

Improving Blood Pressure Management and Disease Severity Documentation in Patients With Acute Intracerebral Hemorrhage

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Abstract

Objective: To ensure prime blood pressure management and intracerebral hemorrhage (ICH) score documentation within 6 hours of arrival and/or before any intervention in patients admitted to Mayo Clinic Hospital with acute ICH.

Patients and Methods: A quality improvement initiative was conducted between September 29, 2015, and May 30, 2017, following the Define-Measure-Analyze-Improve-Control methodology. Our pre-specified goals for the first 8 months postintervention were that at least 80% of patients with ICH will have systolic blood pressure (SBP) control as per guideline-based recommendations (SBP \leq 140 mm Hg) and at least 80% will have ICH score documented within 6 hours postadmission. Neurovascular stakeholders' feedback was included in the process development. Practice gaps and their leading causes were identified and served rational interventions' planning. Education and admission order-set modifications were chosen as intervention methods.

Results: At 4 (first measurement, n=13) and 8 months (second measurement, n=15) postintervention, 92.3% and 100% of patients with ICH, respectively, reached the target SBP, compared with 50% in the preintervention group (comparison group, n=26); 84.6% and 85.7% of the patient population had the ICH score documented at the first and second outcome measurement, respectively, compared with 42.3% in the preintervention group. Stakeholders reported good satisfaction with the novel applications. Sustainability plans and future directions were established.

Conclusion: Effective education methods enhance the introduction of guideline-based clinical practices. This quality improvement project has the potential to impact patient outcomes, staff efficiency, and stroke centers' maintenance of certification and quality care recognition. This initiative warrants implementation at hospitals across all Mayo Clinic campuses and nationwide.

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Spontaneous nontraumatic intracerebral hemorrhage (ICH) has an incidence of 12 to 15 cases per 100,000 individuals¹ and it is associated with high mortality and morbidity.² Blood pressure (BP) control measures initiated early after ICH diagnoses are key factors in the management. Higher systolic BP (SBP) is associated with greater hematoma expansion, neurological deterioration, death, and dependency after ICH.^{3,4} The current American Heart Association/American Stroke Association (AHA/ASA) guideline recommendation is to obtain rapid lowering of SBP to 140 mm Hg for patients presenting with acute ICH and SBP between

150 and 220 mm Hg without contraindication to acute BP treatment. This BP goal was deemed to be safe (Class I; Level of Evidence A) and potentially effective for improving functional outcome (Class IIa; Level of Evidence B), without increasing the incidence of death or serious complications.^{5,6} For patients with ICH presenting with SBP of more than 220 mm Hg, aggressive reduction of BP with a continuous intravenous infusion and frequent BP monitoring is considered reasonable.^{5,6} It is recommended that these measures be performed immediately after diagnosis to prevent recurrent ICH. These 2015 recommendations⁷ are revised from

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previous guidelines published in 2007,⁸ which endorsed rapid lowering of SBP to less than 160 mm Hg.

Furthermore, AHA/ASA recommends the performance of a baseline standardized severity score as part of the initial evaluation of patients with ICH.⁷ Similarly, the Joint Commission (JC) requisite for comprehensive stroke centers is to document the ICH score before any intervention or within 6 hours of arrival to the emergency department or a hospital where no intervention is warranted. The ICH score is a powerful predictor of 30-day mortality and is widely used to risk stratify patients with ICH at presentation.^{9,10} It contains 5 items: Glasgow Coma Scale¹¹ score (3-4 = 2, 5-12 = 1, 13-15 = 0); ICH volume (cm³) (≥ 30 = 1, < 30 = 0); intraventricular hemorrhage (yes = 1, no = 0); infratentorial origin of ICH (yes = 1, no = 0); and age 80 years or more (yes = 1, no = 0). Mortality increases with increasing ICH total score (ICH score range of 0-6 corresponds to mortality range of 0%-100%).⁹ Likewise, the ICH score is a good predictor of functional outcome at 1 year.¹²

Despite guideline-based evidence, gaps in daily clinical practice are identified. Guideline-recommended SBP control is not always achieved in patients admitted with ICH, and revised 2015 guidelines are not widely acknowledged and implemented. Similarly, ICH score calculation and documentation in a timely manner, as per national guidelines and national reporting agencies' recommendations, are not consistently completed.

