BMJ Open

Temporal changes in the documentation of neurological findings among patients with acute ischaemic stroke in a single centre in Japan: a retrospective cross-sectional study

Junpei Komagamine,[1] Tomoko Komagamine[2]

To cite: Komagamine J, Komagamine T. Temporal changes in the documentation of neurological findings among patients with acute ischaemic stroke in a single centre in Japan: a retrospective cross-sectional study. *BMJ Open* 2017;**7**:e019480. doi:10.1136/bmjopen-2017-019480

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2017-019480).

Received 5 September 2017
Revised 17 November 2017
Accepted 20 November 2017

[1]Department of Internal Medicine, National Hospital Organization Tochigi Medical Center, Utsunomiya, Tochigi, Japan
[2]Department of Neurology, Dokkyo Medical University, Shimotsuga-gun, Tochigi, Japan

Correspondence to
Dr Junpei Komagamine;
junpei0919@yahoo.co.jp

ABSTRACT

Objective To evaluate temporal differences in the documentation of neurological findings by the same physicians in patients with ischaemic stroke while in hospital. We also investigated differences in the rate of documentation of neurological findings in patients with stroke between internists and neurosurgeons.

Design A retrospective medical chart review.

Participants Hospitalised adult patients with acute ischaemic stroke who stayed 7 or more days in our hospital. Neurosurgeons (n=8) and internists (n=19) caring for these patients (including up to 10 patients per physician).

Main outcome measures The documentation rate of any neurological finding in the patients on each day (from day 1 to 7 and on discharge). The documentation rates of eight neurological finding components (consciousness, mental status, cranial nerves, motor function, sensory function, coordination, reflexes and gait). We included only documentation by the same physician. Fisher's exact test was used to evaluate differences in outcomes between neurosurgeons and internists.

Results During the study period, we identified 172 patients with stroke who were cared for by 27 physicians. The documentation rates of any neurological findings were 94% (day 1), 58% (day 2), 35% (day 3), 40% (day 4), 32% (day 5), 30% (day 6) and 23% (day 7). On discharge, all eight neurological finding components were documented in less than 10% of all cases. The documentation rate was significantly higher by internists than that by neurosurgeons on each day but not on discharge.

Conclusions The documentation rate of neurological findings by physicians during usual stroke care decreased to less than 50% after the third hospital day. Given the importance of temporal changes in the neurological symptoms of patients with stroke, further study is needed to determine whether this low documentation rate after the third hospital day was due to a lack of physician interest in neurological findings or other factors.

Strengths and limitations of this study

- ► This is the first study to evaluate temporal differences in the documentation of neurological findings by the same physicians in patients with acute stroke.
- ► An association between documentation and patient outcomes was not evaluated.
- ► This study was conducted in only a single hospital in Japan in a small sample of patients.

INTRODUCTION

The renowned stroke neurologist C. Miller Fisher said that we learn about neurology stroke by stroke. The development of imaging tests has improved our ability to localise neurological symptoms, particularly in patients with stroke, compared with previous decades.[1] The continuing development of more accurate neurological examination techniques allows us to learn symptomatology from patients with stroke. Nonetheless, physicians, particularly non-neurologists, often omit important neurological examinations[2 3] and tend to depend on brain imaging during routine stroke care.[4] Furthermore, despite an emphasis on observations of temporal changes in neurological findings in patients with stroke,[5–8] physicians often lose interest in such neurological signs in these patients, particularly after a definite diagnosis is achieved,[9] potentially reducing the documentation of neurological findings. This is problematic because temporal changes in neurological symptoms are key to predicting a prognosis and a need for intervention.[10–13] Moreover, given the limitations of brain imaging for diagnosing acute ischaemic stroke,[14] it is important to determine the typical clinical course in patients with acute stroke. Nonetheless, no studies have evaluated the speed at which the documentation of neurological findings in patients with stroke decreases after admission. Hence, we evaluated temporal changes in the documentation

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

rate of neurological findings by the same physician in patients with ischaemic stroke during hospital stays. We also evaluated differences in the documentation rate of any neurological finding in patients with stroke between internists and neurosurgeons. Given their specialty training and interest in neurology, neurosurgeons might document neurological findings more frequently than internists.

