Background and Purpose—Because 10% of strokes occur in hospitalized patients, we sought to evaluate stroke knowledge and predictors of stroke knowledge among inpatient and emergency department nursing staff.

Methods—Nursing staff completed an online stroke survey. The survey queried outcome expectations (the importance of rapid stroke identification), self-efficacy in recognizing stroke, and stroke knowledge (to name 3 stroke warning signs or symptoms). Adequate stroke knowledge was defined as the ability to name ≥2 stroke warning signs. Logistic regression was used to identify the association between stroke symptom knowledge and staff characteristics (education, clinical experience, and nursing unit), stroke self-efficacy, and outcome expectations.

Results—A total of 875 respondents (84% response rate) completed the survey and most of the respondents were nurses. More than 85% of respondents correctly reported ≥2 stroke warning signs or symptoms. Greater self-efficacy in identifying stroke symptoms (odds ratio, 1.13; 95% confidence interval, 1.01–1.27) and higher ratings for the importance of rapid identification of stroke symptoms (odds ratio, 1.23; 95% confidence interval, 1.002–1.51) were associated with stroke knowledge. Clinical experience, educational experience, nursing unit, and personal knowledge of a stroke patient were not associated with stroke knowledge.

Conclusions—Stroke outcome expectations and self-efficacy are associated with stroke knowledge and should be included in nursing education about stroke. (Stroke. 2014;45:271–273.)

Key Words: education, nursing ■ inpatients ■ stroke

About 10% of all strokes occur among hospitalized patients, and nurses tend to be the first to identify stroke symptoms among inpatients. Prior work has shown that stroke symptoms may not be recognized in hospitalized patients. In addition, many stroke-code activations for inpatients are false-positives. If inpatient providers do not promptly and appropriately activate a stroke code, opportunities for treatment with thrombolitics could be delayed or missed. The goal of this study was to evaluate the knowledge of stroke signs and symptoms among inpatient and emergency department nursing clinical staff, such as nurses, nursing aides, and technicians, at a large academic medical center. We also sought to identify predictors of adequate stroke knowledge.

Methods

Population

All emergency department and inpatient nursing staff complete mandatory yearly education modules both online and in person. An optional anonymous survey was embedded into the online portion of the module in January 2012. After completion of the survey, the clinical staff completed an online module that focused on stroke symptom recognition and response followed by a small group discussion about these same issues. A copy of the online module, the initial survey, and a follow-up survey, as well as details on stroke education at our institution, are available in the online-only Data Supplement.

Covariates

Covariate selection was guided by the theory of planned behavior, which explores the belief that a desired outcome (outcome expectations), perceived capability of performing the behavior (self-efficacy), and social norms are associated with a given behavior, which in this case would be initiation of a stroke code. Respondents were asked to rate their confidence in identifying stroke (self-efficacy) and the importance, in terms of stroke outcomes, of rapid identification of stroke symptoms (outcome expectation) on a 1- to 10-point Likert scale. Nursing units were categorized into neurology-specific, emergency department, non-neurology intensive care unit, medical-surgical, and other nursing unit. We categorized nursing education into 2-year degree, 4-year degree, advanced degree, and other. We also divided clinical experience into <1, 1 to 3, 4 to 10, and ≥11 years.

Outcome Measure

The primary outcome was the ability to name acute stroke warning signs. Using free-text, the survey asked respondents to name 3
important signs or symptoms of stroke. Stroke signs or symptoms were defined according to the published material from the American Heart Association and National Institute of Neurological Disorders and Stroke. All responses were graded by a board-certified vascular neurologist (E.E.A.). A random sample was independently graded by another board-certified vascular neurologist (L.E.S.), and there was near complete agreement.

In prior work in Michigan adults, adequate knowledge of stroke warning signs was defined as naming ≥1. Because our participants have medical training, a priori we defined adequate knowledge of stroke warning signs as correctly naming ≥2 warning signs.

