Design and Implementation of Structured Clinical Documentation Support Tools for Treating Stroke Patients

Kelly Claire Simon, ScD,* Richard Munson, MD,* Archie Ong, MD,* Fulvio R. Gil, MD,* Franco Campanella, MD,* Laura Hillman, BBA,† Rebekah Lai, BS,† Richard Chesis, BBA,† Samuel Tideman, MS,* Rosa Maria Vazquez, BS,* Steven Meyers, MD,* Roberta Frigerio, MD,* and Demetrius Maraganore, MD‡

Background and Purpose: Standardized electronic medical record tools provide an opportunity to efficiently provide care that conforms to Best Practices and supports quality improvement and practice-based research initiatives. *Methods*: We describe the development of a customized structured clinical documentation "toolkit" that standardizes patient data collection to conform to Best Practices for treating patients with stroke. The toolkit collects patients' demographic information, relevant score test measures, and captures information on disability, treatment, and outcomes. *Results*: We describe here our creation and implementation of the toolkits and provide example screenshots. As of August 1, 2018, we have evaluated 2332 patients at an initial visit for a possible stroke. We provide basic descriptive data gathered from the use of the toolkits, demonstrating their utility in collecting patient data in a manner that supports both quality clinical care and research initiatives. *Conclusions*: We have developed an EMR toolkit to support Best Practices in the care of patients with stroke. We discuss quality improvement projects and current research initiatives using the toolkit. This toolkit is being shared with other Departments of Neurology as part of the Neurology Practice-Based Research Network.

Key Words: Quality improvement—data collection—electronic health records—research design—neurology—stroke

Introduction

Stroke represents a substantial cause of morbidity in the United States and is the fourth leading cause of death.[1] The disease is also a major cause of disability, with costs estimated to be approximately $74 billion a year in the United States.[2] The Joint Commission has published standards for the acute care of stroke patients. However, quality improvement initiatives after discharge are largely lacking.[3]

Patient outcomes after stroke are variable, with well-recognized predictors including age, prestroke dependency, and stroke severity.[4] In addition to the temporary and permanent deficits patients suffer as a result of their stroke, they are also at an increased risk of mood disorders, which can impact their outcomes and eventually return to baseline functioning. For example, poststroke depression and anxiety are common. Reports estimate that 33% of stroke survivors experience poststroke depression, and depression is associated with poorer outcomes after stroke.[5-7] Anxiety has been reported in 20%-24% of patients in the 1-6 months after stroke and is also associated with poorer outcomes.[8,9]

Given the high need for intervention and support services for patients and their caregivers, integrating Best Practices

From the *Department of Neurology, NorthShore University HealthSystem, Evanston, Illinois; †Health Information Technology, NorthShore University HealthSystem, Evanston, Illinois; and ‡Department of Neurology, University of Florida, Gainesville, Florida.

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Address correspondence to Demetrius M. Maraganore, MD, Department of Neurology, University of Florida, Box 100236, Gainesville, FL 32610. E-mail: dmaraganore@me.com.

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into routine clinical care represents optimal care for these patients to increase the chance of maximum recovery.

Additionally, it is worthwhile to evaluate whether quality guidelines improve patient outcomes. We view the electronic medical record (EMR) as an opportunity to simultaneously address issues related to patient care, assess potential gaps in care, and study predictors of outcomes in stroke patients. Traditionally, information has been entered in the EMR in a nonstandardized manner, frequently as free text. This makes data extraction challenging and hinders the ability to assess quality measures and conduct quality improvement initiatives and practice-based research. Therefore, we have developed an EMR (Epic) "toolkit" that is customized to stroke patients' care that ensures conformation to Best Practices. Our toolkit collects hundreds of fields of discrete data and writes progress notes with simple mouse clicks. We are also sharing our toolkit with other departments of Neurology through the Neurology Practice-Based Research Network (NPBRN) to conduct collaborative quality improvement and practice-based research to further our understanding of best care for patients following a stroke.