METHODS

Study design and participants

A retrospective medical chart review was conducted to assess data obtained between 1 September 2014 and 30 June 2017 at Tochigi Medical Center, a 350-bed acute care hospital in the Tochigi prefecture of Japan. Since September 2014, all medical records have been electronic in our hospital. We chose a retrospective study design because prospective research can introduce the Hawthorne effect,[15] which affects physicians' documentation in medical records. All consecutive patients aged 18 years old or older who were admitted with acute ischaemic stroke as a primary diagnosis, survived and stayed in our hospital at least 7 days were included. We excluded patients who died because of other factors, such as non-neurological disease and terminal care, which might affect the documentation of neurological findings. Patients whose principal physicians changed during the hospital stay were also excluded. Up to 10 patients per physician were included. The purpose of the study was to characterise temporal changes in the documentation rate of neurological findings in patients with ischaemic stroke by a single principal physician during a hospital stay. We also evaluated differences in the documentation rate of neurological findings between internists and neurosurgeons on each hospital day.

Usual care

In our hospital, consultation with a neurologist (TK) from an academic hospital once per week is possible; however, there is no ward neurologist. Therefore, either internists or neurosurgeons care for most patients with acute ischaemic stroke without consultation with neurologists. All internists included in this study had received formal training for neurology during 1 or 2 months while in their junior residency. No internists included in this study had received additional formal training for neurology. However, all of the internists had cared for patients with stroke on a regular basis in usual care. These practices are common in Japan, and approximately half of hospitals in Japan have no neurologists, even in certified training institutions such as the Japan Neurosurgical Society, the Japanese Society of Neurology and/or the Japan Stroke Society.[16] Furthermore, non-neurologists often care for patients with acute ischaemic stroke even in hospitals with neurologists in Japan. During this study period, the average hospital stay of patients with acute ischaemic stroke (excluding those with a transient ischaemic attack) was 25.1 days, and their in-hospital mortality was 7.0%. These rates were similar to those in other Japanese hospitals.[16 17] This mortality in patients with acute ischaemic stroke was also similar to data from other countries.[18]

In our hospital, patients with acute ischaemic stroke are randomly admitted to either the internal medicine or neurosurgical ward. However, patients with stroke requiring surgery or interventional radiology are admitted to the neurosurgery ward. In most cases, these patients with stroke are treated by a single principal internal medicine or neurosurgery physician without handoffs from admission to discharge. Additional physicians rarely examine or document neurological findings in these patients with stroke. Therefore, we could evaluate temporal changes in the documentation rate of neurological findings by a single physician. Furthermore, in Japan, the mean length of hospital stay among patients with acute stroke is approximately 30 days,[16 17] which is longer than in other countries.[18] Thus, in most patients with stroke, we could also evaluate temporal changes in the documentation rate of neurological findings during at least seven consecutive days. We assumed that the documentation rate would dramatically decrease after the second day and would thereafter change at a lower rate. Hence, even a short-term observation period was enough to evaluate the documentation rate of neurological findings. To reduce the effect of the day of the week at admission,[19] we selected a 7-day evaluation period.

Characteristics

Patient information, including age, sex and duration of hospital stay, was retrieved from medical records obtained at the time of each patient's admission. Physician-related information, including age, sex and specialty, was also retrieved from the database of Tochigi Medical Center.

Outcome measures

One of the authors (JK) evaluated the medical records of all included patients. The primary outcome was the documentation rate of any neurological finding in patients with ischaemic stroke by physicians on each hospital from the day of admission to the seventh day. We also evaluated the documentation rate of neurological findings at discharge (within the 24 hours before discharge). Neurological findings were classified as one of eight categories (consciousness, mental status, cranial nerves, motor function, sensory function, coordination, reflexes and gait) based on a previous study.[2] We allowed any documentation of neurological findings regardless of the quality of the examination. However, some documentations, such as 'no change in neurological findings' and 'no change', were not allowed because they often lacked information regarding which neurological findings were not different and to the extent of the examination. Documentation such as 'no change for right hemiplegia' was allowed though it was low quality because it lacked the quantity of neurological findings. Furthermore, documentation of only a total score on the National Institute of Health

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

Stroke Scale (NIHSS) was not allowed, although documentation of the detailed contents of NIHSS was allowed. Documentation of neurological findings by healthcare providers, including physicians, other than the principal physician, was excluded because we sought to evaluate only documentation by a single principal physician.