**Statistical Analysis**

Nursing staff characteristics and knowledge of stroke warning signs were calculated using descriptive statistics. A logistic regression model was used to explore the association between adequate stroke knowledge and respondent characteristics along with self-reported measures of self-efficacy and outcome expectations. All covariates were determined a priori and included in the final model. We performed a likelihood ratio test comparing the fully adjusted model with stroke self-efficacy and outcome expectations modeled linearly and a second model where they were modeled in tertiles. The log-likelihood ratio statistic was nonsignificant, indicating that the scales were better represented modeled continuously. Statistical analysis was performed using Stata 11.0 (StataCorp). This project was reviewed by the University of Michigan Institution Review Board and determined to be exempt.

**Results**

The response rate for the survey was 83.8% and responses from 875 of the subjects were available for analysis. Most of the respondents were medical-surgical nurses with more than a decade of clinical experience (Table 1). Eighty-seven percent of respondents correctly reported ≥2 stroke warning signs, whereas 31% identified 3 warning signs. Numbness or weakness was the most frequently reported symptom (Table 2). We found that greater self-efficacy in identifying stroke symptoms (odds ratio, 1.13; 95% confidence interval, 1.01–1.27) and a higher outcome expectations rating (odds ratio, 1.23; 95% confidence interval, 1.002–1.51) were associated with stroke knowledge. As shown in Table 3, clinical experience, educational experience, nursing unit, and personal knowledge of a stroke patient were not associated with stroke knowledge.

**Discussion**

More than 85% of emergency department and inpatient nursing staff at our medical center have adequate knowledge of stroke signs and symptoms. Although educational level and clinical experience were not associated with knowledge of stroke symptoms, outcome expectations and self-efficacy were associated with stroke knowledge. Researchers have found that although stroke knowledge is important, it is not the only factor motivating activation of emergency responses for stroke. Thus, efforts to increase stroke knowledge may also increase self-efficacy and outcome expectations and ultimately increase appropriate activation of a stroke code. For example, at our institution, we have implemented mock stroke codes. During these sessions, a staff member evaluates the mock-patient with assistance from other staff members, while physicians on the stroke team provide education, feedback, and answer questions. These role-plays have the potential to not only increase knowledge, but also self-efficacy and outcome expectations.

<table>
<thead>
<tr>
<th>Table 1. Characteristics of the Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical experience, y</strong></td>
</tr>
<tr>
<td>&lt;1</td>
</tr>
<tr>
<td>1–3</td>
</tr>
<tr>
<td>4–10</td>
</tr>
<tr>
<td>≥11</td>
</tr>
<tr>
<td><strong>Missing=12 (1.4% of total)</strong></td>
</tr>
<tr>
<td><strong>Level of nursing training</strong></td>
</tr>
<tr>
<td>2-y degree</td>
</tr>
<tr>
<td>4-y degree</td>
</tr>
<tr>
<td>Advanced nursing degree</td>
</tr>
<tr>
<td>Other or not applicable</td>
</tr>
<tr>
<td><strong>Missing=3 (0.3% of total)</strong></td>
</tr>
<tr>
<td><strong>Work location</strong></td>
</tr>
<tr>
<td>Neurology unit</td>
</tr>
<tr>
<td>ED</td>
</tr>
<tr>
<td>ICU</td>
</tr>
<tr>
<td>Med-surg unit</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Missing=11 (1.3% of total)</strong></td>
</tr>
<tr>
<td><strong>Personal knowledge of a stroke patient</strong></td>
</tr>
<tr>
<td><strong>Missing=10 (1.1% of total)</strong></td>
</tr>
<tr>
<td><strong>Self-efficacy in identifying that someone is having a stroke (from 1 to 10)</strong></td>
</tr>
<tr>
<td>Median (IQR)</td>
</tr>
<tr>
<td><strong>Missing=7 (0.80% of total)</strong></td>
</tr>
<tr>
<td><strong>Importance of quickly identifying stroke symptoms (from 1 to 10)</strong></td>
</tr>
<tr>
<td>Median (IQR)</td>
</tr>
<tr>
<td><strong>Missing=9 (1.0% of total)</strong></td>
</tr>
</tbody>
</table>