Methods

The NorthShore University HealthSystem (NorthShore) Department of Neurology, located in the northern suburbs of Chicago, includes 4 stroke specialists. Our 7-stage process for quality improvement and practice-based research using the EMR, and the resources required has been previously described.[10] Briefly, EMR building required about 3 months per project. Reports were available within 1 month of toolkit implementations. There was 1 Epic programmer for building the toolkit and implementing it and 1 Enterprise Data Warehouse (EDW) programmer for building the data repository and reports. Stroke neurologists met biweekly with our Epic Optimization team as part of this process to determine what data elements and content needed to be collected to support best clinical practices. We briefly review the development of our highly customized stroke-structured clinical documentation support (SCDS) toolkit. Local institutional review board was not needed for this quality improvement project. The toolkit was developed through a physician-driven process, with neurologists specializing in stroke care meeting frequently to determine the data elements necessary to collect to support Best Clinical Practices for the care of stroke patients. We reviewed and evaluated relevant medical literature and referenced the Joint Commission and the American Academy of Neurology guidelines. Once we determined the content, we held biweekly meetings with our Epic Optimization team to build the toolkits. Ultimately, they built an SCDS toolkit that included navigators (a sidebar index of processes to choose from), electronic forms (which have the ability to auto-score and auto-interpret), and summary flow sheets. Although the focus of the toolkits is on discretized data collection, free text fields are available for additional information. The content includes discretized fields to record detailed information regarding the index event, including time of onset, detailed information on presenting symptoms including location and persistence, and detailed information on residual deficits.

NorthShore has a stroke team that responds to inpatient emergency stroke calls. Data about stroke subtypes are collected and determined by the stroke neurologist seeing the patient in clinic. Information on diagnostic tests is also input and available for review, including anatomic and vascular territories of infarcts, size, age, and arterial characteristics (stenosis, dissection, and aneurysm). Diagnostic studies include, but are not limited to, brain MRI, head and neck MRA, head and neck CTA, conventional cerebral angiogram, carotid Doppler, transthoracic echocardiogram, transesophageal echocardiogram, lipid panel, HgA1c, and hypercoagulable panel. Diagnoses of stroke mimics are made on the totality of data available during the office visit. This can be different than the diagnosis made while the patient was hospitalized, as it could incorporate repeated stereotyped events after the hospitalization, clear seizures, etc. The different stroke mimics are listed on the impressions section of our toolkit and include seizure, demyelinating disease, transient global amnesia, migraine/migraine variants, vestibular disorders, functional neurological symptom disorder, transient encephalopathy, syncope, reversible cerebral vasoconstriction syndrome, mass lesion/infection, and hypoglycemia. From these inpatient encounters, the toolkits pull into the outpatient encounter data the initial National Institutes of Health Stroke Scale (NIHSS) and the NIHSS score at discharge. Detailed treatment information is collected, including medication given for the index event as well as any invasive treatments, and detailed imaging information.

We also included several score test measures to capture disease severity and screen for mood disturbances. Captured measures include the Barthel Index,[11] Geriatric Depression Score,[12] Epworth Sleepiness Scale (ESS),[13] NIHSS,[14] modified Rankin,[15] and Short Test of Mental Status (STMS).[16] These measures are autoscored (when appropriate) and provide interpretation to the clinician (for example, normal cognition versus possible cognitive impairment). Our data output is the Mini-Mental State Examination-converted (MMSE-converted) score[17] as both the Montreal Cognitive Assessment and STMS can be converted to the MMSE. Thus, we present the MMSE as a standardized measure of cognitive assessment. We designed workflows (the order and assignment of tasks to a care team that included medical assistants, nurses, and a cognitive disorders neurologist) and mapped items to the progress notes. Self-reported items are entered by medical assistants, cognitive testing by RNs, most of the other data by the stroke neurologist in clinic. Overall, the documentation is time neutral as it relates to the office visit length prior to toolkit implementation.