Statistical analysis

We did not formally calculate sample size because the primary objective was to define the characteristics of neurological documentations by physicians in ischaemic stroke patients. However, we expected a dramatic reduction in the documentation of neurological findings and therefore selected 10 patients per physician. Assuming that the documentation rate of any neurological finding would be 95% on admission and lower than 40% after the second hospital day, approximately 10 patients per physicians was needed to achieve a significance level of 0.05 with a power of 0.8. To minimise the effect on outcomes of a few physicians caring for many patients, only up to 10 patients per physician were included.

The baseline and demographic characteristics of patients and physicians were summarised using standard descriptive summaries. For the primary objective, we determined the documentation rate of any neurological finding in patients with ischaemic stroke on each hospital day. For outcomes on each hospital day, 95% CIs were calculated. For the secondary objective, to evaluate the difference in the documentation rate of neurological findings on each hospital day between internists and neurosurgeons, we used Fisher's exact test. These analyses were performed using the Excel statistical software package V.2.11 (Bellcurve for Excel; Social Survey Research Information, Tokyo, Japan), and the level of significance was set at 5%.

Patient involvement

No patients were involved in determining the research question or outcome measures nor were they involved in developing plans to design or implement the study. No patients were asked for advice during the interpretation or writing up of the results. There are no plans to disseminate the results of this research to study participants or the relevant patient community.

RESULTS

We identified 474 consecutive patient with acute ischaemic stroke who were cared for by 29 physicians during the study period. Forty-six patients (9.7%), including nine patients who had died, were excluded due to discharge before the seventh hospital stay. Of the remaining 428 patients, 172 who were cared for by 27 physicians (19 internists and 8 neurosurgeons) met our inclusion criteria. Among these 172 patients, 105 were discharged to home, 40 to rehabilitation facilities and 27 to other hospitals or long-term care facilities. The baseline characteristics of the patients and physicians are presented in table 1.

Table 1 Characteristics of patients with acute ischaemic stroke and physicians

	Total	Neurosurgery	Internal medicine
Physicians, n=27			
Mean (SD) age (years)	35.5 (7.8)	41.9 (11.0)	32.8 (3.8)
Men	22 (81.5)	7 (87.5)	15 (78.9)
Mean (SD) experience of doctor (years)	8.5 (7.5)	14 (10.9)	6.2 (3.3)
Patients, n=172			
Mean (SD) age (years)	75.1 (11.5)	74.9 (11.6)	75.3 (11.5)
Men	93 (54.1)	38 (55.1)	55 (53.4)
Admission day of week			
Weekday	155 (90.1)	63 (91.3)	92 (89.3)
Weekend	17 (9.9)	6 (8.7)	11 (10.7)
Mean (SD) length of hospital stay (days)	27.1 (18.5)	25.3 (19.0)	28.4 (18.1)

Values are shown as numbers (percentages) unless stated otherwise.

Figure 1 shows the temporal changes in the documentation rate of any neurological finding in all patients according to the specialty of their principal physician. The documentation rate of any neurological finding was 94% (95% CI 91% to 98%) at admission and 58% (95% CI 50% to 65%) on day 2. However, the average documentation rate of any neurological finding from the third to seventh day was lower than 40%. Furthermore, the documentation rate was only 14% within 24 hours of discharge. The documentation rate of any neurological finding was significantly lower in the neurosurgeon-treated group than in the internal medicine-treated group on each hospital day but not at discharge.

Among the eight neurological finding categories, motor function was the most frequently documented during the initial seven hospital days (table 2). Mental status, reflexes and gait were documented in less than 50% of all patients during the same period. Furthermore, after the third hospital day, these three components were documented in less than 10% of all patients. At discharge, all categories of neurological findings were documented in less than 10% of all patients.

