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Reassessing Hourly Neurochecks

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Abstract

Following acute brain injury, frequent neurological examinations ("neurochecks") are commonly prescribed and form the cornerstone of many care protocols and guidelines (e.g., for intracranial hemorrhage). While these assessments are intended to identify and mitigate secondary injury, they may unintentionally contribute to additional injury related to neurocheck-associated sleep disruption. Data are lacking to define patterns of neurological decline following acute brain injury, as are data to define the short- and long-term consequences (e.g., neuropsychological sequelae) of frequent and prolonged neurochecks. A critical need exists for rigorous evaluations of neurocheck practices, perceptions, benefits and risks, along with interventions to optimize neurocheck frequency and duration.

Keywords

neurological examination; neurocheck; neuroassessment; neurocritical care; ICU; sleep disruption

Protocolized neurology is increasingly used to optimize care delivery and outcomes for patients with acute brain injury (ABI). For patients with ABI,[1] a common provision is for "frequent" or "repeated" neurological assessments (neurochecks).[2–4] Excluding guidelines following alteplase administration for ischemic stroke,[3] however, there is minimal guidance on how frequently (e.g., every hour) neurochecks should be conducted, or for how long they should continue. Consequently, patients with ABI often receive hourly or every-other-hour examinations, sometimes for extended periods of time (days or even weeks).[5]

Only a handful of studies have examined neurocheck practices. Studies involving patients with intracerebral hemorrhage (ICH) suggest value in short stretches of

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neuromonitoring that include frequent (e.g., every hour) neurochecks and surveillance imaging.[6] Approximately one-quarter of neurosurgical interventions after intracranial hemorrhage were prompted by monitoring for clinical and/or radiographic instability.[6] Notably, 50% and 75% of these interventions occurred within 15 and 27 hours of ABI,[6] respectively, suggesting that neurochecks may be most important during the initial 24 hour post-ABI period. Following ICH, predictable causes of neurodeterioration—each with their own timeframe—exist.[7] In patients with traumatic brain injury (TBI), individuals examined hourly required very few interventions after 48 hours had elapsed, yet those monitored hourly for more than four days experienced longer lengths of stay.[8]

Predictability of neurodeterioration is predicated on causes of ABI and patient risk factors. Following isolated traumatic subarachnoid hemorrhage (SAH), studies suggest that a higher Glasgow Coma Score (GCS) on admission is associated with significantly lower incidence of surgical intervention when compared with lower GCS.[9] Alternatively, spontaneous SAH has a more unpredictable pattern and timeframe of neurodeterioration. For example, vasospasm can develop around post-bleed day 3, tends to peak on days 8-11 and resolve by day 21.[10] Hence, in spontaneous SAH, the unpredictable secondary injury timeframe may complicate efforts to minimize neurochecks. When complex diagnoses lack predictable patterns of neurodeterioration, or when clear data supporting frequent neurochecks are lacking, supplementary monitoring strategies (e.g., angiography, transcranial Doppler [TCD]) may play an important role in fine-tuning frequent assessment paradigms. Additionally, patients requiring mechanical ventilation with or without sedative medications may require supplementary non-invasive modalities such as electroencephalography or TCD, and/or invasive modalities such as intracranial pressure monitoring.

While neurochecks are intended to capture evolving injury and trigger necessary brain-saving interventions, their associated arousals may paradoxically play a role in exacerbating neurological injury. Sleep is a time for necessary homeostatic and biological processes such as plasticity, glymphatic drainage, and memory consolidation.[11–13] In the intensive care unit (ICU) setting, fragmented and low quality sleep is common and likely disrupted further by the performance of frequent neurochecks.[14,15] There is an association between care interventions, sleep disruption and delirium, and delirium is known to contribute independently to long-term cognitive and neuropsychological impairment following critical illness.[14,16] In fact, one study revealed that 67% of neurodeterioration events in the first 48 hours were attributed to delirium rather than ABI itself.[17] The relationship between delirium and long-term neuropsychological sequelae suggests that the impact of developing this acute encephalopathy in the hospital does not end with ‘resolution’ of the delirium and instead can continue to impact recovery and health-related quality of life over the long term.[16] Furthermore, providers believe that neurochecks may be detrimental to patients, and are more likely to discontinue or downgrade their frequency when a patient develops delirium.[18] There are, of course, multifaceted risk factors for delirium. Rising attention toward delirium as a sign of organ dysfunction following ABI has heightened awareness regarding modifiable risk factors such as sedative medications and immobility.[19,20] Sleep disruption may represent another modifiable risk factor in patients with ABI who are already facing a difficult recovery.