**Knowledge of Stroke Warning Signs (n=875)**

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>No. of Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbness or weakness</td>
<td>760 (86.9%)</td>
</tr>
<tr>
<td>Confusion, trouble speaking, or understanding</td>
<td>725 (82.9%)</td>
</tr>
<tr>
<td>Trouble walking, dizziness, or loss of balance or coordination</td>
<td>89 (10.2%)</td>
</tr>
<tr>
<td>Headache</td>
<td>159 (18.2%)</td>
</tr>
<tr>
<td>Trouble seeing</td>
<td>126 (14.4%)</td>
</tr>
<tr>
<td>≥1 warning signs correct</td>
<td>820 (93.7%)</td>
</tr>
<tr>
<td>≥2 warning signs correct</td>
<td>762 (87.1%)</td>
</tr>
<tr>
<td>3 warning signs correct</td>
<td>270 (30.9%)</td>
</tr>
</tbody>
</table>
staff have had the opportunity to learn about the benefits of tissue-type plasminogen activator.

This work has limitations. Because of the design of the survey, respondents could have used outside sources, to identify stroke symptoms. The response rate to our survey was robust; however, nonrespondents may have more or less knowledge about stroke symptoms and this could affect our results. As this survey was performed at an academic, tertiary care center, the results may not be generalizable to other institutions. In addition, because the majority of respondents were nurses, the results may not apply to other inpatient staff. Future educational efforts for nursing staff should emphasize the importance of outcomes expectations and stroke self-efficacy in addition to stroke knowledge.

**Sources of Funding**

Dr Skolarus is supported by National Institute of Neurological Disorders and Stroke K23NS073685.

**Disclosures**

None.

**References**


**Table 3. Predictors of Adequate Knowledge of Stroke Warning Signs (n=838)**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical experience, y</td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>Reference</td>
</tr>
<tr>
<td>1–3</td>
<td>1.00 (0.43–2.34)</td>
</tr>
<tr>
<td>4–10</td>
<td>0.62 (0.28–1.36)</td>
</tr>
<tr>
<td>≥11</td>
<td>0.98 (0.44–2.18)</td>
</tr>
<tr>
<td>Level of nursing training</td>
<td></td>
</tr>
<tr>
<td>2-y degree</td>
<td>Reference</td>
</tr>
<tr>
<td>4-y degree</td>
<td>0.95 (0.58–1.57)</td>
</tr>
<tr>
<td>Advanced nursing degree</td>
<td>2.56 (0.75–8.79)</td>
</tr>
<tr>
<td>Other or not applicable</td>
<td>0.74 (0.40–1.38)</td>
</tr>
<tr>
<td>Work location</td>
<td></td>
</tr>
<tr>
<td>ICU, med-surg unit, or other</td>
<td>Reference</td>
</tr>
<tr>
<td>Neurology unit or ED</td>
<td>0.90 (0.41–1.97)</td>
</tr>
<tr>
<td>Personal knowledge of a patient with stroke</td>
<td>0.99 (0.58–1.68)</td>
</tr>
<tr>
<td>Self-efficacy in identifying that someone is having a stroke</td>
<td>1.13 (1.01–1.27)</td>
</tr>
<tr>
<td>Importance of quickly identifying stroke symptoms</td>
<td>1.23 (1.002–1.51)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; ED, emergency department; and ICU, intensive care unit.
SUPPLEMENTAL MATERIAL

Stroke awareness among inpatient nursing staff at an academic medical center

Contents:

1. Supplemental methods
2. Supplemental figure I. On-line education module
3. Supplemental figure II. Rapid acute stroke screen
4. Supplemental figure III. Initial survey instrument
5. Supplemental figure IV. Follow-up survey instrument
6. Supplemental Table I. Knowledge of stroke warning signs in the follow-up survey
7. Supplemental references
Supplemental methods

Stroke education

We had no hospital wide mandatory stroke education for nursing staff until early 2012. Prior to this time, neuroscience nurses received regular education about caring for stroke patients, but stroke education for nursing staff who worked on other units was optional and focused on the care of stroke patients rather than stroke symptom recognition.

In early January 2012, stroke education, with a focus on stroke symptom recognition and management of the acute stroke patient, was mandatory for all inpatient nursing staff. The education consisted of an online module, shown in Supplemental Figure I, and a small group discussion. To help nursing staff recognize stroke symptoms, we developed a rapid acute stroke screen, Supplemental Figure II, based on prior work.\textsuperscript{1,2} This instrument was distributed to all nursing staff as a pocket card.