DISCUSSION

In this study, the documentation rate of neurological findings by principal physicians decreased to lower than 50% after the third hospital day during stroke care. Furthermore, the documentation of mental status, reflexes and gait was often omitted by principal physicians during routine stroke care, and the documentation rate of these three categories was extremely low after the third day. These results indicate that physician interest in neurological findings in patients with stroke dramatically decreases after the third hospital day.

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

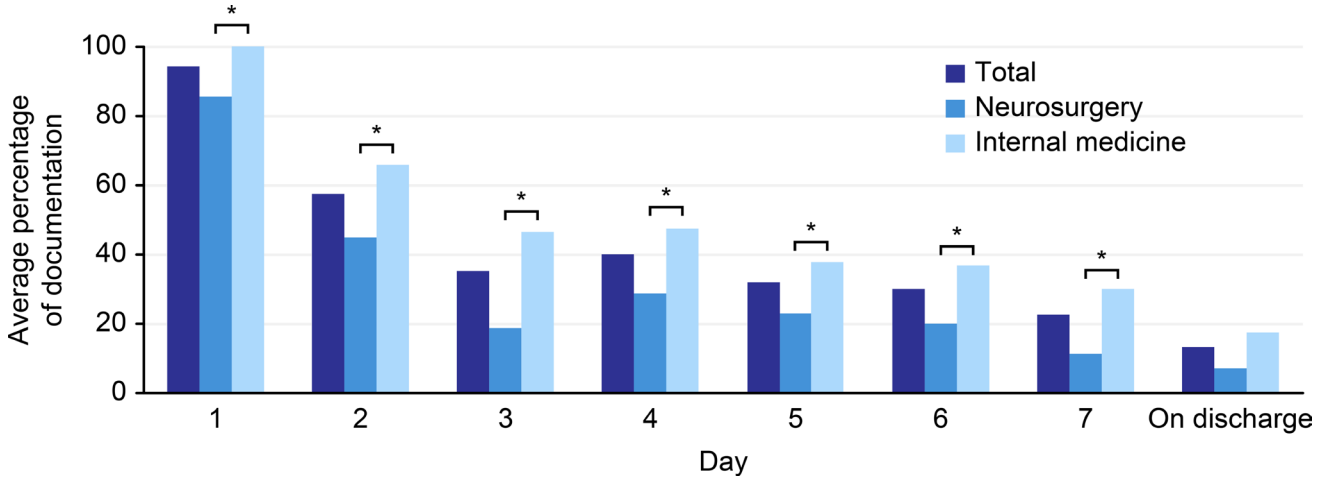

Figure 1 Temporal changes in the documentation rate of any neurological findings in 172 patients with ischaemic stroke during hospital stay. *P value <0.05.

Among the eight categories of neurological findings, motor function was the most frequently documented in this study and is consistent with the results of previous studies.[20–22] Mental status and gait were documented less frequently, as the stroke textbook describes that these important neurological assessments are unfortunately often omitted in routine care.[7] Because cognitive impairment frequently occurs in patients with stroke[23] and can be effectively treated with rehabilitation,[24 25] the low documentation rate of mental status by principal physicians is problematic, although such documentation may not reflect physician awareness.

We did not expect that neurological findings would be more frequently documented in patients with stroke in our hospital by internists than by neurosurgeons, and this result should be interpreted cautiously. Unlike in the internal medicine ward, trained nurses often document NIHSS every day during routine stroke care in the neurosurgery ward of our hospital, and such thorough assessment by other health providers may reduce the need for neurosurgeons to document neurological findings. Furthermore, we did not evaluate the quality or volume of neurological findings. Given their specialty in neurology, neurosurgeons might be more likely than internists to document more detailed and important neurological findings. Further study is needed to investigate whether a physician's specialty affects documentation.

Strengths and weaknesses of the study

To the best of our knowledge, this is the first study to evaluate temporal changes in the documentation of neurological findings by the same physician in patients with stroke. In our hospital, in most cases, a single principal physician cares for each patient with acute ischaemic stroke. This allowed us to evaluate temporal changes in medical record documentation by the same physicians.

