

PRaCTUS BCVI: Pragmatic Randomized Clinical Trial of Universal Screening for BCVI

Protocol: Version 1.1 (Pilot and Feasibility Study, 8/25/26)

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Inova Study Number: INOVA-2026-299

STRUCTURED SUMMARY

Background. Blunt cerebrovascular injury (BCVI) occurs in 3% to nearly 8% of major blunt trauma patients and is typically silent at presentation, with reported stroke and mortality rates of 7% and 12%. Antithrombotic therapy started before symptom onset substantially reduces this risk. Since most strokes occur within 72 hours, early detection is critical. Selective screening (SS) using established screening criteria may miss up to one third of injuries. Universal screening (US) with CTA neck detects more cases, but whether this translates into fewer strokes and deaths at the blunt trauma population level has never been tested prospectively.

Objective and Hypothesis. We hypothesize that US reduces BCVI-related stroke and stroke-related mortality relative to SS through increased detection and earlier treatment. This protocol describes a pilot and feasibility phase preceding a definitive, adequately powered trial.

Design. Pragmatic stepped-wedge cluster-randomized trial. The choice between SS and US is an institutional policy decision rather than an individual patient decision, the unit of randomization is the Trauma Center (TC). Both strategies are widely used at TCs in the United States and considered standard of care. Genuine clinical equipoise exists. The principal risk of US is additional imaging and treatment; the principal risk of SS is a missed injury and a potentially preventable stroke. Neither strategy has been shown to be superior with respect to patient-centered outcomes.

Setting and Participants. Five ACS-verified and/or state-designated Level 1 or 2 TCs currently using SS. The population comprises adult (≥ 18 years) “major blunt trauma” patients, defined as those undergoing whole-body trauma CT or at minimum CT cervical spine and/or CTA chest.

Intervention and Comparator. All centers start using their existing criteria for SS. At two-month intervals, a randomly assigned center crosses over to US of all major blunt trauma activations and remains in that condition

until every center has switched. The sequence is randomized at study start so each center knows its crossover date and can prepare. Each center contributes data under both conditions and serves partly as its own control. Treatment of detected BCVI is not standardized and remains at clinician discretion, consistent with the pragmatic, intention-to-screen design.

Outcomes. The primary outcome is BCVI-related ischemic stroke, measured at the population level as events per 1,000 major blunt trauma admissions. BCVI-related stroke is defined as any ischemic stroke occurring during the hospital stay in a vascular territory suggestive of cervical arterial injury, or any ischemic stroke occurring during the hospital stay in a patient with confirmed BCVI (or before discharge or patient death). Strokes present on admission imaging will be recorded but analyzed separately and not classified as BCVI-related. The secondary outcome is a composite of BCVI-related stroke or stroke-related death. Additional outcomes address safety and resource utilization: antithrombotic-related bleeding, acute kidney injury, BCVI detection rate and grade distribution, and CTA utilization.

Feasibility Objectives. This protocol version 1.1 will focus on the description of a pilot and feasibility study. A study that is powered for clinical outcomes would be expected to comprise at least 20 TCs and a study duration of three or more years. Therefore, this preparatory feasibility study is designed to answer the following questions:

- Can we successfully enroll Level 1 or 2 TCs that currently adhere to a SS strategy but consider changing to a US strategy?
- Do cross-site data patterns suggest major inconsistency in application of key variable definitions, particularly the definition of the primary outcome?
- Do the complications (BCVI-related stroke, stroke-related mortality) that US aims to lower the risk for occur often enough to allow for a subsequent, large-scale clinical trial?
- Can participating TCs reliably report outcomes not routinely reported such as CTA utilization?
- How are adherence rates by institution with the US protocol after changing from SS to US?

Analysis. Analyses follow the intention-to-screen principle. For this pilot and feasibility study, analyses will be primarily descriptive, focusing on feasibility outcomes, event rates, and data quality across sites. The generalized linear mixed model will account for the clustered stepped-wedge structure, with intervention status and study period as fixed effects and center as a random intercept; study period is modeled categorically to adjust for secular trends. Pre-specified subgroup analysis by baseline BCVI prevalence will assess heterogeneity across centers.