The initial survey is shown in Supplemental Figure III and the follow-up survey is shown in Supplemental Figure IV.

Description and results from the follow-up survey

Six months after the initial survey we developed a follow-up survey. A link to this survey was distributed via email to nursing leadership on all of the units (n=36) who participated in the initial stroke educational activities. The email instructed the recipient to forward the link to the survey to all nursing staff on the unit. Survey respondents could submit their email to be eligible
for a $10 gift card to the hospital cafeteria as an incentive for participating. The survey was open for one month.

After the initial educational intervention we did mock stroke codes on 4 units. These mock stroke codes simulated an acute stroke, provided educational material about stroke warning signs, and gave staff an opportunity to ask questions about stroke.

There were 193 responses to the follow-up survey. Six respondents were excluded because they did not respond to any of the questions leaving 187 for analysis. We do not know how many staff members did not respond to the follow-up survey so we are unable to calculate a response rate. Supplemental Table I shows the responses to the stroke signs and symptoms query. The median score for confidence in identifying when someone is having a stroke was 8. The median score for the importance of rapid identification of stroke symptoms was 10.

More respondents correctly identified one or two stroke signs or symptoms on the follow-up survey when compared to the initial survey, however, a lower percentage of respondents were able to name 3 warning signs in the follow-up survey. Self-confidence in identifying stroke symptoms and rating of the importance of rapid identification of stroke symptoms improved in the follow-up survey.
Supplemental figure I. On-line education module
Competency

Staff will recognize symptoms and appropriately intervene for a patient experiencing a stroke.

Critical Behaviors

- Identify three signs of stroke.
- Describe three immediate interventions for a patient suffering an acute stroke.
Introduction

About 795,000 Americans each year suffer a new or recurrent stroke. That means, on average, a stroke occurs every 40 seconds. Therefore, it is likely that one of these strokes might happen while a patient is hospitalized for some other reason. As when strokes occur in the community, it is very important for assessment and treatment to be initiated quickly when patients are under our care for other conditions. This module covers signs of a stroke, how to escalate care, and monitor the patient throughout the process.

Common Stroke Symptoms

Sudden onset:

- weakness or numbness on one side
- confusion, trouble speaking or understanding
- trouble seeing in one or both eyes
- trouble walking, loss of balance or coordination
- severe headache with no known cause
Stroke Screen

1. Review the Rapid Acute Stroke Screen (pdf)
2. Watch the normal exam video clip
3. Watch the abnormal exam video clip

Get the Adobe Flash Player to see this video.
## Acute Stroke Nursing Response When Patient Has a Positive Stroke Screen

### Adult Acute Care Response - Nurse
- Rapidly assess VS, bedside glucose, neuro check (GCS, pupils, motor function – same as what’s in the shift assessment)
- Call 141 ask for Rapid Response Team. Page the primary team and page the Stroke Team (#90004)
- Stay with patient, continue Q15min VS and neuro check assessment and assure patient safety; notify physician of any changes or if BP >185/110
- Determine time patient was last seen normal
- Facilitate STAT CT scan when ordered

### Adult ICU Rapid Response - Nurse
- Rapidly assess VS, bedside glucose, neuro check (GCS, pupils, motor function – same as what’s in the shift assessment)
- STAT page the primary team and page the Stroke Team (#90004)
- Stay with patient, continue Q15min VS and neuro check assessment and assure patient safety; notify physician of any changes or if BP >185/110
- Determine time patient was last seen normal
- Facilitate STAT CT scan when ordered

### Adult Acute Care Response – Tech/Aide (UAP)
- Inform nurse of change in patient’s status
- Stay with patient and assure safety

### Adult ICU Response – Tech (UAP)
- Inform nurse of change in patient’s status
- Stay with patient and assure safety
Treatment Guidelines

Nursing Guidelines for Initial Evaluation of Patients with Acute Stroke

- Oxygen at 2 LPM via nasal cannula for oxygen saturation < 95%
- Check if STAT “possible tPA candidate” non-contrast head CT ordered, if not, suggest to ordering physician