Its major limitation is that the extent of documentation does not necessarily reflect the interest of the recorder.

Table 2 Temporal changes in the documentation rates of eight categories of neurological findings

	Day of hospital stay							
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	On discharge*
Any neurological finding	94 (91 to 98)	58 (50 to 65)	35 (28 to 43)	40 (33 to 48)	32 (25 to 39)	30 (23 to 37)	23 (16 to 29)	13 (8 to 19)
Level of consciousness	80 (74 to 86)	23 (16 to 29)	17 (11 to 23)	13 (8 to 19)	13 (8 to 19)	12 (7 to 16)	8 (4 to 12)	5 (1 to 8)
Mental status	46 (38 to 53)	12 (7 to 17)	9 (5 to 14)	5 (1 to 8)	6 (3 to 10)	6 (3 to 10)	4 (1 to 7)	3 (1 to 6)
Cranial nerves	84 (79 to 90)	35 (28 to 43)	19 (13 to 24)	22 (15 to 28)	15 (9 to 20)	13 (8 to 19)	10 (5 to 14)	6 (2 to 9)
Motor function	92 (88 to 96)	45 (38 to 53)	28 (21 to 35)	31 (24 to 38)	22 (16 to 28)	22 (15 to 28)	16 (10 to 21)	7 (3 to 11)
Sensory function	58 (51 to 66)	17 (12 to 23)	12 (7 to 17)	10 (6 to 15)	5 (2 to 9)	7 (3 to 11)	7 (3 to 11)	2 (0 to 4)
Coordination	51 (44 to 59)	13 (8 to 19)	9 (4 to 13)	6 (2 to 9)	5 (1 to 8)	3 (0 to 5)	5 (1 to 8)	3 (0 to 5)
Reflex	45 (37 to 52)	5 (1 to 8)	4 (1 to 7)	2 (0 to 4)	2 (0 to 5)	2 (0 to 5)	1 (–1 to 2)	1 (–1 to 2)
Gait	17 (11 to 23)	5 (1 to 8)	3 (0 to 5)	4 (1 to 7)	4 (1 to 7)	4 (1 to 6)	2 (0 to 4)	3 (0 to 5)

*Within 24 hours of discharge.
Values are shown as percentages (95% CIs).

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

Furthermore, in patients with stroke, it is impossible to distinguish an interest in neurological findings from interest in a prognosis. In addition, the role of clinical documentation has changed in the modern era, and billing and quality indicators affect medical record documentation.[26–28] However, the documentation of neurological findings during stroke care does not affect medical fees and is not considered a quality indicator in Japan. Therefore, billing for inpatient hospital care, litigation and quality indicators have few effects on the documentation of neurological findings by physicians. Furthermore, documentation itself is also important. As William Osler said, 'observe, record, tabulate, communicate'.[27] We were unable to retrospectively learn or perform detailed discussions about brain function without access to the sequential documentation of neurological findings, and physicians who are more interested in neurological findings will more thoroughly document them.