To address predictable quality gaps, a quality improvement (QI) initiative was implemented at Mayo Clinic in Arizona in the Department of Neurology on October 1, 2016, following the Define, Measure, Analyze, Improve, Control methodology.¹³ The scope of our project was to ensure that patients admitted to Mayo Clinic in Arizona with a diagnosis of acute ICH had adequate SBP management performed on admission and continued throughout the hospital stay unless contraindicated and ICH score calculation documented within 6 hours of arrival to the emergency department and/or before any surgical intervention.

PATIENTS AND METHODS

Define Project

The process was reviewed via direct verbal communications and e-mails with key stakeholders, including neurology, vascular neurology, and neurosurgery consultants, neurology trainees, registered nurse stroke coordinator, and associate neurovascular providers. Their suggestions and feedback were included in the development of the protocol. Our target population was represented by the population of patients admitted to Mayo Clinic Hospital in Arizona with a diagnosis of acute ICH.

Our initial assessment revealed that many stakeholders were using SBP goals of less than 160 mm Hg in their patients with acute ICH. Only some stakeholders incorporated revised guidelines into their practice. One reason was that updated 2015 AHA/ASA recommendations were underrecognized. Another impediment was that the admission order set did not include the SBP cutoffs corresponding to the revised guidelines (< 140 mm Hg), but rather previous guidelines (< 160 mm Hg).

In regard to the ICH score, some trainees were unaware of its use for risk stratification and correlation with outcomes, as well as of the AHA/ASA and JC recommendations for the ICH severity scoring documentation on admission. Other trainees reported difficulties in calculating the ICH volume and subsequently the ICH score.

On the basis of the aforementioned feedback, a team of neurovascular consultants suggested a QI initiative to implement revised BP management goals and ICH score documentation as per national associations' recommendations. The implementation date was October 1, 2016. Baseline data measurements were derived from all patients with a diagnosis of ICH admitted to Mayo Clinic in Arizona between September 29, 2015, and July 1, 2016.

For the first outcome measurement, the goals were that in the ensuing 4 months after QI implementation at least 80% of patients with acute ICH would have an SBP goal of less than 140 mm Hg and ICH score documented within 6 hours of admission. The second remeasurement was planned to follow 4 months later. Similarly, aims were that at least 80% of patients with ICH would have an SBP

goal of less than 140 mm Hg and ICH score documented within 6 hours of admission. At its completion, the ownership of this project will be transitioned to the registered nurse stroke coordinator, with goals for sustained improvements through at least 12 months postimplementation.

Project Measurement

Electronic medical records including consecutive patients from the Mayo Clinic in Arizona Acute Intracerebral Hemorrhage Database were retrospectively reviewed to obtain baseline and outcome measurements. The data of interest (SBP <140 mm Hg [yes/no], ICH score documented within 6 hours and/or before any intervention [yes/no]) were extracted on a data spreadsheet.

All consecutive medical charts pertaining to patients admitted with ICH to Mayo Clinic in Arizona before the implementation (September 2015 to July 2016) were used for baseline measurements (n=26). We calculated the percentages of patients who had SBP goal of less than 140 mm Hg and ICH score documented within 6 hours of admission and/or before any intervention. The numerators were the number of patients with ICH who had SBP goals of less than 140 mm Hg and an ICH score documented in the proposed time window. The denominators were the total number of patients with acute ICH admitted to Mayo Clinic in Arizona. At baseline before the intervention, 50% of patients with ICH had SBP goal of less than 140 mm Hg and 42.3% of patients had ICH score documented within 6 hours of admission and/or before any intervention.

At the 4-month data point after the QI project implementation (first postintervention remeasurement), all medical records pertaining to consecutive patients with admitting diagnosis of acute ICH (n=13, consisting of the entire population) were reviewed and the data of interest were extracted. All medical records pertaining to patients with acute ICH admitted in the 4- to-8-month interval postintervention (postintervention second remeasurement, n=15) were reviewed to ensure that the target goals were maintained.

The process measures were compliance with the intervention tools and target goals by a review of consecutive medical records at

4 and 8 months, respectively, after the implementation of the proposed intervention.

