 and 2 milestones were regularly achieved while acquisition of Level 3 and 4 actions varied. **Discussion:** Case actions were uniquely characterized by the ACGME milestones, which helped to delineate learners' knowledge gaps and provided concrete areas for improvement.

Keywords

Simulation, Professionalism, Stroke, Standardized Patient, Emergency Medicine, Communication Skills, Ischemic Stroke, ACGME Milestones, Clinical/Procedural Skills Training, tPA, NIH Stroke Scale

Educational Objectives

By the end of this activity, the learner will be able to:

1. Manage ischemic stroke following American Heart Association/American Stroke Association 2018 guidelines.
2. Discuss risks, benefits, and alternative treatments for acute ischemic stroke.
3. Formulate a differential for acutely worsening mental status change following intravenous thrombolysis administration.
4. Implement strategies to manage acute stroke-related complications.

Introduction

Strokelike symptoms are a common complaint in the Emergency Department (ED). Moreover, the management of stroke has evolved over the last 5-10 years. Implementing a multidisciplinary approach to treatment can help deliver the highest quality of care.[1] However, emergency medicine (EM) physicians are often asked to take the lead in treating these patients. It is important that EM residents are able to diagnose and manage patients presenting with acute ischemic stroke. Furthermore, residents must be well versed in discussing treatment options, including thrombolytic therapy and neurointervention, with patients and families as morbidity and mortality associated with these treatments are not insignificant.[2]

Other acute stroke simulation cases have been published in the past, showing learning objectives that primarily focus on stroke diagnosis, discussion of risk benefit alternatives, and initial management of acute ischemic strokes.[3,4] However, none of these cases address severe complications of stroke or critical care interventions in the ED. Our simulation case provides a unique learning opportunity for the management of an acute ischemic stroke and its related complications.

Despite the high rate of ED visits for patients with stroke or transient ischemic attack, we observed that learners at large centers have less opportunity to independently manage acute ischemic stroke and may rely on a multidisciplinary stroke team.[5] At our institution, a number of providers descend into the ED when a patient presents with symptoms consistent with a stroke. This often includes a neurologist, a stroke physician assistant, an Emergency Center pharmacist, and several members of the medical intensive care team. Our simulation team created this case based on an actual patient encounter after observing that many of our upper-level residents were not facile in completing a stroke scale or comfortable making the decision regarding the administration of tissue plasminogen activator (tPA). We hoped that increased exposure to solo management of a stroke case would improve residents' comfort level managing stroke, including the decision to administer thrombolytics, and potential acute complications. Simulation was determined to be a useful modality to accomplish this goal.

Simulation is an efficient and effective means to deliver educational content. Furthermore, simulation serves as a tool that can be used to directly evaluate a learner, especially when done in an individual setting. Given our observation of residents caring for stroke patients, we felt residents would benefit from additional independent exposure to this patient population along with direct and concrete evaluation of their assessment and management.

We present a case of a patient with acute ischemic stroke who decompensates and requires further emergent intervention. Although the clinical presentation is relatively straightforward, the development of an algorithm for managing acute stroke, along with the complexity of the decision making, makes this an excellent teaching case. Also unique to this simulation case is a feedback tool containing anticipated behaviors based on training level that are directly linked to Accreditation Council for Graduate Medical Education (ACGME) milestone levels.[6] Paired with the critical action checklist, this novel tool contributes additional formative evaluation metrics to a resident's academic record and provides a framework for more specific and concrete feedback during debriefing.

Although other stroke simulations are available in *MedEdPORTAL,* this case is unique in its presentation of additional complications following initial evaluation, its target audience of the solo EM resident learner, and its incorporation of anticipated behaviors linked specifically to the ACGME milestones and their levels.

Methods

Development

We had two specific goals in the development of this simulation. The first was to allow the individual learner to manage an acute ischemic stroke, administer tPA, and deal with the complication of an expanding stroke and cerebral herniation. We wanted this to be done in a setting that did not include an extensive multidisciplinary team. An ischemic stroke presentation along with the question of need for thrombolysis could easily be presented within a simulation case. The case included the decision to proceed with intubation, which could be performed and assessed during simulation. Lastly, identification of vital sign changes (e.g., Cushing reflex) and the clinical exam made this an optimal case for learning how to diagnose and manage stroke in the simulation setting.