Other limitations include the following. First, this study included a small sample size and was limited to a single centre in which patients with stroke are admitted to neurosurgeons or internists. Therefore, our findings may not be applicable to hospitals in which patients with stroke are admitted to a neurology ward. However, this practice is common in Japan,[16] and a previous German study also reported that patients with acute ischaemic stroke were admitted in the internal medicine ward in approximately half of 225 acute care hospitals that participated in a stroke registry.[29] Moreover, given that the number of neurologists is not sufficient worldwide,[30] our findings for non-neurologists are important. Nonetheless, these findings should be confirmed in other settings, such as neurology ward in other countries. Second, it is uncertain whether a higher rate of documentation of neurological findings is associated with higher clinical skill and better patient outcomes. However, interest in stroke is associated with a more accurate clinical diagnosis of lacunar stroke.[31] Furthermore, poor documentation may mean poor monitoring, which causes a delay in awareness of acute changes in patient status. Therefore, poor documentation may result in worse patient outcomes, because a delay in the response to an acute change in patient status is associated with increased mortality.[10] Third, we did not evaluate outcomes between the eighth hospital day and discharge, but given the very low rate of documentation of neurological findings within 24 hours of discharge, we are confident that the documentation of neurological findings continued to gradually decrease after the eighth hospital day. Fourth, we did not individually evaluate the documentation of other important neurological signs, such as neuro-ophthalmic findings and visual problems,[7] and we did not evaluate the thoroughness of medical histories, which is important. As C. Miller Fisher showed, in patients with ischaemic stroke, the frequency and importance of transient ischaemic attacks can be determined from a thorough history of prodromal symptoms.[32] Fifth, a single observer evaluation might introduce bias and affect our results. However, past studies reported good inter-rater reliability in audits of neurological finding documentation.[19 22] Sixth, the prevalence of inappropriate copying and pasting[33] suggests that we may have overestimated clinically meaningful documentation. Seventh, we regarded two or more documentations per day as one documentation per day. Hence, we might have underestimated documentation by physicians. Finally, although a higher patient volume is associated with a lower rate of documentation of important information,[34] we did not consider the effect of work load on outcomes.

Meaning of findings

Several factors could have caused the observed reduction in the documentation of neurological findings after the third hospital day. First, the low documentation rate of neurological findings after the third hospital day might derive from the initial stable course of patients with stroke rather than a loss of physician interest in neurological findings.[20] However, because neurological findings often change day by day in the early course of acute stroke,[35 36] this possibility seems unlikely. Second, fatigue might occur in the documentation of neurological findings by physicians. If so, a similar phenomenon could occur in the documentation of non-neurological findings in non-neurological disease. Third, spending more time communicating, such as during neurological examinations of patients, is of utmost importance for learning about neurology and might reduce the documentation of neurological findings after the third hospital day. However, a previous study demonstrated acceptable concordance between documentation in medical records and actual performance during direct observations.[37] Furthermore, in previous studies, time spent communicating with patients and direct patient care were not affected by time spent during medical record documentation.[38 39] Fourth, participation in annual meetings during conferences and holidays could affect medical record documentation.

Although these factors might have affected our findings, physicians interested in neurological findings are more likely to frequently document neurological signs regardless of their fatigue, and the temporal reduction in documentation observed in our study is considered a reflection of loss of physician interest. Nonetheless, further study is needed to determine whether the low documentation rate after the third hospital day is truly due to a lack of physician interest in neurological findings.

Implications for clinical practice

C. Miller Fisher described many syndromes and mechanisms using thorough neurological examinations and observations of patients with stroke.[40] One of his significant contributions was an understanding of the relationship between carotid artery disease and ischaemic stroke. Before his work, approximately 55% of ischaemic strokes were thought to be caused by vasospasm.[41] When the first key patient who gave him an initial clue died while he was away for a weekend, the resident on call for the

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

patient did not request an autopsy. When Fisher asked the medical staff why they did not request an autopsy, he was amazed that the resident on call did not consider it necessary.[32] This episode reflects a gap in interest in patients with stroke between Fisher and the resident. Unlike Fisher's era, modern imaging tests provide us a more detailed localisation of neurological symptoms, especially in patients with stroke. Hence, our findings are disappointing even if they truly indicate a rapid loss of postadmission interest in patients with stroke by physicians. We propose that now is the time for physicians to relearn about neurology stroke by stroke.[42]

CONCLUSIONS

The documentation rate of neurological findings by physicians in usual stroke care decreased to lower than 50% on the third hospital day and subsequently continued to decrease. Given the importance of learning and monitoring temporal changes in neurological symptoms in patients with stroke, further study is needed to determine whether the low documentation rate after the third hospital day was caused by a lack of physician interest in neurological findings or other factors.

Acknowledgements We would like to thank Akihiko Tamura and Masaki Kobayashi for their advice for improving the clarity of the manuscript.

Contributors JK conceived the project. Both authors wrote the protocol for this study. JK collected and analysed the data. Both authors interpreted the results and wrote the manuscript. Both authors gave final approval for the submission of this revised version for consideration for publication.

