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Extended delays in recognition of stroke symptoms and stroke code activation for in-hospital strokes: The DELAY study

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Additional data and materials can be made available on reasonable request by a qualified investigator.

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PNC**:** Interpretation of clinical data critically revised the manuscript, agreement to be accountable for all aspects of the work.

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Abstract:

Background: Patients with stroke while hospitalized experience important delays in symptom recognition. This study aims to describe the overall management of an in-hospital stroke population and how it compares with out-of-hospital community onset stroke population. ***Methods:*** In this retrospective observational study, we included consecutive patients with in-hospital and out-of-hospital strokes (both ischemic and hemorrhagic) over a period of one year treated at a comprehensive stroke center. Demographic and clinical data were extracted, and patient groups were compared with regards to stroke treatment times metrics. ***Results:*** 362 patients diagnosed with acute stroke were included, of whom 38 (10.5%) had in-hospital and 324 (89.5%) had out-of-hospital strokes. The median delay to stroke recognition (time between the last time seen well and first time seen symptomatic) was significantly longer in in-hospital compared to out-of-hospital strokes (77.5 (0-334.8) versus 0 (0-138.5) minutes, $p = 0.04$). The median time interval from stroke code activation to arrival of the stroke team at bedside was significantly shorter in in-hospital versus out-of-hospital cases (10 (6-15) versus 15 (8-24.8) minutes, $p = 0.01$). In-hospital strokes were less likely to receive thrombolysis (12.8% versus 45.4%, $p<0.01$) with a significantly higher mortality (18.2% versus 2.6%, $p<0.01$) and longer overall median hospital stay (3 (1-7) versus 12 days (7-23), $p<0.01$) compared to out-of-hospital strokes. ***Conclusion:*** This study showed significant delays in stroke symptom recognition and stroke code activation for in-hospital stroke patients despite comparable overall stroke time metrics. Development of in-hospital stroke protocols and systematic staff training on stroke symptom recognition should be implemented to improve care for hospitalized patients.

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Introduction

In-hospital strokes account for approximately 6.5% to 15% of all strokes but are associated with higher mortality, extended hospitalization, and less rehabilitation potential.[1–3] Patients who suffer an stroke while being hospitalized often have many comorbidities, including thromboembolic risk factors.[1,4,5] Medical procedures and surgery also confer a higher risk of stroke.[6] Management of strokes during hospital stay is challenging as many confounding factors such as delirium, immobilization, or sedation may contribute to delays in the recognition of stroke symptoms. Comorbid conditions, functional status and post-surgical bleeding risks can limit eligibility for thrombolysis. Compared to out-of-hospital strokes, strokes in hospitalized patients are associated with a less guideline-based stroke treatment from the medical team.[3] Intracerebral hemorrhage (ICH) can also occur in-hospital and is associated with higher mortality than ischemic stroke.[7] While patients with ICH cannot benefit from acute reperfusion therapies, rapidly lowering blood pressure, reversing anticoagulation, controlling blood sugar levels and treating fever can improve functional outcomes and these patients should also be managed urgently.[8–10] Delays in diagnosis and treatment should be shortened as much as possible to optimise patient outcomes.

The **Diagnosis and EvaLuation of stroke in-hospitAl and in the communitY (DELAY)** study aims to describe the in-hospital stroke population at a single comprehensive stroke center and compare their baseline characteristics, time metrics and treatment with out-of-hospital stroke patients to identify areas for possible improvement.

Methods

We conducted a single-center, retrospective cohort study of all acute ischemic or hemorrhagic strokes that occurred between November 27th, 2017 and November 27th, 2018, at a large academic comprehensive stroke center in Montreal, Canada. Patient data was retrieved by hospital chart review by medical archivists using ICD codes including cases with stroke as a final diagnosis or as a complication of hospitalization. In addition, cases were identified by a review of the electronic patient record which includes data from all acute stroke codes evaluated by the vascular neurology team – the MOntreal Neurovascular and StrokE data Repository (MONSTER).

We excluded patients with subacute out-of-hospital strokes (patients with last seen well to first seen symptomatic delay of more than 24 hours), stroke mimics, transient ischemic attack, and

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patients initially evaluated in another center and transferred for thrombectomy. After a review of imaging reports, patients in whom the acute stroke was an incidental finding were excluded.

Patient characteristics

Baseline patient characteristics including the type of stroke (hemorrhagic or ischemic) and prior use of antithrombotic treatment were documented. Medical or surgical procedures in the days preceding stroke were recorded.