Our second goal was to evaluate the EM resident on behaviors linked to the ACGME milestones.[6] A framework for progression of competency through resident training, the ACGME milestones lent themselves to being incorporated into the context of the case. Evaluation of the EM resident was done through the use of a novel feedback tool and a critical action checklist. The feedback tool was constructed based on expected actions, author consensus, and ideal case flow. Minor modifications based on faculty and resident feedback were made in the early stages of case development.

Equipment/Environment

The simulation took place in a setting that mirrored an ED resuscitation bay. The following equipment was available and used to optimize the case: a high-fidelity mannequin, a full range of airway management and vascular access equipment and supplies, and simulated (and appropriately labeled *SIM USE ONLY—NOT FOR PATIENT USE*) medications including tPA, rapid sequence intubation, and vasoactive drugs. The mannequin was dressed in a gown and placed upright in bed. A chair for the family member was next to the bed. Radiographs (Appendix D), laboratory results (Appendix E), and the National Institutes of Health (NIH) Stroke Scale[7] were available to the nurse and released as requested.

Personnel

This simulation required a minimum of three faculty or simulation personnel. One person, usually a faculty member, managed the simulator software and provided relevant history to the learner. This person also provided subspecialty information via the phone if a service was consulted. Subspecialties included neurology, medical intensivist, interventional neuroradiology, stroke team, and neurosurgery. Learners called consultants on the room phone or verbalized whom they would like to have called. Consultants were portrayed as unavailable or reluctant to direct care, driving the learner to perform necessary actions independently or to continue to advocate for the patient.

A second person functioned as a family member. Typically, this was a spouse. A case instructor or simulation staff member played this role. This person answered the learner's questions about past medical history, timing, and shared decision-making responsibility regarding treatment. Ultimately, the family member acted as the only medical decision maker after the patient had been intubated.

A third helper functioned as the ED nurse. The nurse was commonly played by a case instructor, rarely played by simulation center personnel or an actual ED nurse. If enough simulation personnel were available, we found it best for the lead instructor to focus solely on completion of the feedback tool and critical action checklist. This improved recall of case flow and decreased time between the ending of the case and the debriefing. If the lead instructor played an additional role, then the feedback tool and critical action checklist were completed with the assistance of other faculty prior to the debriefing.

Implementation

The simulation leader reviewed and organized all documents before the start of each simulation. All faculty helpers received simulation documentation for review via email at least 1 week prior to the session. Every effort was made to invite the same faculty helpers to each session to minimize time spent reviewing the case and to improve standardization. The simulation team held a brief, 5- to 10-minute session to review key points and answer any questions before the case began. Reviewing materials and meeting beforehand were important to ensure standardization of the case and evaluation. Having hard copies of the case available for the instructors during this briefing was helpful. A small cadre of experienced evaluators, intimately familiar with the case, completed the feedback tool and checklist. The simulation scenario details and flow are detailed in Appendix A. Additional resources used during the case included a history and physical form (Appendix B), a triage information sheet (Appendix C), imaging studies (Appendix D), laboratory studies (Appendix E), a critical action milestone-based evaluation form (Appendix F), a milestone-based feedback tool (Appendix G), and the NIH Stroke Scale[7] if requested. The simulator was programed to the initial set of vital signs per Appendix A, and changes in vital signs proceeded based on scenario progression per the table shown in Appendix A.

The learner was familiar with the simulation room, the available equipment, and the staff who helped with the case. Learners participating in the case were scheduled for a 1-hour session. The target audience, PGY

3 EM residents, had participated in previous simulation sessions and therefore did not require additional orientation prior to the start of this case.

The case began with the nurse inviting the resident into the simulation room and handing him or her a triage information sheet (Appendix C). The mannequin was dressed in a hospital gown and sitting upright on a stretcher. The patient's family member was positioned in a chair at the bedside. The family member and nurse had their case packets with them during the simulation session in case they needed to refer to the documents when answering questions or giving the learner prompts during the case.