Competing interests None declared.

Ethics approval This study was approved by the Medical Ethical Committee of National Hospital Organization Tochigi Medical Center (protocol No. 29-14) and was performed in accordance with the Declaration of Helsinki. This study was also conducted in accordance with the Ethical Guidelines for Epidemiological Research in Japan. We were not required to obtain individual informed consent because we used de-identified data obtained from medical records and did not contact the patients. According to Japanese Ethical Guidelines, we did display a poster in the waiting room of the hospital to provide information about the collection and use of data for this study and the protection of personal information.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Data sharing is not applicable because we did not receive informed consent for data sharing from the participants. The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

© Article author(s) (or their employer(s) unless otherwise stated in the text of the article) 2017. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

REFERENCES

1. Sacco RL, Kasner SE, Broderick JP, *et al*. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2013;44:2064–89.
2. Sarko J. Emergency medicine residents do not document detailed neurologic examinations. *Acad Emerg Med* 2009;16:1371–3.
3. Kerber KA, Morgenstern LB, Meurer WJ, *et al*. Nystagmus assessments documented by emergency physicians in acute dizziness presentations: a target for decision support? *Acad Emerg Med* 2011;18:619–26.
4. Savitz SI, Caplan LR, Edlow JA. Pitfalls in the diagnosis of cerebellar infarction. *Acad Emerg Med* 2007;14:63–8.
5. Ropper A, Adams SM. *Victor's principles of neurology*. 9th edn. New York: McGraw Hill Medical, 2009:746–52.
6. Rowland LP, Pedley TA. *Merritt's neurology*. 12th edn. Philadelphia: Lippincott Williams & Wilkins, 2010:1–3.
7. Caplan LR. *Caplan's stroke: a clinical approach*. 4th edn. Philadelphia: Elsevier, 2009:64–86.
8. Caplan LR, Hollander J. *The effective clinical neurologist*. 3rd edn. Shelton, CT: People's Medical Publishing House, 2009:3–61.
9. Caplan LR. Fisher's rules. *Arch Neurol* 1982;39:389–90.
10. Downey AW, Quach JL, Haase M, *et al*. Characteristics and outcomes of patients receiving a medical emergency team review for acute change in conscious state or arrhythmias. *Crit Care Med* 2008;36:477–81.
11. Alexandrov AV, Felberg RA, Demchuk AM, *et al*. Deterioration following spontaneous improvement: sonographic findings in patients with acutely resolving symptoms of cerebral ischemia. *Stroke* 2000;31:915–9.
12. Smith ME, Chiovaro JC, O'Neil M, *et al*. Early warning system scores for clinical deterioration in hospitalized patients: a systematic review. *Ann Am Thorac Soc* 2014;11:1454–65.
13. Jones DA, DeVita MA, Bellomo R, *et al*. Rapid-response teams. *N Engl J Med* 2011;365:139–46.
14. Chalela JA, Kidwell CS, Nentwich LM, *et al*. Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective comparison. *Lancet* 2007;369:293–8.
15. Sedgwick P, Greenwood N. Understanding the Hawthorne effect. *BMJ* 2015;351:h4672.
16. Iihara K, Nishimura K, Kada A, *et al*. Effects of comprehensive stroke care capabilities on in-hospital mortality of patients with ischemic and hemorrhagic stroke: J-ASPECT study. *PLoS One* 2014;9:e96819.
17. Fujino Y, Kubo T, Muramatsu K, *et al*. Impact of regional clinical pathways on the length of stay in hospital among stroke patients in Japan. *Med Care* 2014;52:634–40.
18. Organisation for Economic Cooperation and Development. OECD health statics. http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT# (accessed 17 Jul 2017).
19. Rudd AG, Hoffman A, Down C, *et al*. Access to stroke care in England, Wales and Northern Ireland: the effect of age, gender and weekend admission. *Age Ageing* 2007;36:247–55.
20. Chen RY, Lim JK, Chuo AM, *et al*. Stroke audit. *Med J Malaysia* 2003;58:330–6.
21. Patel S. Improving documentation within the acute stroke unit: Introducing a stroke specific clerking proforma. *BMJ Qual Improv Rep* 2015;4:u208852.w3847.
22. Davenport RJ, Dennis MS, Warlow CP. Improving the recording of the clinical assessment of stroke patients using a clerking pro forma. *Age Ageing* 1995;24:43–8.
23. Pendlebury ST, Rothwell PM. Prevalence, incidence, and factors associated with pre-stroke and post-stroke dementia: a systematic review and meta-analysis. *Lancet Neurol* 2009;8:1006–18.
24. Brady MC, Kelly H, Godwin J, *et al*. Speech and language therapy for aphasia following stroke. *Cochrane Database Syst Rev* 2016;6:CD000425.
25. Winstein CJ, Stein J, Arena R, *et al*. Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2016;47:e98–169.
26. Bernat JL. Challenges to ethics and professionalism facing the contemporary neurologist. *Neurology* 2014;83:1285–93.
27. Kuhn T, Basch P, Barr M, *et al*. Clinical documentation in the 21st century: executive summary of a policy position paper from the American College of Physicians. *Ann Intern Med* 2015;162:301–3.
28. Berenson RA, Basch P, Sussex A. Revisiting E&M visit guidelines-a missing piece of payment reform. *N Engl J Med* 2011;364:1892–5.
29. Heuschmann PU, Kolominsky-Rabas PL, Roether J, *et al*. Predictors of in-hospital mortality in patients with acute ischemic stroke treated with thrombolytic therapy. *JAMA* 2004;292:1831–8.
30. World Health Organization. Atlas: country resources for neurological disorders. 2004 http://www.who.int/mental_health/neurology/neurogy_atlas_lr.pdf?ua=1 (accessed 28 Sep 2017).
31. Lodder J, Bamford J, Kappelle J, *et al*. What causes false clinical prediction of small deep infarcts? *Stroke* 1994;25:86–91.

