An Acute Stroke Evaluation App: A Practice Improvement Project

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Abstract

A point-of-care workflow checklist in the form of an iOS (iPhone Operating System) app for use by stroke providers was introduced with the objective of standardizing acute stroke evaluation and documentation at 2 affiliated academic medical centers. Providers used the app in unselected, consecutive patients undergoing acute stroke evaluation in an emergency department or hospital setting between August 2012 and January 2013 and August 2013 and February 2014. Satisfaction surveys were prospectively collected pre- and postintervention from residents, staff neurologists, and clinical data specialists. Residents (20 preintervention and 16 postintervention), staff neurologists (6 pre and 5 post), and clinical data specialists (4 pre and 4 post) participated in this study. All 16 (100%) residents had increased satisfaction with their ability to perform an acute stroke evaluation postintervention but only 9 (56%) of 16 felt the app was more help than hindrance. Historical controls aligned with preintervention results. Staff neurologists conveyed increased satisfaction with resident presentations and decision making when compared to preintervention surveys. Stroke clinical data specialists estimated a 50% decrease in data abstraction when the app data were used in the clinical note. Concomitant effect on door-to-needle (DTN) time at 1 site, although not a primary study measure, was also evaluated. At that 1 center, the mean DTN time decreased by 16 minutes when compared to the corresponding months from the year prior. The point-of-care acute stroke workflow checklist app may assist trainees in presenting findings in a standardized manner and reduce data abstraction time. The app may help reduce DTN time, but this requires further study.

Keywords

mhealth, stroke, neurohospitalist, stroke and cerebrovascular disease, quality

Introduction

Acute stroke remains a highly morbid and mortal public health scourge throughout the world,^{1,2} and there are evidence-based guidelines for the evaluation and management of stroke in the acute setting.³ These are in place to improve rapid identification of patients eligible for acute reperfusion therapy, including intravenous recombinant tissue plasminogen activator (t-PA), to achieve best possible outcomes. An acute stroke evaluation is relatively standardized and must be efficient. The Target: Stroke initiative⁴ identifies “stroke tools” containing clinical decision support systems, stroke-specific order sets and guidelines, hospital-specific algorithms, critical pathways, and the National Institute of Health Stroke Scale (NIHSS) as 1 of the 10 best practices to reduce door-to-needle (DTN) time.

Although paper-based checklists may be available, an evaluation might be more expeditious if all clinical tools necessary—from tracking a NIHSS score to counseling benefits and risks of thrombolysis—were integrated into an electronic format. Also, given the importance of clinical data

tracking and reporting for stroke center certification,⁵ a standardized electronic clinical document generated from an integrated point-of-care tool may enhance efficiency of data abstraction. Mobile applications have proven themselves promising in many facets of medicine, from public health^{6,7} to medical education^{8,9} to handling the coming deluge of biometrics from “wearable technology.”¹⁰ There remains, however, a dearth of studies making use of mobile applications in the neurology literature. What exists is in the realm of cerebrovascular neurology, with reports of Apple devices to perform telestroke,^{11,12} mobile acute stroke teleradiology,¹³ and objectify mild pyramidal weakness.¹⁴ There is also a study

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of a stroke checklist in a now obsolete mobile operating system.¹⁵ Finally, there is also a narrative review of potential uses of mobile applications for neurology¹⁶ but, overall, a lack of primary studies to guide the practicing neurologist.

Telecommunication technology has already distinguished itself as useful to stroke providers and patients in particular.^{15,17-20} The purpose of this study was to develop a point-of-care iOS app (Apple Inc, Cupertino, California) with the aforementioned functionality in an effort to improve the process of acute stroke evaluation and management at 2 different hospitals within our institution.

Methods

The study was designed as a voluntary, historically controlled, “before–after” prospective, observational investigation of the implementation of the acute stroke workflow checklist app with satisfaction surveys as the primary source of data. Surveys were distributed to stroke care participants before and after implementation of the app. The preintervention survey was also sent to neurology residents who provided acute stroke care the year prior to the original study period as an historical control. Due to the nature of this intervention, which posed minimal to no risk in participants and was designed to qualitatively assess a potential system and practice improvement, the study was exempted from review by our institutional review board in accordance with the Code of Federal Regulations 45 CFR 46.