Ethics and Regulatory Framework. The trial follows the Ottawa Statement on the Ethical Design and Conduct of Cluster Randomized Trials and is classified as research for ethical review. The Trauma Medical Director at each site serves as gatekeeper, providing written organizational permission for the randomized crossover

schedule. An external IRB will serve as the IRB of record for the coordinating center. Due to funding limitations, participating sites will obtain approval through their local IRB. For the definitive trial, a single IRB may serve as the IRB of record for the coordinating center and all participating sites. Inova Fairfax Medical Campus will serve as the Clinical Research Coordinating Center (CRCC) and Data Coordinating Center (DCC). Informed consent and HIPAA authorization will be waived, as both strategies are guideline-endorsed standard of care posing minimal incremental risk and individual consent is not practicable in this population. Data reach the coordinating center as a de-identified data set under a Data Use Agreement (DUA) via REDCap. The trial will be registered with ClinicalTrials.gov prior to the activation of the first participating site and before any data collection begins, in compliance with federal regulations and AAST requirements. The coordinating center will be responsible for maintaining the study record and ensuring that any required updates (e.g., protocol amendments, enrollment status, study completion) are reflected on ClinicalTrials.gov throughout the study. No data safety monitoring board will be formed for the feasibility study, given the minimal risk, and pilot design not powered for clinical outcomes.

Study Sites. The feasibility study will be conducted at five investigative sites in the United States with eventual expansion to 20 sites for the full-scale trial. Inova Fairfax Medical Campus (IFMC), Falls Church, VA, serves as the data coordinating center only and no patient enrollment or data collection from patients at IFMC will occur, because IFMC currently utilizes a US approach. All participating sites will be ACS-verified and/or State-designated Level 1 or Level 2 TCs currently using SS for BCVI. The following Inova site will be conducting this study:

Inova Fairfax Medical Campus (Coordinating Center)
3300 Gallows Rd
Falls Church, VA 22042

Number of Participants to be Enrolled. Zero participants will be enrolled at IFMC, which serves as coordinating center only. At each participating site, data collection will occur via REDCap as follows: prior to study start, all participating TCs will complete Form 1 with information about the TC and existing protocols for BCVI screening and management. Monthly data on patients with major blunt trauma will be obtained locally from the institution's Trauma Registry and reported using REDCap Form 2; no individual participant enrollment occurs for these data. This data will be reported in batches of every 2 months. For individual patients with confirmed BCVI or ischemic stroke during the study period, Form 3 will be completed. Designated site staff will remove identifiers before entering data into REDCap. Based on anticipated TC volume of major blunt trauma patients, published rates of BCVI, and BCVI-related stroke, we anticipate 1,000 to 4,000 cases of major blunt trauma per TC per year, 30 to 80 cases of BCVI per TC per year, and 3 to 5 cases of BCVI-related stroke per TC per year.

Timeline and Deliverables. Twelve months of data collection following study start, with an interim analysis at four months focusing on feasibility outcomes and descriptive data for presentation at the 2027 AAST Annual Meeting. Discussion of the trial and initial findings are expected to facilitate recruitment for the definitive trial (Protocol Version 2.x), which is anticipated to enroll at least 20 Level 1 and 2 TCs for three or more years.

Funding. This study is made possible due to a “Sprint Grant” by the American Association for the Surgery of Trauma (AAST).

STUDY PROTOCOL

Background

The reported incidence of blunt cerebrovascular injury (BCVI) in major blunt trauma patients ranges from less than 3% to almost 8%¹⁻³. Stroke and death are the most devastating potential consequences with reported rates of 7% and 12%, respectively⁴, though much higher with increasing degree of injury. Initiation of antiplatelet or antithrombotic therapy appears to dramatically decrease the risk for these complications, but must be initiated prior symptom development^{4,5}. Since most strokes occur within the first 72 hours after injury, early diagnosis of BCVI is critical. When BCVI was first described and its diagnosis required invasive angiography, screening criteria (Denver, expanded Denver, Memphis) were invaluable to identify high-risk patients. Yet even the most extensive screening criteria for BCVI, established and refined over the last three decades^{1,6-8} may miss up to one third of all injuries^{2,3,9}. “Universal screening” (US), which today can be done rapidly and effectively with a neck CTA as part of the commonly employed “whole body trauma CT scan”, offers an alternative. Studies of US consistently demonstrate higher rates of BCVI than historic studies using screening criteria (“selective screening”, SS). Importantly, a 2024 systematic review and meta-analysis found that the incidence of stroke per case remained similar over time despite the increase in detection rates with expanded and eventually US, suggesting that the additionally identified lesions are indeed clinically relevant¹⁰. What remains unclear is if US, and subsequently earlier treatment of more BCVIs, results in actual patient benefit, i.e., lower stroke and stroke-related mortality rates.