Stroke time metrics

We used a standardized data collection form in all acute stroke cases assessed by the neurovascular team. The time of imaging was calculated using the time recorded at the start of acute neurovascular imaging. The time of thrombolysis was defined as the time of administration of an intravenous bolus of thrombolysis. The time of thrombectomy was defined as the time of initial arterial puncture in the angiography suite.

Statistical analysis

We summarized baseline characteristics using descriptive statistics such as median and interquartile ranges (IQR) or frequencies (proportions) where appropriate. We performed univariable comparisons of the median time intervals from last time seen well to first seen symptomatic, stroke code activation, stroke team arrival at bedside, imaging, and treatment initiation (thrombolysis, thrombectomy) using either Chi-square test or Fischer Exact test (with expected cell frequencies less than 5) for nominal data and the Mann-Whitney U test for ordinal data with a cutoff for statistical significance of 0.05. The analyses were performed using Statistical Package for Social Sciences (SPSS) version 27(Armonk, NY).

Results

A total of 362 patients were diagnosed with an acute stroke during the study period. Thirty-eight patients (10.5%) had strokes in-hospital while 324 (89.5%) had out-of-hospital strokes as seen in Figure 1. The demographic features and comorbidities of each group are presented in Table 1. Both groups were comparable in terms of conventional cerebrovascular risk factors except for a higher prevalence of history of cancer in the in-hospital group ($p = 0.02$). Anticoagulation was stopped for a medical procedure in significantly more in-hospital patients as compared to the out-of-hospital treatment group. Among the 38 in-hospital patients, 23 underwent a procedure shortly before their stroke (60.5%) (Table 2).

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Among the 324 out-of-hospital patients, 74% were assessed by the stroke team within 4.5 hours of the last time seen well compared to 57% in the in-hospital group (p = 0.03). In the out-of-hospital group, 45.4% received thrombolysis compared to 12.8% in the in-hospital group (p = 0.02). In terms of stroke time metrics as shown in Table 2, the median delay to stroke onset recognition (time between the last time seen well and first time seen symptomatic) was 77.5 (0-334.8) minutes in hospitalized patients and 0 (0-138.5) minutes, in out-of-hospital patients (p = 0.04), presumably because more out-of-hospital strokes were witnessed at onset. After stroke recognition, the time to stroke code activation was similar for in-hospital and out-of-hospital cases (60 (25-141) versus 58 (37-107.8) minutes, p = 0.72). On the other hand, the median time interval from stroke code activation to arrival of the stroke team at the bedside of the patient was significantly shorter in hospitalized patients compared to out-of-hospital patients (10 (8-15) versus 15 (8-24.8) minutes, p = 0.01). Time to imaging and treatment initiation including thrombolysis and thrombectomy were similar between groups. Out-of-hospital patients were significantly more likely to receive thrombolysis (45.4% versus 12.8 %, p<0.01) whereas thrombectomy rates were not statistically different in both groups (24.4% versus 12.8%, p = 0.12).

The proportion of patients with ICH was similar in both the in-hospital and out-of-hospital groups (10.5% and 10.8%). Among in-hospital patients with ICH, 3 of 4 (75%) had a recent procedure (nephrectomy, carotid endarterectomy, and mitral valve replacement). Regarding acute ICH management of hospitalised patients, 2 out of 4 (50%) received intravenous blood pressure lowering therapy (one before and one after the arrival of the stroke team), while 2 out of 4 (50%) did not need any change in their medication. All 4 hospitalised patients with ICH died during hospitalization. For out-of-hospital patients with ICH, only 4 out of 35 (11%) patients did not receive any intravenous blood pressure lowering therapy, and 10 (29%) died while hospitalized.

Patients with in-hospital stroke included those with and without varied invasive procedures prior to the incident stroke (Table 3 and Table 4). The code stroke was not called for 9 in-hospital stroke patients (23.7%) and specific reasons could not be identified on retrospective review of the case records. In-hospital patients had a significantly higher mortality (12.0% versus 36.0 %, p<0.01) and longer overall median hospital stay (3 (1-7) versus 12 (7-23) days, p<0.01) than out-of-hospital patients.

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Discussion

In this observational, retrospective cohort study comparing in-hospital and out-of-hospital patients at our comprehensive stroke center, we found significantly longer delays for stroke symptom recognition in hospitalised patients with similar time intervals to stroke code activation in both groups. There were no statistically significant differences in the overall management times after activation of the stroke team.