The outcomes measures were the percentage of patients with acute ICH who had SBP goals of less than 140 mm Hg and an ICH score documented within 6 hours postadmission at 4 and 8 months, respectively, after implementation.

The counterbalance measure was the staff and trainee satisfaction with the novel interventions. All stakeholders were surveyed informally via direct communication and/or via e-mail, inquiring about level of satisfaction with new SBP parameters and calculating the ICH score.

RESULTS

Analyze the Project

To understand the gaps related to the addressed items and to rationally plan our interventions, verbal interviews were administered preintervention to all neurovascular health care professionals and neurology trainees.

Although all stakeholders identified BP management in ICH as a priority, only some of them recognized the latest national guidelines recommendations for rapid SBP lowering to less than 140 mm Hg. On the other side, the electronic medical record (EMR) admission order set followed cutoffs of less than 160 mm Hg in line with older guidelines. The identified factors were the lack of knowledge of the updated 2015 AHA/ASA guidelines for BP management based on most current randomized clinical trials and the lack of an electronic reminder to change the BP parameters in the admission order set that followed previous recommendations.

Similarly, although most neurovascular health care professionals recognized that the ICH score had a direct relationship with mortality and 1-year functional outcome, not all the neurology trainees and associate neurovascular and neurosurgery professionals acknowledged the importance of its timely documentation in the EMR.

Education was the selected intervention method given that the key factor contributing to the gap was the lack of recognition of national guidelines and certification requirements. The objective of the education sessions

and strategies was to incorporate and build constant awareness of the updated AHA/ASA guidelines into daily clinical neurovascular practice. Deficiency in EMR admission order sets in patients with an admission diagnosis of ICH was also identified as contributing to the gap; therefore, modifications in the order sets were subsequently sought and implemented.

The QI method used was the Plan-Do-Study-Act method. A plan was created by obtaining data and interviewing key stakeholders. The plan was carried out through the implementation of the project. After the implementation of the project, trends were reviewed to determine whether the project impacted the appropriate BP management goals and ICH score documentation in the target patient population. After reviewing the data and trends, the action was taken to continue best clinical practice and enhanced staff efficiency.

Improvement Intervention

One formal didactic session was conducted by the team leader and was attended by all the stakeholders (neurology trainees, neurovascular consultants, and midlevel associated neurovascular professionals). Updated 2015 AHA/ASA ICH evidence-based guidelines recommendations for BP management and ICH score documentation on admission, the baseline measurements at Mayo Clinic in Arizona, and the institutional QI project goals and targets were presented. A Microsoft PowerPoint presentation was subsequently e-mailed to stakeholders for future reference. In addition, the 5-item ICH score was printed on a pocket card that was distributed for daily use to all neurology trainees and neurovascular midlevel professionals. Periodic follow-up e-mails (initially every 2 weeks) with key features of the PowerPoint presentation were used to reeducate and remind all stakeholders about the QI initiative goals and rationale. The internal medicine residents rotating on the neurology service were educated by senior neurology stakeholders at the beginning of their neurology inpatient rotations. Two months postimplementation, the EMR admission order set was changed to reflect the indication for SBP goals of less than 140 mm Hg for patients with ICH. The recommendation was for all patients with ICH and SBP higher

than 140 mm Hg to receive intravenous nicardipine while the BP was continuously monitored and the infusion rate was adjusted to achieve a goal SBP of less than 140 mm Hg.

The first remeasurement was performed 4 months after the intervention implementation. The percentages of patients with ICH who had SBP at target and ICH score documented were calculated on the basis of retrospective review of 13 consecutive medical records from the Mayo Clinic in Arizona Acute Intracerebral Hemorrhage Database (entire ICH patient population). A total of 92.3% of patients had SBP goal of less than 140 mm Hg, compared with 50% in the preintervention group (comparison group), and 84.6% of patients had the ICH score documented compared with 42.3% in the preintervention group (comparison group). At the 8-month postintervention time point (second remeasurement), 15 more medical records pertaining to the entire ICH patient population were retrospectively reviewed. All patients had an SBP goal of less than 140 mm Hg, and 85.7% had the ICH score documented (Figures 1 and 2). All health care professionals reported good satisfaction with the implemented SBP goals and ICH score calculation and documentation.