If acute treatment - IV tPA or intra-arterial (IA) intervention - is under consideration:

- Do not give aspirin, heparin or warfarin
- Keep patient NPO
- IV access x 2; NS at 75cc/hr.; saline lock in opposite arm
- Avoid arterial sticks, if possible
- STAT nurse blood draw for:
  - CBC with platelets
  - PT, aPTT, and INR
  - Glucose (preferably checked at bedside)
  - type and screen to blood bank
- Check if STAT EKG has been ordered, if not, suggest to ordering physician (do not delay head CT or treatment for EKG)
- Establish patient’s weight (actual or estimated)
- Obtain IV pump for possible infusion

Nursing Orders for Treating Stroke with IV Activase/Alteplase (tPA)

- USE ONLY ACTIVASE/ALTEPLASE (tPA)
- DO NOT USE RETAVASE/RETEPLASE OR OTHER TPA-CLASS DRUGS!
- DO NOT USE CARDIAC DOSING
- Make sure Pharmacy informed of “STAT TPA ORDER FOR ACUTE STROKE”
  - 6th floor pharmacy for adult UH/CVC patient (6-8251) or
  - Children’s and Women’s pharmacy if adult C & W patient (4-8208)
  - If no response, call ED pharmacy (2-6708)
- On drug arrival
  - Verify drug, tPA, (Activase/Alteplase) and dosing with treating physician
  - Dosing chart for weight-based total, bolus and infusion doses is included in the tackle box/bag supplied by the pharmacy with the tPA
  - Confirm total dose and bolus dose (10% of total dose)

Common Stroke Symptoms

Sudden onset:

- weakness or numbness on one side,
- confusion, trouble speaking or understanding,
- trouble seeing in one or both eyes,
- trouble walking, loss of balance or coordination
- severe headache with no known cause
Confirm infusion dose (90% of total dose)
- Bolus dose is given IV push over 1 minute. Infusion dose is given over 1 hour
- Set the infusion rate on the pump
- At the end of infusion, hang a 50 ml bag of normal saline and infuse at rate of t-PA infusion rate to empty the line completely of t-PA. This will be provided in the tackle box/bag
- Continue vital signs and neuro checks q 15 minutes and record, for 2 hours after the bolus of tPA, then q 30 minutes, continue to check and record until patient handoff to accepting unit
- Notify physician immediately for:
  - Any change in level of consciousness
  - Any worsening of neurologic function
  - Any abrupt rise in blood pressure
  - Any systolic blood pressure > 180 OR diastolic blood pressure > 105
  - New onset headache
- Transfer to Stroke Unit (or Neuro ICU) when bed available

**If pharmacy is not available to prepare tPA:** (only in extraordinary circumstances)

- Follow the reconstituting and administration instructions for Activase/alteplase tPA on the dosage chart in the acute stroke tackle box/bag from the pharmacy

**Nursing Orders for possible IA treatment**

- Continue vital sign and neuro checks at least q15-30 minutes until patient care is transferred to anesthesia, or decision is made that patient is not an IA candidate
- Patient must be monitored by a nurse until care transferred to another provider who will continue monitoring
Resources

- UMHS In-Patient Acute Ischemic Stroke Treatment Guidelines
- Nursing Guidelines for Initial Evaluation of Patients with Acute Stroke
- Clearinghouse (Patient Education materials) – search “stroke”
- MD Consult for additional clinical info about stroke
Supplemental figure II. Rapid acute stroke screen
If any item is abnormal (not the patient’s baseline) and new in the last 10 hours
STOP: Rapid Stroke Screen is Positive!
* Call Rapid Response (141) and
* Page Acute Stroke Team (90004)
* Check BP, O2 sat, & glucose
* Check and record neuro checks and vital signs q 15 minute
1. Facial asymmetry with expression?
2. Have patient extend arms straight out in front. Does one arm drift downward within 5 seconds? (Test both together)
3. Lift up patient legs one at a time. Does either drift (not just bounce) downward within 5 seconds?
4. Wiggle fingers of one hand in upper and lower vision fields. Have patient point to the hand moving. Is vision absent on one side?
5. Ask these questions (or state command).
   - “How old are you?”
   - “What month is it?”
   - “Point to the ceiling”

Is patient incorrect on ANY? (and would be able to answer/do prior to event)
Supplemental figure III. Initial Survey Instrument

The following questions are part of a research project designed to improve the quality of care for stroke patients. Your answers will be used to evaluate how much inpatient healthcare workers know about stroke symptoms. This information will be used to help make future educational interventions more effective. We will be repeating the survey in a few months to gauge the effectiveness of the stroke curriculum at Blitz. You will receive an email in the future, inviting you to complete the survey.