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.

32. Fisher CM. A career in cerebrovascular disease: a personal account. *Stroke* 2001;32:2719–24.
33. Weis JM, Levy PC. Copy, paste, and cloned notes in electronic health records: prevalence, benefits, risks, and best practice recommendations. *Chest* 2014;145:632–8.
34. Gravely-Witte S, Stewart DE, Suskin N, *et al*. Cardiologists' charting varied by risk factor, and was often discordant with patient report. *J Clin Epidemiol* 2008;61:1073–9.
35. Moulin T, Tatu L, Crépin-Leblond T, *et al*. The besançon stroke registry: an acute stroke registry of 2,500 consecutive patients. *Eur Neurol* 1997;38:10–20.
36. Toni D, Fiorelli M, Bastianello S, *et al*. Acute ischemic strokes improving during the first 48 hours of onset: predictability, outcome, and possible mechanisms. A comparison with early deteriorating strokes. *Stroke* 1997;28:10–14.
37. McDermott MF, Lenhardt RO, Catrambone CD, *et al*. Adequacy of medical chart review to characterize emergency care for asthma: findings from the illinois emergency department asthma collaborative. *Acad Emerg Med* 2006;13:345–8.
38. Becker G, Kempf DE, Xander CJ, *et al*. Four minutes for a patient, twenty seconds for a relative-an observational study at a university hospital. *BMC Health Serv Res* 2010;10:94.
39. Block L, Habicht R, Wu AW, *et al*. In the wake of the 2003 and 2011 duty hours regulations, how do internal medicine interns spend their time? *J Gen Intern Med* 2013;28:1042–7.
40. Adams RD, Richardson EP. Salute to C. Miller Fisher. *Arch Neurol* 1981;38:137–9.
41. Estol CJ. Dr C. Miller Fisher and the history of carotid artery disease. *Stroke* 1996;27:559–66.
42. Krakauer JW, Hillis AE. The future of stroke treatment: bringing evaluation of behavior back to stroke neurology. *JAMA Neurol* 2014;71:1473–4.

BMJ Open: first published as 10.1136/bmjopen-2017-019480 on 14 December 2017. Downloaded from http://bmjopen.bmj.com/ on October 29, 2024 by guest. Protected by copyright.