The simulation operator provided history and physical exam findings when requested. The patient's family member also provided historical information and helped in decision making for the patient. The learner assessed the patient, including airway, breathing, and circulation, and then should have quickly transported him to CT for brain imaging.

Upon the patient's return from radiology, the learner ordered appropriate lab work (Appendix E) and imaging (Appendix D). Point-of-care glucose result was ordered and was normal. The decision to administer tPA followed evaluation of the NIH Stroke Scale. If an institution has pharmacy resources available regarding the use of tPA, then those guidelines can provide additional information to the resident. The patient's elevated blood pressure and warfarin use were addressed prior to the administration of tPA. While the resident was on the phone with the admitting physician following the administration of tPA, the patient experienced a rapid decline in mental status. He became unresponsive, developed a dilated right pupil with right gaze palsy, and had vital signs consistent with a Cushing response. Thrombolytics, if started, were held until repeat brain CT ruled out hemorrhagic transformation. Management for potential herniation included hyperosmolar therapy, hyperventilation in the short term, and elevation of the head of the bed.[8] The patient was intubated and underwent repeat brain CT that showed an expanding area of stroke without hemorrhage. Further involvement of neurosurgery and the neurologic intensive care unit was required given concern for herniation and worsening clinical status. A CT perfusion study, if ordered, verbally confirmed left middle cerebral artery stroke. The patient was not a candidate for mechanical thrombectomy following consultation with neuroradiology.

The lead instructor focused on real-time completion of the milestone-based critical action checklist (Appendix F) and feedback tool (Appendix G). The simulation took approximately 20 minutes to complete. A debriefing session followed, which elicited a verbal evaluation from the participant and covered review of the critical action checklist and feedback tool. This portion lasted 15-20 minutes.

Assessment

We developed the critical action checklist (Appendix F) and feedback tool (Appendix G) with the ideal case setting in mind. While the checklist delineates critical actions, the feedback tool lists specific behaviors categorized as milestone levels to better delineate the nuances of a resident's current skill level. While the case was running, the lead instructor assessed each learner by completing the feedback tool and critical action checklist. If additional staff were available, it was helpful to have them take real-time notes. The critical action checklist contained 11 critical actions with associated milestones. The feedback tool represented a series of behaviors arranged in the context of ACGME milestones, which are imperative for EM residents to acquire during their training. Each anticipated behavior needed to be fully satisfied for the instructor to mark "clear evidence" on the feedback tool form. If a behavior was demonstrated only in part, then "some evidence" could be marked. The feedback tool included suggested examples of behavior for more complicated actions where ambiguity might exist. If a behavior did not occur, then "no evidence" was noted.

The critical action checklist and feedback tool were used as one component to demonstrate competency prior to graduation. Both were shared with our clinical competency committee and used as part of a holistic process for residents' current stage in training.

To evaluate learning objectives, we presented each participant with a postsimulation evaluation that consisted of seven questions on a 4-point Likert scale (1= *strongly disagree,* 4 = *strongly agree*). This anonymous and voluntary evaluation was completed by the participant while watching the postsimulation performance video.

Debriefing/Feedback

The evaluator participated in a one-on-one feedback session with the participant following the simulation. In some cases, there was a small break of up to 5 minutes to allow the lead evaluator to complete the critical action checklist and feedback forms (Appendices F & G). The debriefing/feedback session had three parts. The first part was the resident's self-reflection on his or her performance. This was accomplished by means of a simple question put to the participant by the evaluator: "How do you think it went?" Next, the evaluator reviewed the critical action checklist, highlighting areas completed and noting any deficient areas. Lastly, the evaluator provided the participant with detailed feedback using the milestone-based feedback tool. Since the scenario was written to run with an individual learner, the goal was to highlight the milestone-based feedback tool and home in on areas where there was no clear evidence of completion, especially in milestones at or below Level 3. Any learner who required remediation was able to receive one-on-one feedback. Following the feedback session, each learner watched the video recording of his or her simulation scenario. This helped promote additional self-reflection and solidify points reviewed on the checklist and feedback tool.