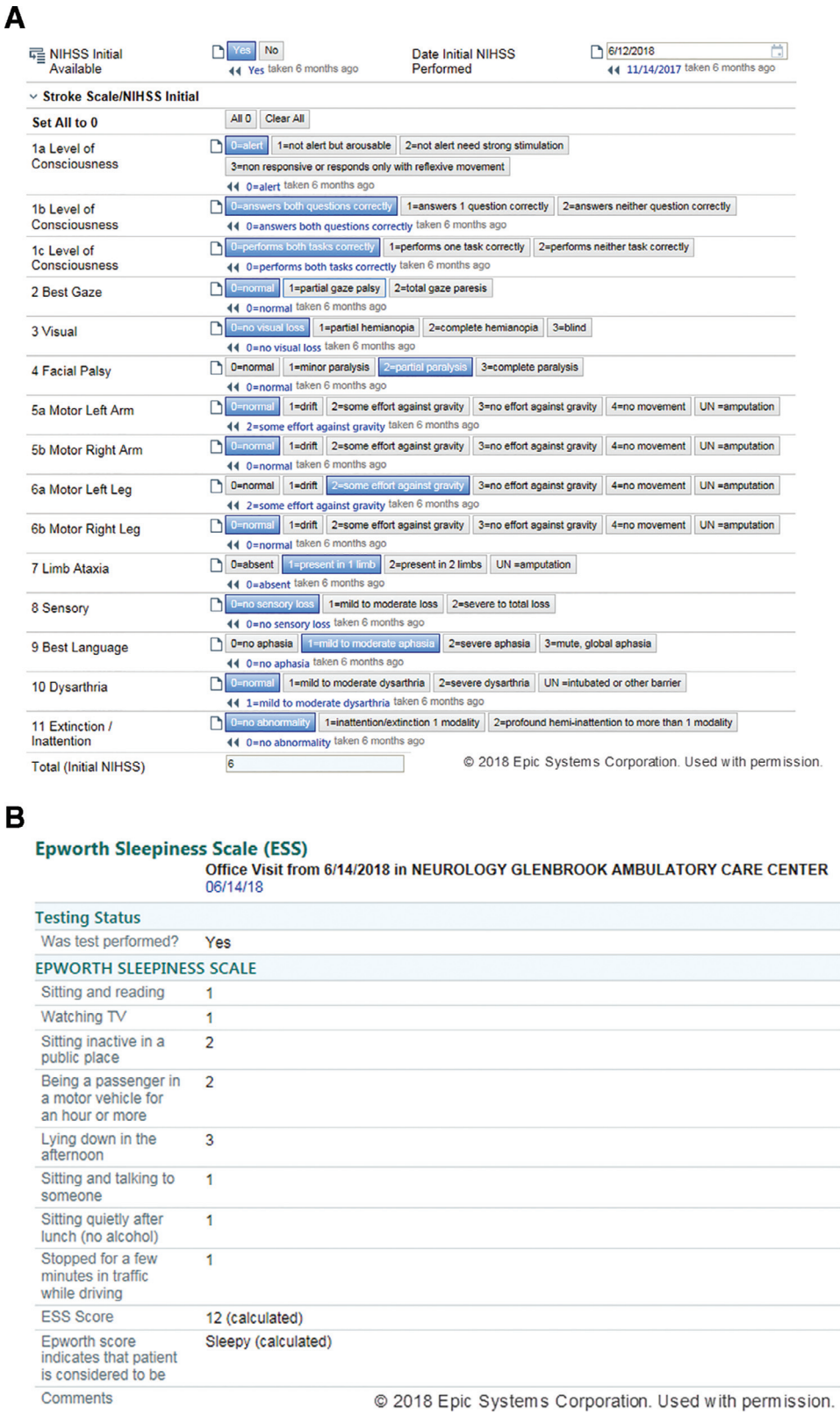

Figure 1. *Select screenshots of the Stoke SDCS toolkit within the EMR, ©2018 Epic Systems Corporation. Used with permission. Abbreviations: EMR, electronic medical record.*

After the SCDS toolkit implementation, we met every 2 weeks with programmers to review their usage and make modifications. This process is ongoing and the team regularly reassesses the literature and guidelines to incorporate changes based on issues encountered in clinics and to make modifications of existing practice-based guidelines. We have team members who are specialized in extracting, transforming, and loading data from the EMR's data repository to specific data marts in NorthShore's EDW. To assess toolkit performance in the clinical environment, the EDW programmers created reports for tracking patients and produced data quality reports indicating which required data were missing from office visits. These data quality reports were distributed to the care team monthly. When systematic errors occurred, the teams had the opportunity to improve their use of the toolkits or to request optimizations or a change in data requirements. The monthly reports produced only a few or no data checks per provider once the project was established.

Results

Examples of our screenshots from our toolkits are shown in Figure 1 (additional screenshots in Supplemental File I). As of August 1, 2018, we have evaluated 2332 patients with our stroke toolkits at the initial posthospitalization visit. The most common diagnosis was arterial ischemic stroke followed by stroke mimics and transient ischemic attacks. The distribution of stroke types at the initial visit is shown in Table 1. Select clinical characteristics collected from our patients are shown in Table 2. As expected, depending on stroke type, there are noticeable differences in modified Rankin and NIHSS, with ICH patients having worse scores. Full descriptive data generated by the toolkits are shown in Supplemental File II.