At institutions that commonly prescribe neurochecks for patients with ABI, practices must be analyzed with a focus on neurocheck frequency and indications for initiation, continuation, and discontinuation. An analysis of nearly 9,000 ABI patients revealed that prolonged hourly neurochecks are common, with 20% of patients receiving greater than 3 days of consecutive hourly neurochecks and 3% greater than 14 days, with an average duration of 20.1 days (482 consecutive hourly neurochecks).[5] Notably, nearly 25% of hourly orders transitioned directly to no neurochecks, suggesting that they were not necessary for the full time they were ordered.[5] In support of this surmise, a recent study of TBI patients estimated that 6,012 hourly examinations in 287 patients could have been avoided by following an algorithm designed to identify patients at risk for deterioration.[21] Regarding neurocheck utility, in a study of greater than 200 patients with acute ischemic stroke, 45% of neurodeterioration episodes were observed via neurochecks, and an additional 26% were observed via alternative modalities.[22] In addition, regardless of the intended neurocheck frequency, studies of patients with acute neurological injury reveal inconsistencies in documentation of neurochecks and inexplicable gaps in performance of ordered neurological assessments.[23,24]

Despite lingering uncertainties, some things are clear. There are known disease and severity-specific risks of neurodeterioration. There is a clear link between neurodeterioration and poor outcomes. There is a well-accepted relationship between delirium and poor outcomes. There is a potential link between sleep disruption, delirium, and poor outcomes for patients with ABI. Therefore, as providers, we must ensure that our patients do not receive frequent assessments for longer than necessary. It is likely that some timeframe (e.g., 24-48 hours for many neurological diseases) is sufficient to capture neurodeterioration while minimizing the risk of incident delirium, while longer periods of time (e.g., >72 hours) render patients vulnerable to harm with lower yield in identifying neurodeterioration.

What remains unclear is whether frequent monitoring is necessary or if less frequent (every-other-hour, or even every four hours) monitoring can promptly capture neurodeterioration, trigger appropriate interventions, and mitigate adverse neurological outcomes. Also unknown is how long patients can withstand frequent awakenings without developing cognitive sequelae such as delirium. Further, it is unknown how and whether the dose (duration and frequency) of neurochecks contributes to short-term sequelae, particularly in the context of risk factors (e.g., pre-existing sleep disorders). Finally, in the setting of ABI, it is important to identify delirium risk factors and associated consequences, and thereby tailor individualized neurological assessment plans accordingly.

In summary, there is no question that efforts to improve neurocheck practices will involve careful considerations of risks and benefits, weighing above all the catastrophic consequences of missed neurodeterioration events. Developing standardized algorithms will involve application of advanced models to delineate common early from uncommon late neurodeterioration events, with consideration of key variables such as type and degree of ABI and pre-existing conditions. These efforts *must* be counterbalanced by evaluations of prolonged neurochecks, including associated risk factors for and assessment of outcomes such as short- and long-term cognitive and neuropsychological sequelae. In the meantime, ABI care can focus on awareness; for instance, at our institution, electronic alerts now signal

to providers when patients have reached a pre-defined duration of hourly neurochecks. In this way, the decision to continue neurochecks can become a deliberate and measured one. The first step in reassessing frequent neurochecks must be active.