Results

This case has been run with a total of 69 PGY 3 EM residents, during solo 60-minute sessions, over the past 5 years. Thirty-two learners completed the postsimulation evaluation that assessed seven questions on a 4-point Likert scale (1= *strongly disagree,* 4 = *strongly agree*). Table 1 presents these results. Residents strongly agreed that the simulation was appropriate for their level of training and that the case scenario was consistent with a case they could potentially see in the ED. Almost all learners felt strongly that their participation in the simulation-based case increased their confidence and was applicable to their practice.

Table 1. Postsimulation Evaluation Results (*N* = 32)

Question	Average[a]	*SD*
Objectives were clearly communicated at the beginning of the activity.	3.91	0.4
The objectives were achieved.	3.97	0.2
The teaching methods were appropriate for my level of training.	3.97	0.2
The instructors were knowledgeable of the topic.	3.94	0.2
Clinical content presented in consistent manner.	3.97	0.2
The course simulated activities reflected actual activities.	3.91	0.3
Based on what was provided today, I will be able to apply what I have learned and feel more confident in my practice.	3.94	0.2

[a]Rated on a 4-point Likert scale (1 = *strongly disagree,* 4 = *strongly agree*).

Comments from the postsimulation evaluation form included the following:

- "A practical way of going through the cases in real time with subsequent evaluation."
- "Good practice for real life situations."
- "Good to think about tPA indications/contraindications."
- "Good case including medicine and the art of medicine."

Some learners felt that in real situations, they would have more resources. However, we pointed out that our institution's pharmacy protocol and NIH guidelines were available if requested. Faculty also reminded residents that many would practice in the community setting without a stroke center.

We aggregated results from the milestone-based feedback tool (Appendix G). Analysis of these data identified several interesting trends. As expected, PGY 3 residents more regularly completed anticipated actions within Level 1 and 2 categories. There were some exceptions to this. For patient care (PC) milestone PC5, only 33.3% (23 of 69 residents) had clear evidence of assessment of patient allergies

(Level 1), and 63.7% (44 of 69 residents) had clear evidence that they began treatment with oxygen (Level 2). For milestone PC10, 62.3% (43 of 69 residents) had clear evidence of endotracheal tube confirmation with a postintubation chest X-ray (Level 2), and 43.4% (30 of 69 residents) had clear evidence that they checked all equipment prior to proceeding with endotracheal intubation (Level 2).

Anticipated actions that fell under milestone Levels 3, 4, and 5 had increased variability. These milestones highlighted knowledge gaps for a resident based on the current stage in training. For this simulation, several anticipated actions seemed to best distinguish the sophistication of the resident's clinical practice. Table 2 shows the average number of residents who obtained either clear, some, or no evidence for the anticipated action evaluated within Levels 3, 4, and 5. Each milestone corresponds to the anticipated actions listed on the milestone-based feedback tool (Appendix G).

Table 2. Results of Milestone-Based Feedback Tool for Levels 3-5

Milestone	Clear Evidence	Some Evidence	No Evidence
PC1-3[a]	58	2	6
PC1-4[a]	50	2	13
PC2-3[a]	10	16	43
PC2-4[a]	24	36	9
PC2-5	1	9	59
PC3-3[a]	51	14	4
PC3-4	63	2	1
PC4-3	44	19	3
PC4-4	56	9	1
PC5-3[a]	60	2	8
PC5-4	44	10	12
PC7-3[a]	67	1	1
PC7-4	62	1	3
PC10-4	20	1	44
ICS1-3	60	5	1
ICS2-3	58	8	0

Abbreviations: ICS, Interpersonal and Communication Skills; PC, Patient Care.
[a]Multiple anticipated actions measured within this milestone have been averaged.

Discussion

We developed a simulation exercise for the solo learner that focused on the incorporation of milestones into the critical actions and feedback that may be difficult to accomplish in other settings. This case underscored the need to review institutional guidelines in managing acute stroke patients and required each learner to have in-depth knowledge of stroke management.

Based on the postsimulation evaluation, learners almost unanimously agreed that objectives were clearly communicated and achieved. Participants felt that the case was both realistic and appropriate for their level of training. They felt increased confidence in their practice, which is an extremely valuable learning objective as senior residents transition to being attending physicians.