As an example of the standardized, discrete data collected on each patient, we show the distribution of select score test measures at an initial visit in Figure 2 (MMSE-converted, ESS, Geriatric Depression Score, and Barthel Index) for patients with the 3 most common stroke subtypes (transient ischemic stroke, arterial ischemic stroke, and intracerebral hemorrhage). Though data are shown for the initial visit, these measures (and all clinical information) are collected at all follow-up visits allowing for longitudinal assessment of patient outcomes.

Discussion

We describe here our experience with creating and implementing a customized toolkit to care for patients with stroke. In addition to ensuring care conforms to Best Practices, the toolkit identifies quality improvement opportunities at the point-of-care, allowing the physician to take immediate action. Given we can effectively collect data, we are planning quality improvement projects to assess how adherence to guidelines correlates with patient outcomes. For example, as part of a department-wide initiative in Neurology, when a patient screens positive for depression, a Best Practice Advisory (BPA) is displayed alerting the physician. The physician must take an action (place a referral order or place a medication order from a smartset list) or select a reason for no action (for example, physician to treat primary condition first, patient is already under care of a mental health specialist, or patient is currently being treated by the primary care physician). We plan to evaluate the impact of our depression BPA by assessing clinical measures of depression and quality of life, before and after the implementation of this BPA. We are also planning similar BPAs specific to patients in our stroke clinic. For example, we could consider whether patients with evidence of cognitive disorder as evidenced by the Montreal Cognitive Assessment or STMS have neuropsychiatric testing or advanced care planning documented. In another application for patients reporting falls within the past year, we plan to assess the frequency that a physical therapy referral is ordered. Once these are implemented, we can assess the effectiveness by determining whether there is a change in physician behavior and how these changes relate to patient outcomes.

Table 1. *Diagnosis of patients evaluated with the stroke toolkit at initial visit*

	N	%
Arterial ischemic stroke	1265	60.0%
Stroke mimics	364	17.3%
Transient ischemic	323	15.3%
Intracerebral hemorrhage	118	5.6%
Subarachnoid hemorrhage	20	.9%
Venous infarct	8	.4%
None	6	.3%
Primary intraventricular hemorrhage	3	.1%
Total	2107	

Currently, our toolkits support practice-based research using data collection as part of routine clinical practice. In addition to quality improvement projects, we are interested in understanding predictors of long-term outcomes in these patients and will leverage our standardized longitudinal data to conduct outcomes research. Additionally, we are currently enrolling eligible patients in a DNA biobanking study. We have developed a BPA that activates when patients meet eligibility criteria and this allows for enrollment at the point-of-care. Other than a one-time blood draw, there is no additional burden on the patient outside of routine clinical care. Data are completely captured within the context of the office visit through the use of the toolkit. Genome-wide SNP genotyping was recently completed on these patients and will be used to complement the clinical data and conduct novel studies of biomarkers and risk assessment. Additionally, because we have an annual follow-up as part of our Best Practices, we will have robust, standardized clinical data on patients to assess changes over time.

Last, we are actively involved in data sharing through the NPBRN, which we created through a grant from the