Stroke recognition delays

A possible explanation for the significantly longer delay in stroke symptom recognition in hospitalized versus out-of-hospital cases is that most patients in the community recognized their symptoms immediately by themselves or had a witnessed stroke onset with rapid emergency medical service activation by bystanders. Contrarily, hospitalized patients may be less alert or have other conditions masking their stroke symptoms and may have onset of stroke while unsupervised in their room. We can infer that valuable time is lost in hospitalized stroke patients due to delays in the recognition of stroke symptoms. It is also important to acknowledge that there may be patients with out-of-hospital strokes who may not have been appropriately referred to stroke team irrespective of stroke code activation.

A delay in timely stroke recognition among in-hospital patients has been found several other studies.[11–13] Akbik et al. (2020) determined that fewer than 30% of patients were assessed within ninety minutes, and more than 25% were not seen within 12 hours of symptom recognition.[11] In-hospital stroke patients may be subject to significantly longer delays from onset to imaging and from imaging to treatment.[12] A large Canadian cohort comparing stroke care delivery and outcome for 973 patients with in-hospital strokes and 28 837 patients with out-of-hospital strokes revealed significantly longer times in symptom recognition among in-hospital patients, with a smaller proportion undergoing brain imaging.[13]

Several hypotheses could help explain these findings. First, public awareness campaigns have been focused on FAST signs and symptoms recognition in the community[14], but the same efforts have not been devoted to training hospital personnel for acute stroke detection.[15] Delays in stroke code activation for hospitalized patients may also stem from infrequent patient evaluations by staff, particularly among patients considered stable, and absence of families or caregivers at the bedside. Secondly, many symptoms can be misattributed to another comorbid condition. For example, speech disturbance, drowsiness or dizziness can be erroneously associated with

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medication use, a post-surgical state, or delirium.[1,16] Paresis can also go unnoticed in a bedridden patient if there is no standardized screening for neurological deficits by clinical staff.

Stroke code activation

We observed similar time intervals to stroke code activation in hospitalized and out-of hospital stroke patients even though this delay should presumably be shorter given that they are surrounded by healthcare staff. It is also concerning that the stroke team was not notified for 9 of the 38 in-hospital stroke patients (23.7%), thereby limiting their access to acute reperfusion therapy. A possible explanation may be that seven out of nine patients had recent surgery (77.8%) which may have been deemed an automatic contra-indication to thrombolysis by the treating medical team – but in which case urgent neurovascular evaluation would still be indicated, to consider patient eligibility for endovascular thrombectomy.

Others have also reported delayed stroke team activation even after recognition of a possible stroke by medical staff in hospitalised patients,[12] which may in part be due to the absence of clear protocols and care pathways for these patients. If bedside staff notify the treating physician or on-call resident instead of directly activating the stroke code, delayed notification is assured. Another possible reason for delay could be erroneous attribution of stroke symptoms to non-acute neurological symptoms triggering delayed general neurology consultations instead of direct stroke team activation.[1] Furthermore, patient comorbidities and their post-surgical state may bias staff towards prematurely concluding that stroke activation is futile or of little benefit. This only underscores the importance of widespread education regarding the availability of effective non-thrombolytic treatment options like mechanical thrombectomy, even in later time-windows, which can reduce post-stroke morbidity and mortality.

Stroke investigation and treatment

Streamlined workflows with rapid access to baseline neurovascular imaging are essential in effective acute stroke management. In our study, the median time from “first time seen symptomatic” to imaging was not significantly different between in-hospital and out-of hospital stroke groups. However, this represents suboptimal management of hospitalized strokes as these patients are already physically closer to the imaging suite. Given the very short delays between imaging and treatment initiation (i.e. time to administration of a bolus of intravenous thrombolysis) in both groups (9 min in hospitalised and 11 min in out-of hospital strokes), our results emphasize that time from symptom onset to imaging is where quality improvement

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efforts should be focused for in-hospital strokes. Again, formal protocols detailing where neurovascular imaging should be done for in-hospital strokes (ex. emergency department CT versus radiology department CT) and where thrombolysis administration should occur (ex. CT scan room, stroke unit, ICU, patient's own unit) can better inform hospital personnel and thereby reduce uncertainty and unnecessary delays.

Only 57% of in-hospital patients were evaluated by the stroke team within 4.5 hours of the last time seen well as compared to 74% of out-of hospital patients ($p = 0.03$). The significant discrepancy ($p = 0.01$) between the proportion of patients who received thrombolysis in strokes in hospitalized patients (12.8%) and out-of hospital strokes (45.4%) is likely only partially explained by delayed evaluations. We found a similar discrepancy between patients who had both thrombolysis and thrombectomy being 2.6% in the in-hospital group and 18.2% in the out-of hospital (18.2%), ($p = 0.02$) stroke group. Given that 62.8% of hospitalized stroke patients had a recent procedure or surgery prior to their stroke, IV thrombolysis is more likely to be contra-indicated in this group. The difference in thrombolysis administration rates was not explained by anticoagulant use, as the proportion of anticoagulated patients was similar in both groups.