Participation in the survey is optional. To protect confidentiality, your responses to the questions will be kept in a password protected database. We will also report the results of the survey in aggregate, so your specific answers cannot be identified.

What are three important signs or symptoms of stroke?
1) ____________________
2) ____________________
3) ____________________

How confident are you that you can identify when someone is having a stroke?
Not at all confident 1 2 3 4 5 6 7 8 9 10 Very confident

When it comes to stroke outcomes, how important is it to quickly identify stroke symptoms?
Not at all important 1 2 3 4 5 6 7 8 9 10 Very Important

Do you know someone who has had a stroke?
• No
• Yes

What unit/area do you work on, the majority of the time? Pull down menu with all units listed.

Please indicate your highest nursing degree obtained.
• Not applicable/other
• LPN
• RN-ADN
• RN-Diploma
• RN-BSN
• RN-MSN
• NP
• RN-Doctorate

How many years of clinical experience do you have?
• Less than 1 year
• 1-3 years
• 4-10 years
• More than 11 years
Supplemental figure IV. Follow-up survey instrument

The following questions are part of a research project designed to improve the quality of care for stroke patients. This information will be used to help make future educational interventions more effective. When you finish the survey, you will have the option of entering a drawing for a $10 gift card as a small thank you for your time.

Participation in the survey is optional. To protect confidentiality, your responses to the questions will be kept in a password protected database. We will also report the results of the survey in aggregate, so your specific answers cannot be identified. This research has been granted an exemption by the IRB. If you have questions, feel free to contact, Dr. Eric Adelman at eriadelm@med.umich.edu.

What are three important signs or symptoms of stroke?
1) __________________
2) __________________
3) __________________

How confident are you that you can identify when someone is having a stroke?
Not at all confident 1  2  3  4  5  6  7  8  9  10  Very confident

When it comes to stroke outcomes, how important is it to quickly identify stroke symptoms?
Not at all important 1  2  3  4  5  6  7  8  9  10  Very Important

Do you know someone who has had a stroke?
• No
• Yes

What unit/area do you work on, the majority of the time?
*Pull down menu with all units listed.*

Did you participate in the stroke educational module during Nursing Blitz in January?
• No
• Yes

Have you participated in a mock stroke code in the past year?
• No
• Yes

Please indicate your highest nursing degree obtained.
• Not applicable/other
• LPN
• RN-ADN
• RN-Diploma
• RN-BSN
• RN-MSN
• NP
• RN-Doctorate

How many years of clinical experience do you have?
• Less than 1 year
• 1-3 years
• 4-10 years
• More than 11 years
Supplemental Table I. Knowledge of stroke warning signs in the follow-up survey

<table>
<thead>
<tr>
<th>Correct answers</th>
<th>Number with response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbness or weakness</td>
<td>180 (96.3%)</td>
</tr>
<tr>
<td>Confusion, trouble speaking, or understanding</td>
<td>170 (90.9%)</td>
</tr>
<tr>
<td>Trouble walking, dizziness, or loss of balance or coordination</td>
<td>9 (4.8%)</td>
</tr>
<tr>
<td>Headache</td>
<td>16 (8.6%)</td>
</tr>
<tr>
<td>Trouble seeing</td>
<td>28 (15%)</td>
</tr>
<tr>
<td>One or more warning signs correct</td>
<td>183 (97.9%)</td>
</tr>
<tr>
<td>Two or more warning signs correct</td>
<td>178 (95.2%)</td>
</tr>
<tr>
<td>Three or more warning signs correct</td>
<td>39 (20.9%)</td>
</tr>
</tbody>
</table>

*Total number of responses=187*
Supplemental References