The App

The Mayo Clinic Acute Stroke Evaluation App was created to serve as a point-of-care workflow checklist for acute stroke evaluations in the emergency department or hospital setting. It was largely based on publicly available content from the Web sites of the American Heart Association/American Stroke Association and the NIHSS International organizations. The content was scripted by the authors and developed by Mayo Clinic information technology staff (see Figure 1).

The design of the checklist flow was to assist a provider in gathering data necessary for t-PA decision making, prior to a more comprehensive evaluation. The app opens with data entry points for the time of the page and time of arrival to the bedside. The next prompt reminds the provider to confirm the history, time of symptom onset, and provisional diagnosis of acute stroke. At that time, the patient’s weight is entered and a reminder is in place to ensure large bore peripheral vascular access in case contrast-based angiography is needed. The app then transitions into an easy-to-use, tap-to-score NIHSS calculator with a running score along the top of the screen. The prompts are based on the exact text from the NIHSS score form made publicly available as are the scoring clarifications (which can be accessed by tapping on the “i” button). The app then reminds the provider to accompany the patient to the radiology suite and, while the noncontrast head computed

tomography (CT) study is being prepared, review any laboratory test results that might be available for review and check for contraindications (displayed). At this stage, the provider typically has enough clinical information to decide t-PA candidacy, thus the next step in the app is a button that allows the provider to securely text page the on-call staff neurologist to discuss the case, which is our standard protocol. Thereafter, standard patient counseling forms and a t-PA calculator are available to the provider. Once the t-PA decision is made, the final checklist pages guide a provider to consider advanced studies as indicated (eg, CT angiography and/or perfusion) and enter other relevant data for proper documentation of the encounter. A summary display is then made available with stroke metrics calculated (eg, door to neurologist, DTN, etc). Once the summary is checked for accuracy, it can be securely e-mailed to relevant providers and quickly entered manually into our electronic medical record via copy–paste functionality. No data are stored on the device or in the cloud and it requires logging into the secure, Health Insurance Portability and Accountability Act-compliant wireless network for use.

Satisfaction Surveys

Short surveys were sent to participants before and after the implementation of the app into clinical practice. At Mayo Clinic Rochester, senior neurology residents (postgraduate year [PGY] 4) are the primary stroke providers in the emergency setting and neurology residents of all levels (PGYs 2 through 4) are the primary stroke providers at Mayo Clinic Florida. At both centers, thrombolysis decisions are discussed with the on-call staff neurologist in real time. After the acute phase, a stroke clinical data specialist then scrutinizes the medical record for core quality data including critical test turnaround time and DTN time. Questionnaires were sent to these participants before and after the implementation of the app (see Table 1). The preintervention surveys were also sent to residents at Mayo Clinic Rochester who had provided acute stroke care in the year prior to implementation of the app at that center. They were asked to answer the surveys from their perspective as a rising PGY4, less than 1 year prior to survey distribution, so as to best approximate the responses of study participants. Most of the questions asked to rate satisfaction, which was measured with a 5-point scale. Higher numbers indicated higher satisfaction. One question had a dichotomous answer (eg, app “help/hindrance”) and one question asked for free text (eg, time to abstract data).

Stroke Center Metrics

Reportable stroke metrics relevant to Joint Commission Primary Stroke Center certification were tracked in a standard fashion during the study period. Monthly performance on key metrics during the study period was compared to the same month of the year prior.

Figure 1. The Mayo Clinic Acute Stroke Evaluation App.

Implementation

The app was clinically implemented at Mayo Clinic Rochester in August of 2012 and at Mayo Clinic Florida in August of 2013. It was used on Apple devices (eg, iPhone or iPad) running the iOS operating system (Apple Inc). No restrictions were in place as to which exact devices could be used, and the app was designed to work on any iteration of both the iPhone and the iPad devices.