Significance

Despite its low incidence, BCVI can have a devastating impact, particularly when considering the consequences of stroke-related permanent neurologic deficits in an often relatively young patient population sustaining severe blunt trauma. Yet, liberal adoption of US may come at a steep price as well. Not only measured in the cost, radiation exposure, and contrast administration necessary for neck CTAs, but also in the consequences of increased treatment with antiplatelet and antithrombotic medications, which can cause life-threatening bleeding complications. Importantly, to date none of the published comparisons of US and SS has demonstrated an increase in imaging- or treatment-related complications attributable to US^{2,3,11,12}. By contrast, the risk of SS is concrete: a missed injury and a potentially preventable stroke in a patient who did not meet screening criteria^{2,3,11,13}. Further retrospective studies and meta-analyses of existing studies will not be able to provide high-quality evidence to address this clinical dilemma. This will be the first prospective, pragmatic cluster randomized* trial (CRT), comparing BCVI screening strategies after more than two decades of retrospective, observational studies, which form the basis of the “low evidence” grade of all current guidelines and best practices recommendations.

*Randomization by Trauma Center, not individual patient

Hypothesis

Our central hypothesis is that US as opposed to SS reduces BCVI-related stroke and stroke-related mortality due to increased detection and treatment. To test our hypothesis, we have the following two aims:

Aim 1. Determine whether a universal BCVI screening protocol as compared to SS (based on recommended screening criteria for BCVI¹⁴) reduces BCVI-related stroke (primary outcome) and a composite of BCVI-related stroke or any stroke-related mortality (secondary outcome). This will be measured at population level, i.e., as strokes per 1,000 major blunt trauma patients admitted to the hospital.

BCVI-related stroke will be classified as any ischemic stroke occurring during the hospital stay in a vascular territory suggestive of a cervical arterial injury, or any ischemic stroke occurring during the hospital stay in a patient with confirmed BCVI (or before discharge or patient death). Hemorrhagic strokes will not be included in this definition as these could represent progression of concomitant traumatic brain injury (TBI) with intracranial hemorrhage (ICH), if present, or a complication of antiplatelet or -thrombotic therapy. Strokes present on admission imaging will be recorded but not classified as BCVI-related stroke.

Stroke-related mortality will be classified as any in-hospital death deemed to be primarily a consequence of a BCVI-related stroke by the clinical treatment team, including patients who expire as result of “comfort care” code status. Any in-hospital death will be recorded as well but not classified as stroke-related death.

The definitive trial may include a vascular neurologist to assist with adjudication. This will not be required for the pilot feasibility study as the feasibility study is not assessing clinical outcomes.

Aim 2. Quantify the potential harms and resource utilization of US protocols including BCVI therapy-related bleeding complications and screening-related complications.

Bleeding complications due to BCVI-treatment will be classified as any cessation of antiplatelet or antithrombotic therapy due to bleeding as reported by the clinical treatment team or progression of TBI/ICH, if present, on imaging. Screening-related complications will be defined as the development of acute kidney injury (AKI). The additional resource burden due to universal screening will be quantified by counting the number of neck CTAs during a patient’s hospital stay.

Limitations

A limitation of this pragmatic trial design is detection asymmetry between the two screening arms. Under SS, only patients meeting screening criteria receive CTA neck. As such, BCVI can only be detected, and subsequent strokes attributed to BCVI, in symptomatic patients, or those who met screening criteria. Under the arm of US, more BCVIs will be detected overall, and consequently more strokes may be attributed to BCVI. Since SS will mostly capture symptomatic strokes that may have already prompted further workup aside from screening criteria,

the fraction of the strokes relative to detected BCVIs may appear higher in the SS arm because the denominator of detected BCVIs is smaller. This asymmetry cannot be fully resolved in this pragmatic study setting. This limitation will be discussed in the context of the pragmatic nature of the trial and should be considered when interpreting any between-arm comparisons of stroke rates.

Approach and Methods (Protocol Version 1.1, feasibility study)

Study Type

This will be a pragmatic stepped-wedge CRT. The decision whether to screen major blunt trauma patients for BCVI using defined criteria (SS) or universally (US) with neck CTA is one made on the level of the TC, not the individual patient. Therefore, the unit of randomization will be the trauma center (the cluster).