An important limitation was the low evaluation response rate. We received 32 postsimulation evaluations, a 46% response rate. This leads to a potential sample bias: Learners who felt less confident about their performance may have been less likely to fill out an evaluation. This in turn could have led to an over- or underestimation of the simulation's impact. Another possible cause for the low completion rate is that evaluations were left in a common area for participants to fill out after watching their simulation videos and we did not supervise collection. In the future, simulation leaders should consider having an instructor remind participants to fill out the evaluation or sending a follow-up survey. Another limitation is that our feedback tool (Appendix G) was lengthy and therefore required an evaluator who was very familiar with the content and location of the milestones. Additionally, the evaluation focused primarily on perceptions and simulated actions that may not result in translation to actual practice.

We tracked challenges encountered during the simulation in our follow-up evaluations. One knowledge gap identified was the failure of a large number of participants to utilize the NIH Stroke Scale. Out of 69 participants, 43 showed no evidence and 16 showed only some evidence of being able to calculate a stroke scale or use a resource tool. We found significant variability in whether the participants performed a full stroke scale prior to administration of tPA. This poses an interesting question as to why participants would order tPA without performing a full stroke scale given its importance as a branch point in the treatment algorithm. Some learners indicated that they were unclear as to what resources were available during the simulation and had difficulty performing the stroke scale based on memory. This level of knowledge is typical of a Level 5 or seasoned attending (PC2, Level 5). Those not well versed in calculating the stroke scale reported that the stroke team often performs this part of the evaluation. For institutions with a stroke team, this points out a potential deficit in EM resident training. Moreover, there was a trend towards participants giving tPA without reviewing all contraindications. Only 35% of participants met the milestone that involved reviewing relative and absolute contraindications to thrombolytics (PC2, Level 4). This presents an important question about what actions the EM resident would take in a real-life scenario and the potential outcomes. Participants reported knowing resources such as stroke scales and hospital protocols were available but did not ask for these resources. This was an important teaching point for our learners.

We observed another interesting trend in the area of pharmacotherapy (PC5). Participants completed higher-level milestones but missed critical actions in lower-level categories. Twenty-three of 69 participants failed to ask about allergies before administering medications (PC5, Level 1). A potential explanation may be that due to the use of computer medical records, participants relied on ancillary staff to obtain this information. Despite having knowledge of advanced medication regimens for blood pressure and treatment of increased intracranial pressure, participants did not ask about allergies. Furthermore, only 43 of 69 participants initiated oxygen therapy (PC5, Level 2). This may show a reliance on ancillary staff such as nursing and respiratory to start oxygen without direction from the physician.

Milestones for airway management (PC10) seemed to be more challenging for learners throughout all levels. Only 43.4% and 63.3% checked airway equipment before intubation (PC10, Level 2) or confirmed endotracheal tube placement with a postintubation chest X-ray (PC10, Level 2), respectively. Twenty out of 69 considered a backup airway maneuver prior to intubation (PC10, Level 4), again demonstrating a reliance on respiratory therapy to set up for airway management. Participants indicated that this had been discussed in the past.

Lastly, an interesting cognitive error occurred repeatedly during the simulation that involved recognition of an intracranial bleed on repeat head CT results when the reading actually showed vasogenic edema in the area of the stroke. This was an example of anchoring, as participants immediately related a change in mental status and increased intracranial pressure to a complication of giving tPA. Learners felt that it was beneficial to see themselves work through the case and recognize their own bias.

In conclusion, while the management of acute ischemic strokes often involves a multidisciplinary stroke team at many institutions, this case highlights the importance of the ED physician's role in making the decision to give tPA; discussing risks, benefits, and alternatives with patients or family; and managing acute complications related to cerebrovascular accident (CVA).[9] The case also emphasizes the need to use clinical resources for management of patients with a CVA. Furthermore, our results also bring up the question of how reliance on ancillary staff and consultants changes residents' medical practice. Some limitations to assessing the learning objectives included a small sample size in completion of postsimulation evaluations. Opportunities in the future would include running this scenario with involvement of the stroke team or in an ED setting as opposed to the simulation lab.

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