Table 2. *Select clinical characteristics of patients collected with SCDS tools*

	Arterial ischemic	TIA	ICH
Index event symptoms, N (%)			
Weakness/paralysis	625 (49)	98 (30)	43 (36)
Speech or language disorders	492 (39)	165 (51)	35 (30)
Numbness/parasthesias	250 (20)	83 (26)	11 (9)
Other symptoms	194 (15)	37 (12)	51 (43)
Vision	169 (13)	56 (17)	22 (19)
Ataxia	165 (13)	27 (8)	4 (3)
Vestibulococholear	65 (5)	18 (6)	4 (3)
Medical treatments for index event, N (%)			
Antithrombotic	1082 (86)	279 (86)	12 (10)
Lipid lowering agent	843 (67)	211 (65)	33 (28)
Antihypertensive	717(57)	181 (56)	71 (60)
Diabetic medication	233 (18)	52 (17)	14 (12)
Antidepressant	148 (12)	45 (14)	15 (13)
Anticonvulsant	60 (5)	14 (4)	18 (15)
Other	21 (2)	5 (2)	2 (2)
None	113 (9)	24 (7)	32 (27)
Medical treatments prior to index event, N (%)			
Antihypertensive	734 (58)	193 (60)	60 (51)
Antithrombotic	597 (47)	170 (53)	56 (48)
Lipid lowering agent	554 (44)	160 (50)	45 (38)
Diabetic medication	281 (22)	68 (21)	20 (17)
Antidepressant	107 (9)	51 (16)	12 (10)
Other	65 (5)	21 (7)	10 (9)
None	281 (22)	58 (18)	27 (22)
Subsequent medical treatments, N (%)			
No change	920 (73)	257 (80)	79 (67)
Antithrombotic	294 (23)	61 (19)	21 (18)
Antihypertensive	187 (15)	39 (12)	13 (11)
Lipid lowering agent	181 (14)	42 (13)	24 (20)
Diabetic medication	47 (4)	13 (4)	3 (3)
Antidepressant	45 (4)	10 (3)	8 (7)
Other medication	21 (2)	1 (<1)	9 (8)
Anticonvulsant	15 (1)	1 (<1)	2 (2)
None	7 (<1)	6 (2)	0
Physical treatments for index event, N (%)			
Outpatient therapy	473 (38)	37 (12)	48 (41)
Inpatient therapy	431 (35)	28 (9)	54 (46)
Skilled nursing	184 (15)	11 (3)	31 (26)
None	505 (38)	257 (80)	29 (25)
Modified Rankin prior to event score, N(%)			
No symptoms at all	996 (76)	256 (79)	84 (71)
No significant disability	59 (5)	16 (5)	8 (7)
Slight disability	94 (7)	20 (6)	10 (9)
Moderate disability	38 (3)	7 (2)	7 (6)
Moderately severe disability, unable to walk without assistance	18 (1)	9 (3)	1 (1)
Severe disability	2 (<1)	1 (<1)	0
Current modified Rankin score, N (%)			
No symptoms at all	341 (27)	242 (75)	13 (11)
No significant disability	330 (29)	27 (8)	21 (18)
Slight disability	350 (26)	30 (9)	40 (34)
Moderate disability	137 (10)	10 (3)	21 (18)
Moderately severe disability	76 (6)	9 (3)	18 (15)
Severe disability	20 (2)	2 (1)	3 (3)
Parenchymal imaging findings, N (%)			
Acute ischemic infarct	832 (66)	8 (3)	17 (14)

(*Continued*)

Table 2. (*Continued*)

	Arterial ischemic	TIA	ICH
White matter disease	259 (21)	90 (28)	8 (7)
Old ischemic infarct	210 (17)	52 (16)	4 (3)
Acute hemorrhage	31 (3)	7 (2)	104 (88)
Other parenchymal finding	21 (2)	8 (3)	3 (3)
None	154 (12)	146 (45)	1 (1)
Arterial imaging findings, N (%)			
Stenosis	339 (27)	74 (23)	8 (7)
Occlusion	192 (15)	7 (2)	2 (2)
Intracranial cerebral aneurysm	34 (3)	11 (3)	5 (4)
Dissection	25 (2)	2 (1)	0
Anatomic variations	9 (1)	4 (1)	3 (3)
Arteriovenous malformations	1 (<1)	0	0
Other	24 (2)	11 (3)	3 (3)
Other diagnostic studies, N (%)			
Thansthoracic echocardiogram	875 (69)	217 (67)	34 (29)
Electrocardiogram	374 (30)	106 (33)	27 (21)
Carotid imaging	284 (23)	95 (29)	5 (4)
Prolong rhythm monitoring	109 (9)	24 (7)	0
Transesophageal echocardiogram	87 (7)	10 (3)	2 (2)
Electroencephalogram	61 (5)	20 (6)	15 (13)
Transcranial doppler	2 (<1)	0	1 (1)