Patient Population

Currently, both US and SS are widely used in TCs across the United States and considered standard of care¹⁴ for adult patients, but many centers are re-assessing their choices (based on personal communication by the PI and discussions at major trauma society meetings). The evaluation of most major blunt trauma patients already consists of CT head, CT cervical spine, CTA chest, and CT abdomen/pelvis. In such patients, CTA neck and CT cervical spine are performed in a single run without additional radiation exposure, and the increase in administered contrast is minimally more than what is already administered for a CTA chest. The most recent 2024 ACS Best Practices Recommendations for The Management of Traumatic Brain Injury provide a list of 20 screening criteria¹⁴ that should prompt neck CTA (selective screening), but also state that “the practice [US] is supported by the American College of Radiology (ACR) Appropriate Use Criteria of CT scans for major blunt trauma.”¹⁵ . The 2020 Eastern Association for the Surgery of Trauma practice management guideline provide only conditional recommendations on BCVI screening, explicitly acknowledging the low quality of the underlying evidence¹⁶ . Thus, there is true equipoise as to which approach is best, and practice patterns vary widely: existing Best Practices Recommendations and Guidelines state that both approaches are acceptable and considered standard of care¹⁴.

For the purposes of this study, a “major blunt trauma” patient will be defined as a patient who undergoes whole body trauma CT scan or at least CT cervical spine and/or CTA chest based on the trauma team’s concern for major injuries¹¹. We will include data from all patients who are adult (18 years and older), major blunt trauma patients (as above), and presented as trauma activation or consultation. Transferred patients, and pregnant patients will not be targeted for this study, but their data may be incidentally included in the monthly summaries (Form 2). Form 3 will not be collected for transferred patients and pregnant patients. Most of the existing data on BCVI is limited to adult patients. US and SS protocols are not part of the management of pediatric trauma patients. Therefore, this study protocol does not apply to pediatric patients.

Based on anticipated TC volume of major blunt trauma patients, published rates of BCVI, and BCVI-related stroke, we anticipate 1,000 to 4,000 cases of major blunt trauma per TC per year, 30 to 80 cases of BCVI per TC per year, and 3 to 5 cases of BCVI-related stroke per TC per year^{2,3,11}.

Initial Feasibility Study

The eventual goal will be enrollment of at least 20 Level 1 and 2 TCs with an expected duration of data collection for three or more years, given the relatively low incidence of BCVI and BCVI-related stroke. This protocol, version 1.x, describes the initial pilot and feasibility study that aims to enroll five Level 1 or Level 2 TCs for a period of data collection of 12 months, with an anticipated protocol 2.x to be drafted after completion of the feasibility study. This pilot is not powered for clinical outcomes and therefore, at this stage no data safety monitoring board will be formed.

This preparatory feasibility study is designed to answer the following questions:

- Can we successfully enroll Level 1 or 2 TCs that currently adhere to a SS strategy but consider changing to a US strategy?
- Do cross-site data patterns suggest major inconsistency in application of key variable definitions, particularly the definition of the primary outcome?
- Do the complications (BCVI-related stroke, stroke-related mortality) that US aims to lower the risk for occur often enough to allow for a subsequent, large-scale clinical trial?
- Can participating TCs reliably report outcomes not routinely reported such as CTA utilization?
- How are adherence rates with the US protocol after changing from SS to US?

Trauma Center Enrollment

The feasibility trial will enroll only Trauma Centers that currently employ SS and are ACS-verified and/or state-designated Level 1 and 2 TCs. All trauma centers must hold an active Federalwide Assurance (FWA) with OHRP and the individual site PI must be a board-certified surgeon with active trauma privileges. All such TCs rigorously track all their trauma patients and outcomes using a Trauma Registry, which is a mandatory standard for Level 1 and Level 2 TCs. Data is entered by dedicated, trained Trauma Registrars, and all major complications are routinely reviewed at monthly Process Improvement meetings of the Trauma Program at every Level 1 and 2 TC¹⁷. Feasibility of these institutions as site participants in this study will be determined by responsiveness to initial communications and completeness of information provided during the selection process, and availability of site personnel to attend conference calls and complete data entry within specified timelines. Upon completion of the evaluation, the coordinating center will provide each prospective site with a written letter of acceptance or a letter of non-selection with justification. Sites will not be activated until all regulatory requirements are met, i.e., IRB approval, executed Data Use Agreement (DUA), signed gatekeeper letter, and completed training.