Results

There were 20 residents (excluding the author MNR who was a provider and used the app but abstained from the surveys) who had stroke coverage responsibilities during the study periods of August 2012 to January 2013 and August 2013 to

February 2014. Eight residents served as historical controls. In all, 6 staff neurologists and 4 stroke clinical data specialists were given their respective pre- and postimplementation surveys in the same time course.

Residents

Resident survey response was 100% (20 of 20) preintervention and 70% (7 of 10) and 90% (9 of 10) postintervention at the first and second centers, respectively. Regarding overall satisfaction with ability to perform an acute stroke evaluation, the mode scores were 3 and 4 prior to implementation and climbed to 4 and 5 after. The mode score for the historical controls for this question was 4. Residents rated their satisfaction with relaying data to consultant staff at a mode of 4 prior to implementation and this did not change postimplementation,

Table 1. Questionnaires.

Questions Asked			
Residents	Please rate your overall level of satisfaction with your ability to perform a standardized acute stroke evaluation	Please rate your overall level of comfort with your ability to relay clinical data from an acute stroke evaluation to staff in a brief, standardized fashion	Do you think an acute stroke evaluation checklist will be/ was helpful or a hindrance?
Consultants	Please rate your level of satisfaction with the quality of resident presentations of acute stroke evaluations (eg, over the telephone)	Overall, please rate your level of satisfaction with the acute stroke evaluations (eg, staff presentation, examination, decision-making, documentation, etc) performed by the ED neurology residents in general	
Stroke data specialists	Please rate your overall level of satisfaction with the quality of ED neurology resident acute stroke evaluation documentation, as regards ease of quality measure tracking	Please enter the average amount of time (in minutes) it takes to extract all necessary data from a single ED neurology acute stroke evaluation document for quality tracking	

Abbreviation: ED, emergency department.

Figure 2. Survey responses from neurology residents.

although it should be noted that scores of “5” jumped from 0 to 5 in the pre- and postintervention surveys, respectively. The historical controls also rated their satisfaction with relaying data to staff at a mode of 4. The first survey revealed 85% (17 of 20) of residents considered the app more likely to help than be a hindrance prior to implementation as well as 88% (7 of 8) historical controls, but only 56% (9 of 16) thought the app was more helpful than hindrance postimplementation (see Figure 2).

Staff Neurologists

The staff neurology survey response was 100% (6 of 6) preintervention and 83% (5 of 6) postintervention. The staff neurologists gave a mode score of 4 regarding satisfaction with resident presentation of data over the phone and the residents’ overall evaluation and management pre- and postintervention (see Figure 3).

Stroke Data Specialists

Four data specialists participated pre- and postintervention, and survey response was 100% at both centers. Their

satisfaction with resident documentation of acute stroke evaluations was scored at a mode of 4 pre- and 3 postintervention. The average estimated amount of time required to abstract data from a clinical note dropped from 10 minutes preintervention to 5 minutes postintervention at the first study center. The average estimated amount of time did not change at the second center (eg, 10 minutes pre- and postintervention; see Figure 4.)

Stroke Data

Selected stroke center quality data for the study period at the first center (August 2012-January 2013) and the corresponding months from the year prior are presented in Table 2. The combined monthly data preintervention were averaged and compared to the average of the combined monthly data from the study period. Notable changes include a decrease in the mean DTN time of 16 minutes postintervention.

Similar stroke data from the second center were not analyzed for the purposes of this study because another large-scale stroke center quality improvement project had been implemented in the months prior to this study and an effect of the app could not be separately evaluated.

Figure 3. Survey responses from staff neurologists.

Figure 4. Survey responses from quality data specialists.

Table 2. Selected Stroke Core Measure Data From the Study Period and Historical Control.