Potential solutions

The management of in-hospital strokes could, in theory, be more rapid and streamlined, given that the patient is already hospitalized and monitored by medical personnel. There is certainly an unmet need for stroke awareness education among medical and non-medical staff. Recognition of sudden-onset focal neurological deficits using simple tools like FAST, as well as regular training to identify other stroke-like symptoms among patients with pre-existing co-morbidities, should be offered to all clinical hospital staff caring for in-patients. Training should also focus on nursing or medical staff notifying the stroke team using the stroke code as soon as there is a suspicion of stroke, without notifying the general neurology team or general on-call resident first. The development of an in-hospital stroke protocol can increase the efficiency of patient management and treatment administration (see algorithm detailing standard of care for treatment of in-hospital strokes at our center in Figure 2).[24] Indeed, having clear directions to follow makes it easier for healthcare professionals to react within the therapeutic time window, thereby reducing management delays and increasing the possibility for in-hospital stroke patients to have access to appropriate acute stroke treatment.[16,25–27] These need to be tailored to local infrastructure, but should include clear delineation of the medical team responsible for evaluating

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that patient (stroke physician, stroke nurse), having rapid access to thrombolytic therapy (ex. a dedicated stroke toolbox for in-hospital strokes in a fixed, easily accessible location), ensuring proper intravenous access and acute stroke laboratory tests, identifying patient transport protocols and location of neurovascular imaging, determining where thrombolytic therapy will be administered and where the patient will be admitted for specialized stroke care. Implementation of regular stroke code activation simulations following detailed in-hospital protocols may also contribute toward reducing false positive activations which can represent an important burden on acute neurology services.

Strengths

A strength of this study is the inclusion of patients for which the stroke team was not notified, by comparing patients identified by the medical archivists using ICD codes with data from the electronic patient record that includes all acute stroke codes evaluated by the vascular neurology team. Given that a large majority of these "missed" patients were post-operative, we identified an area of unmet need wherein future quality improvement initiatives could be tailored to focus on surgical and intensive care units. Another strength was the use of standardized data collection tool among patients for whom the stroke team was activated, using a clinical report form completed at the time of patient evaluation, allowing for more complete retrospective data gathering.

Limitations

Our study has several limitations. The retrospective design is subject to many pitfalls and biases. Our sample size was relatively small and captured from a single comprehensive stroke center, with insufficient power to provide statistical significance when comparing both groups and attenuating generalizability of our findings. Our results were heterogeneous, representing the diversity of stroke cases encountered but also limiting the analysis and without adjustment for potential confounding factors. The calculation of stroke metrics like time to imaging could be influenced by variability in estimation of first onset of stroke symptoms in both groups. Our study did not evaluate patients with false positive stroke code activations. Finally, we did not have access to clinical outcomes beyond the index hospitalization period.

Conclusion

This study did not reveal significant differences between overall treatment time metrics in the management of in-hospital compared to out-of hospital stroke patients. However, substantial

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delays in stroke symptom recognition and stroke team activation were observed in patients with a stroke while being hospitalised. Since these delays are likely modifiable, institutions should emphasize targeted interventions to help expedite and expand treatment of in-hospital stroke patients to potentially decrease hospital stays and post-stroke morbidity, such as systematic hospital staff stroke recognition training and dedicated, widely circulated in-hospital acute stroke protocols.