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REFERENCES

1. Kraus JF, Black MA, Hessol N, et al. The incidence of acute brain injury and serious impairment in a defined population. Am J Epidemiol 1984;119:186–201. [PubMed: 6695898]
2. Hemphill JC 3rd, Greenberg SM, Anderson CS, et al. Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2015;46:2032–60. [PubMed: 26022637]
3. Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2019;50:e344–e418. [PubMed: 31662037]
4. Diringer MN, Bleck TP, Claude Hemphill J 3rd, et al. Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care 2011;15:211–40. [PubMed: 21773873]
5. LaBuzetta JN, Hirshman BR, Malhotra A, Owens RL, Kamdar BB. Practices and Patterns of Hourly Neurochecks: Analysis of 8,936 Patients With Neurological Injury. J Intensive Care Med 2021:8850666211029220.
6. Maas MB, Rosenberg NF, Kosteva AR, et al. Surveillance neuroimaging and neurologic examinations affect care for intracerebral hemorrhage. Neurology 2013;81:107–12. [PubMed: 23739227]
7. Lord AS, Gilmore E, Choi HA, Mayer SA, Collaboration V-I. Time course and predictors of neurological deterioration after intracerebral hemorrhage. Stroke 2015;46:647–52. [PubMed: 25657190]
8. Stone JJ, Childs S, Smith LE, Battin M, Papadakos PJ, Huang JH. Hourly neurologic assessments for traumatic brain injury in the ICU. Neurol Res 2014;36:164–9. [PubMed: 24410060]
9. Phelan HA, Richter AA, Scott WW, et al. Does isolated traumatic subarachnoid hemorrhage merit a lower intensity level of observation than other traumatic brain injury? J Neurotrauma 2014;31:1733–6. [PubMed: 24926612]
10. Dorsch NW, King MT. A review of cerebral vasospasm in aneurysmal subarachnoid haemorrhage Part I: Incidence and effects. J Clin Neurosci 1994;1:19–26. [PubMed: 18638721]
11. Xie L, Kang H, Xu Q, et al. Sleep drives metabolite clearance from the adult brain. Science 2013;342:373–7. [PubMed: 24136970]
12. Tononi G, Cirelli C. Sleep and the price of plasticity: from synaptic and cellular homeostasis to memory consolidation and integration. Neuron 2014;81:12–34. [PubMed: 24411729]
13. Nir Y, Andrillon T, Marmelshtein A, et al. Selective neuronal lapses precede human cognitive lapses following sleep deprivation. Nat Med 2017;23:1474–80. [PubMed: 29106402]

14. Chang VA, Owens RL, LaBuzetta JN. Impact of Sleep Deprivation in the Neurological Intensive Care Unit: A Narrative Review. Neurocrit Care 2020;32:596–608. [PubMed: 31410770]
15. LaBuzetta JN, Malhotra A, Zee PC, Maas MB. Optimizing Sleep and Circadian Health in the NeuroICU. Curr Treat Options Neurol 2022;24:309–25. [PubMed: 35855215]
16. LaBuzetta JN, Rosand J, Vranceanu AM. Review: Post-Intensive Care Syndrome: Unique Challenges in the Neurointensive Care Unit. Neurocrit Care 2019;31:534–45. [PubMed: 31486026]
17. McLaughlin DC, Hartjes TM, Freeman WD. Sleep Deprivation in Neurointensive Care Unit Patients From Serial Neurological Checks: How Much Is Too Much? J Neurosci Nurs 2018;50:205–10. [PubMed: 29894442]
18. LaBuzetta JN, Kazer MR, Kamdar BB, et al. Neurocheck Frequency: Determining Perceptions and Barriers to Implementation of Evidence-Based Practice. Neurologist 2022.
19. Maas MB, Naidech AM. Critical Care Neurology Perspective on Delirium. Semin Neurol 2016;36:601–6. [PubMed: 27907964]
20. Marra A, Ely EW, Pandharipande PP, Patel MB. The ABCDEF Bundle in Critical Care. Crit Care Clin 2017;33:225–43. [PubMed: 28284292]
21. Bryant P, Yengo-Kahn A, Smith C, Smith M, Guillamondegui O. Decision Support Tool to Judiciously Assign High-Frequency Neurologic Examinations in Traumatic Brain Injury. J Surg Res 2022;280:557–66. [PubMed: 36096021]
22. De Leon Benedetti AM, Bhatia R, Ancheta SR, Romano JG, Koch S. How Well Do Neurochecks Perform After Stroke? Stroke 2021;52:1094–7. [PubMed: 33504183]
23. Qureshi AA, Mulleady V, Patel A, Porter KM. Are we able to comply with the NICE head injury guidelines? Emerg Med J 2005;22:861–2. [PubMed: 16299193]
24. Banzon PC, Vashisht A, Euckert M, et al. Original Research: Practice Variations in Documenting Neurologic Examinations in Non-Neuroscience ICUs. Am J Nurs 2023;123:24–30. [PubMed: 36546384]