Opportunities for feedback and questions were provided to all stakeholders at the initial didactic conference and throughout the implementation and postimplementation period. The team leader sent periodic educational e-mails and reminders of the BP management goals and ICH score calculation and documentation in a timely fashion, as well as the rationale behind the implementation. Once the EMR ICH admission order set was modified, stakeholders were notified and the rationale was reinforced. Direct in-person feedback, followed by e-mail reminders, was provided to neurovascular stakeholders during acute ICH admissions or morning neurovascular rounds if the team leader was involved directly in ICH patients' management.

Control Summary

Baseline data followed by the implementation plan were communicated to the stakeholders during the initial neurovascular conference. Communication e-mails and reminders were periodically sent afterward. First remeasurement and second remeasurement outcomes

were communicated to all stakeholders via e-mail while obtaining their satisfaction and comfort with the intervention. Periodic face-to-face discussion and data review with the Stroke Center Director, Vascular Neurology Fellowship Director, and Stroke Nurse Coordinator took place.

To ensure improvement sustainability plans, the staff will discuss continued use of the BP management guidelines and ICH score timely documentation in patients with ICH with neurology trainees. Neurovascular consultants will provide qualitative feedback at the weekly Stroke Center meeting. Continual feedback on tracked data and other issues has been openly encouraged.

The Mayo Clinic in Arizona Stroke Coordinator who is responsible for the Acute Intracerebral Hemorrhage database maintenance and reporting ICH scores to the JC will periodically (monthly) review and track the data moving forward. If the target falls below 80%, reintervention consisting of reeducation of all stakeholders will be implemented. E-mails with reminders and PowerPoint presentations will be sent. New trainees' stroke education at the beginning of each academic year will incorporate the recommended BP management guidelines for ICH, as well as the method and rationale for ICH score documentation within 6 hours of admission in patients with ICH.

Moving forward, the ICH admission order set will continue to reflect the recommended current BP cutoffs in the upcoming EMR (Epic) to reflect the change in care. In addition, an electronic ICH score and its step-by-step calculation could be implemented in Epic to help with timely and accurate documentation in every patient with the admission diagnosis of ICH.

DISCUSSION

By conducting this project, we learned that effective education methods (didactic lectures, periodic e-mails and in-person timely reminders, printed pocket cards) enhance the introduction of guideline-based clinical practices. In addition, we learned that changes in the EMR increase compliance and are likely more effective than teaching modules alone.

Our improvement targets and timelines were met in accordance with the original

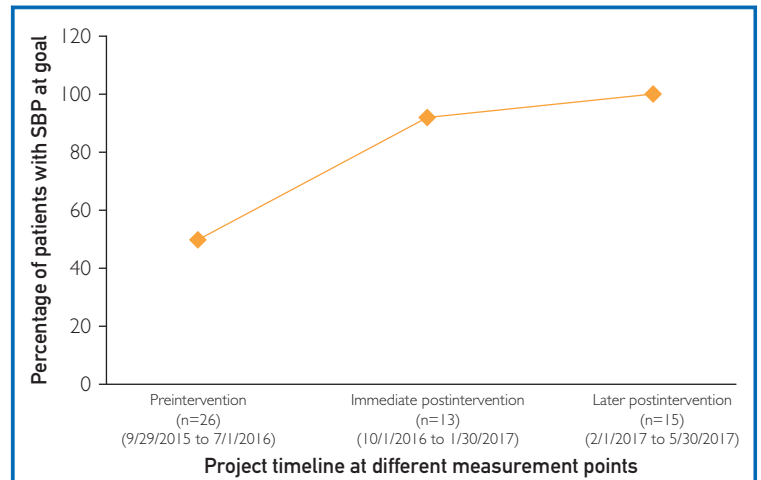


FIGURE 1. Graphic display of the blood pressure management data. SBP = systolic blood pressure.

established objectives. Minor implementation barriers were encountered. Calculation of the ICH score, and specifically ICH volume calculation, remains a challenge for new neurology trainees and internal medicine residents during their neurology rotations. They required teaching at the beginning of their rotation and direct supervision with the ICH score calculation during the first ICH case they encountered. Their timely instruction was targeted and prioritized (as senior neurology residents were reminded periodically by the team lead). They also