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References

1. Blacker DJ. In-hospital stroke. Lancet Neurol 2003;2:741-746.
2. Chen S, Singh RJ, Kamal N, Hill MD. Improving care for acute in-hospital ischemic strokes-A narrative review. Int J Stroke 2018;13:905-912.
3. Cumbler E, Wald H, Bhatt DL, et al. Quality of care and outcomes for in-hospital ischemic stroke: findings from the National Get With The Guidelines-Stroke. Stroke 2014;45:231-238.
4. Emmett ES, Douiri A, Marshall IJ, et al. A comparison of trends in stroke care and outcomes between in-hospital and community-onset stroke - The South London Stroke Register. PLoS One 2019;14:e0212396.
5. Wang J, Wen X, Li W, et al. Risk Factors for Stroke in the Chinese Population: A Systematic Review and Meta-Analysis. J Stroke Cerebrovasc Dis 2017;26:509-517.
6. Farooq MU, Reeves MJ, Gargano J, et al. In-hospital stroke in a statewide stroke registry. Cerebrovasc Dis 2008;25:12-20.
7. Benjamin EJ, Muntner P, Alonso A, et al. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. Circulation 2019;139:e56-e528.
8. Gladstone DJ, Lindsay MP, Douketis J, et al. Canadian Stroke Best Practice Recommendations: Secondary Prevention of Stroke Update 2020. Can J Neurol Sci 2022;49:315-337.
9. Ma L, Hu X, Song L, et al. The third Intensive Care Bundle with Blood Pressure Reduction in Acute Cerebral Haemorrhage Trial (INTERACT3): an international, stepped wedge cluster randomised controlled trial. Lancet 2023;402:27-40.
10. Schrag M, Kirshner H. Management of Intracerebral Hemorrhage: JACC Focus Seminar. J Am Coll Cardiol 2020;75:1819-1831.
11. Akbik F, Xu H, Xian Y, et al. Trends in Reperfusion Therapy for In-Hospital Ischemic Stroke in the Endovascular Therapy Era. JAMA Neurol 2020;77:1486-1495.
12. Masjuan J, Simal P, Fuentes B, et al. In-hospital stroke treated with intravenous tissue plasminogen activator. Stroke 2008;39:2614-2616.
13. Saltman AP, Silver FL, Fang J, et al. Care and Outcomes of Patients With In-Hospital Stroke. JAMA Neurol 2015;72:749-755.

https://doi.org/10.1017/cjn.2024.304 Published online by Cambridge University Press

14. Rioux B, Brissette V, Marin FF, et al. The Impact of Stroke Public Awareness Campaigns Differs Between Sociodemographic Groups. Can J Neurol Sci 2022;49:231-238.
15. Kassardjian CD, Willems JD, Skrabka K, et al. In-Patient Code Stroke: A Quality Improvement Strategy to Overcome Knowledge-to-Action Gaps in Response Time. Stroke 2017;48:2176-2183.
16. George P, Wisco DR, Gebel J, et al. Nurses Are as Specific and Are Earlier in Calling In-Hospital Stroke Alerts Compared to Physicians. J Stroke Cerebrovasc Dis 2017;26:917-921.
17. Dulli D, Samaniego EA. Inpatient and community ischemic strokes in a university hospital. Neuroepidemiology 2007;28:86-92.
18. Shiber JR, Fontane E, Adewale A. Stroke registry: hemorrhagic vs ischemic strokes. Am J Emerg Med 2010;28:331-333.
19. Smith EE, Shobha N, Dai D, et al. A risk score for in-hospital death in patients admitted with ischemic or hemorrhagic stroke. J Am Heart Assoc 2013;2:e005207.
20. Bhatia R, Singh H, Singh S, et al. A prospective study of in-hospital mortality and discharge outcome in spontaneous intracerebral hemorrhage. Neurol India 2013;61:244-248.
21. Fernando SM, Qureshi D, Talarico R, et al. Intracerebral Hemorrhage Incidence, Mortality, and Association With Oral Anticoagulation Use: A Population Study. Stroke 2021;52:1673-1681.
22. Zhang Y, Wang Y, Ji R, et al. In-hospital complications affect short-term and long-term mortality in ICH: a prospective cohort study. Stroke Vasc Neurol 2021;6:201-206.
23. Krueger H, Lindsay P, Cote R, et al. Cost avoidance associated with optimal stroke care in Canada. Stroke 2012;43:2198-2206.
24. Kawano H, Ebisawa S, Ayano M, et al. Improving Acute In-Hospital Stroke Care by Reorganization of an In-Hospital Stroke Code Protocol. J Stroke Cerebrovasc Dis 2021;30:105433.
25. Koge J, Matsumoto S, Nakahara I, et al. Improving treatment times for patients with in-hospital stroke using a standardized protocol. J Neurol Sci 2017;381:68-73.
26. Manners J, Khandker N, Barron A, et al. An interdisciplinary approach to inhospital stroke improves stroke detection and treatment time. J Neurointerv Surg 2019;11:1080-1084.

https://doi.org/10.1017/cjn.2024.304 Published online by Cambridge University Press

27. Yang SJ, Franco T, Wallace N, et al. Effectiveness of an Interdisciplinary, Nurse Driven In-Hospital Code Stroke Protocol on In-Patient Ischemic Stroke Recognition and Management. J Stroke Cerebrovasc Dis 2019;28:104398.

https://doi.org/10.1017/cjn.2024.304 Published online by Cambridge University Press