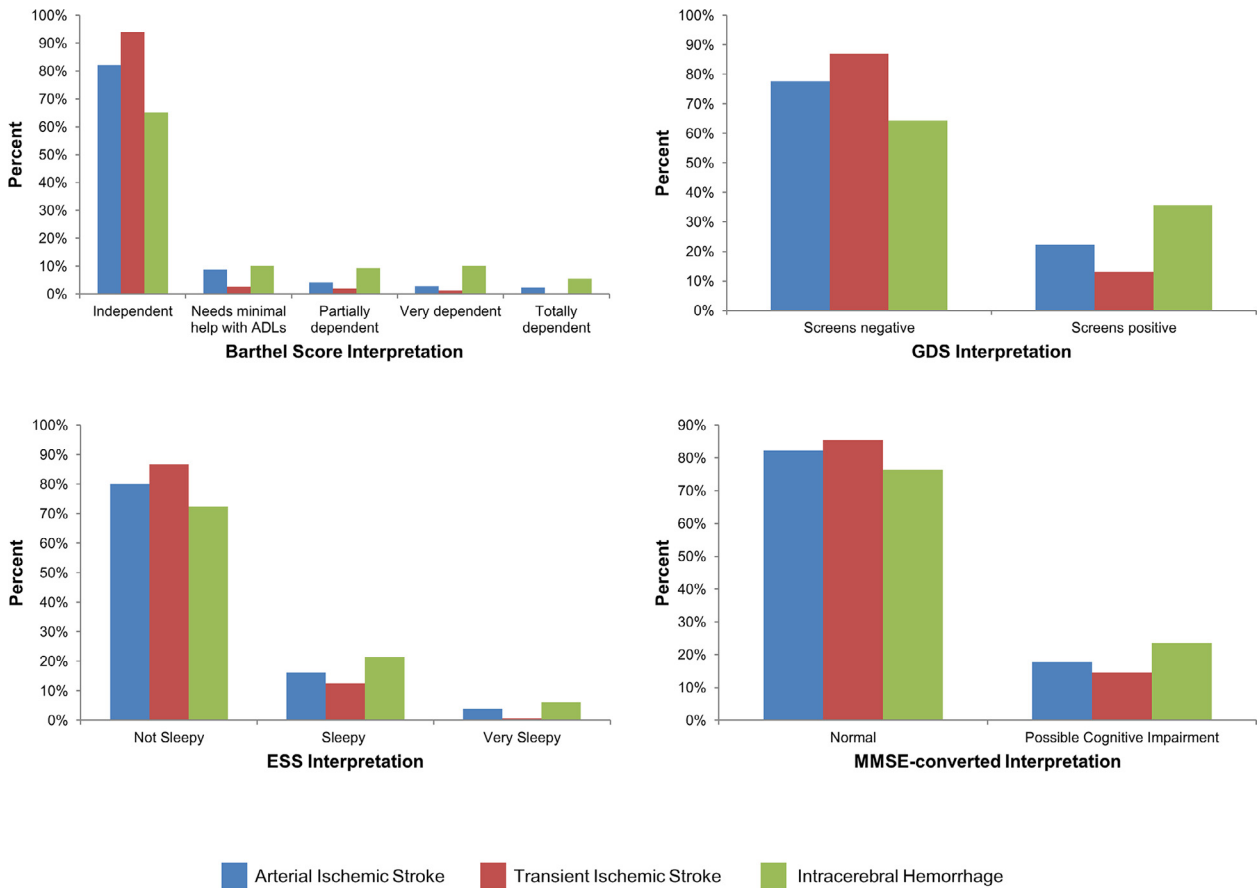

Figure 2. *GDS, Barthel Index, ESS, and MMSE-converted score interpretation for patients at initial visit with the 3 most common stroke subtypes (transient ischemic stroke, arterial ischemic stroke, and intracerebral hemorrhage). Abbreviations: ESS, Epworth Sleepiness Scale; MMSE, Mini-Mental State Examination. In color online.*

Agency for Healthcare Research and Quality. The NPBRN partner sites adopt relevant toolkits at their site for data sharing, to benchmark performance and to conduct quality improvement initiatives and practice-based research. Multi-site research is often challenging because of differences in data collection. Standardized data collection allows for the opportunity to assess quality and research questions in diverse patient populations across geographic sites, all with comparable data.

The EMR presents a novel opportunity to improve patient care through quality assessment and research initiatives. We demonstrate here the creation of a standardized EMR that we are currently using in clinical practice to conduct quality initiatives and practice-based research. Through these projects, we strive to identify opportunities to improve care and outcomes for stroke patients.

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Disclosures

The authors have no disclosures to report.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jstrokecerebrovasdis.2019.01.011.

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