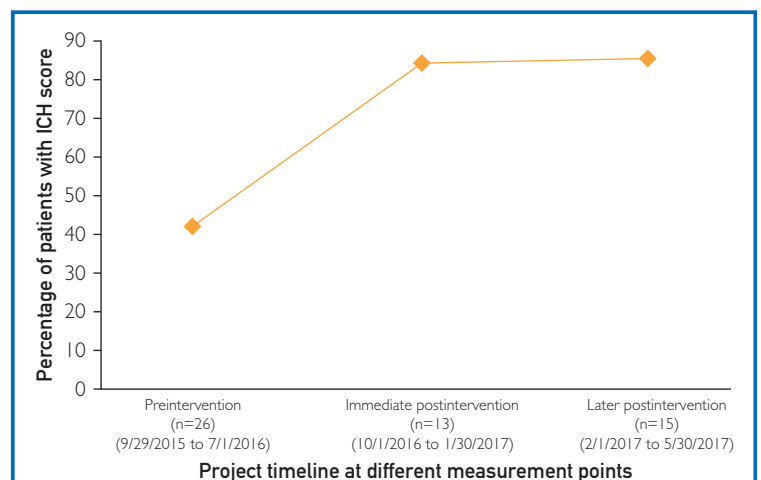


FIGURE 2. Graphic display of the intracranial hemorrhage (ICH) score documentation data.

received pocket cards and short educational PowerPoint materials to understand the national guidelines, reporting agencies' requirements, and the rationale behind their requirements (correlation with outcomes of both individual patient and the hospital). Expanding the education spectrum, the relevance of keeping SBP goal of less than 140 mm Hg was also communicated to the nursing staff involved in the care of patients with ICH.

Revised BP management in acute ICH is safe and associated with better functional outcomes and reduced risk of ICH recurrence, based on the latest randomized clinical trials.^{5,6} Therefore, all neurovascular trainees and physicians providing comprehensive stroke care should be aware of the BP management goals and rationale in patients with ICH. Calculation and documentation of the ICH score as soon as a patient is diagnosed and/or before any intervention is essential for outcome prognostication and counseling of patients and families. Indirectly, stroke centers' outcomes are nationally regarded in reference to the ICH score. Therefore, QI initiatives in teaching the importance of timely ICH score calculation and its documentation is paramount for neurovascular education and compliance with national stroke reporting measures.

There are no direct financial benefits expected from this project. Indirect benefits are however estimated. By decreasing complications with better BP control, we expect that the duration of inpatient and rehabilitation stay will be reduced and more patients will be discharged directly to home. Similarly, the ICH-related 30-day mortality and 1-year functional outcomes are expected to correlate with the ICH score documented on admission or before any intervention. Although classically morbidity and mortality correlate with the ICH score at presentation, this does not prohibit the opportunity for any intervention, medical or surgical, to have a favorable effect.

The Define, Measure, Analyze, Improve, Control methodology proved its benefits from multiple perspectives: promoting teamwork in planning and defining aims and target measurements, joint effort in identifying and implementing specific process changes/improvements and assessing the impact of the intervention, review and interpretation of performance data, communication of the lessons learned to

develop strategies for sustaining gains, and communicating project results to stakeholders. Prospective plans for expanding the interventional components in contingent areas include targeting additional factors that play key roles in the management of patients with ICH, such as correction of coagulopathy, proper glycemic control, deep venous thrombosis prophylaxis, criteria for intubation, and prophylactic use of antiepileptic therapies.

CONCLUSION

This QI project has the potential to have a major impact on patient care, outcomes, staff efficiency, and stroke centers' maintenance of certification and recognition of quality care. This initiative could easily be implemented across all Mayo Clinic campuses. In addition, this initiative importantly meets neurology trainees' educational needs for understanding and applying national association guidelines and risk stratification reporting requirements in patients with ICH.

Abbreviations and Acronyms: AHA/ASA = American Heart Association/American Stroke Association; BP = blood pressure; EMR = electronic medical record; ICH = intracerebral hemorrhage; JC = Joint Commission; QI = quality improvement; SBP = systolic blood pressure

Potential Competing Interests: The authors report no competing interests.

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