Month/Year	# of Stroke Pages	# t-PA Given	Door to Neuro MD, min	Door to CT Done, min	Door to CT Interpret, min	Door to Needle, min
Preintervention						
08/2011	17	3	18	33	66	78
09/2011	19	1	12	40	65	111
10/2011	23	6	13	27	33	79
11/2011	12	5	10	29	43	70
12/2011	11	3	13	37	39	83
01/2012	17	4	14	36	37	62
Postintervention						
08/2012	21	3	15	30	38	53
09/2012	20	2	17	33	50	81
10/2012	24	3	11	33	39	52
11/2012	12	0	13	25	25	NA
12/2012	20	3	14	31	47	83
01/2013	20	4	17	34	43	51

Abbreviations: CT, computed tomography; NA, not available; t-PA, tissue plasminogen activator.

Discussion

This study provides qualitative pilot data from a novel iOS app-based workflow checklist for providers of acute stroke care in an academic medical center. The checklist was designed to assist neurology trainees in optimizing the completeness and efficiency of the acute stroke clinical evaluation, case presentation to the staff neurologist, and documentation of core quality measures in the medical record. The effect of implementation was measured by pre- and postintervention surveys. Overall, residents perceived that the app improved their ability to perform and convey a complete acute stroke evaluation, staff neurologists were more satisfied with the resident presentations and the quality of the clinical evaluations, and time of data abstraction of key metrics from clinical notes was halved. A key stroke center quality metric, average DTN time, substantially improved at 1 site by 16 minutes.

The study has a number of limitations. This was a small pilot study to assess the effect of using the tool for acute stroke evaluation. The app needs to be tested in a larger number of cases and in other emergency departments. The app appeared to improve efficiency of presentation and documentation but was perceived as a hindrance to workflow by some residents. This indicates that the app may need to be modified to become more user friendly. Although technical failures were not formally studied, experience with utilization and informal feedback from study participants described network connectivity as a primary source of app failure. Furthermore, the historical control was applied only to residents at 1 center with potential for recall bias as they were asked to answer a survey as if they had little experience after providing acute stroke care extensively for 1 year. It is worthwhile noting, however, that the responses of historical controls aligned with those of preintervention study participants at both centers. It is most important to note that several quality improvement projects relevant to our acute stroke practice were operating in parallel with this workflow checklist. These include a pilot of a “stroke kit” complete with t-PA decision making and care guidelines for emergency department nurses, continuous feedback and scorecards for providers, and “Stroke Tip of the Month” for trainees. That being the case, the favorable changes noted during the study period were likely multifactorial and not solely attributed to the effect of using a workflow checklist app. The decrease in DTN times may have been related to other ongoing efforts to optimize this metric, such as improving communication across teams and minimizing delays with the initial diagnostic evaluation.

Workflow checklists are not new to the practice of medicine and surgery. Furthermore, there are stroke-specific studies where a checklist-like intervention was a primary intervention. There are at least 2 studies of checklists for post-stroke care,^{21,22} and, apropos the current investigation, a single study of a checklist tool for acute stroke evaluations.¹⁵ That tool, which the investigators called HandiStroke, was

an NIHSS score calculator and t-PA contraindication list that the authors developed, integrated into their practice, and presciently suggested that a handheld checklist may be a way to accurately and efficiently document a stroke encounter for clinical and research purposes, offering their tool for free online. The software was developed for now obsolete operating systems (eg, Palm OS & PocketPC) and lacked many of the features of the Mayo Clinic Acute Stroke Evaluation App mentioned earlier but was novel and important to move decision support tools for acute stroke to the bedside on our mobile devices. It is the authors' view that the use of workflow checklists that streamline the provision of guideline-based care while still allowing for the flexibility requisite of real-world practice may help navigate the increasingly complex and heavily regulated environment of acute stroke care. Further study is needed to establish whether or not clinical outcomes or health economics are affected by such workflow checklists.

Conclusions

The Mayo Clinic Acute Stroke Evaluation App, a point-of-care acute stroke workflow and evaluation checklist, may assist trainees in presenting findings in a more standardized manner and reduce data abstraction time for Joint Commission Primary Stroke Center reportable metrics. A point-of-care acute stroke checklist app may help reduce DTN time, but this requires further study.

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Declaration of Conflicting Interests

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