Trauma Center Randomization

All centers at baseline will begin in the SS (control) condition, and at fixed intervals (every two months per Protocol 1.x), randomly selected centers will cross over to universal screening of all major blunt trauma activations and remain in this group (Figure 1). The trial will conclude when every center has switched and concluded, i.e., after 12 months. Data entry from months 11 and 12 may take up to an additional two months, and patients admitted during the study time will be followed while in-hospital until discharge or death. Randomization (process see below) will be performed at study start, i.e., all participating trauma centers will know when they are scheduled to change from selective to universal screening, which will allow for preparation and protocol development. US will be “easier” from a clinical perspective, minimizing any potential challenges related to a change in protocol.

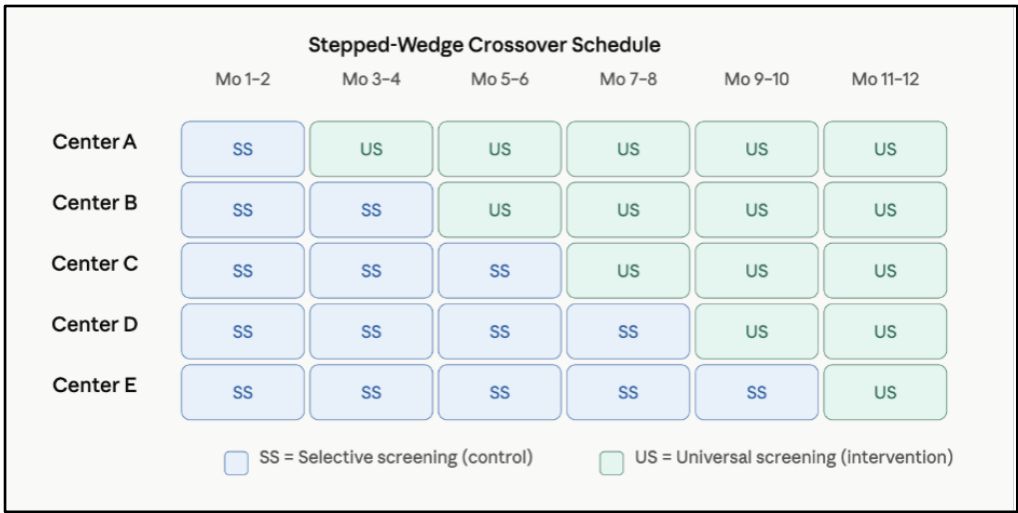


Figure 1: Schedule for transition from selective to universal screening

Each center will contribute data from both their selective and universal screening period, serving partly as its own control. In the control arm (SS), trauma centers will utilize the screening criteria at the time of and prior to participation in this study. While there may be institutional differences, current screening criteria are all based on well-published literature and Best Practices Recommendations^{14,16}. For the intervention arm (US), trauma centers will perform a neck CTA as part of the imaging workup for all major blunt trauma activations. All modern multi-slice CT scanners (64-slice, 128-slice, or higher) are appropriate for this task¹⁸. Trauma Medical Directors and Trauma Program Managers routinely review the literature and adjust their protocols for the management of trauma patients based on current best practices recommendations and guidelines. As such, for TCs agreeing to participate in this study, changing from SS to US is an adjustment of their trauma management policies that is frequently done for other aspects of trauma care. Adherence to TC management policies for clinicians at the institution is regularly monitored as part of TC Process Improvement meetings, which will facilitate adherence to the screening method.

Randomization Process

For the current stepped-wedge cluster randomized trial, randomization will be performed at the cluster level (i.e., TC), not at the individual patient level. All clusters begin in the control condition and cross over to the intervention according to the randomized schedule until all clusters had implemented the intervention. Before the start of data collection (Month M0), the study biostatistician will generate random numbers using IBM SPSS (version 30.0) to determine the order in which clusters cross over. A reproducible randomization sequence will be generated by setting up a fixed random seed, followed by assigning each participating cluster with a random number generated from a uniform distribution (0–1). Clusters will be then sorted in ascending order of the generated random numbers, and the resulting sequence determined the order in which clusters transitioned to the intervention. Once the randomization is executed, the coordinating center PI will notify all participating sites of their assigned crossover period. Advance disclosure of the cross-over schedule is inherent to the stepped-wedge design and necessary to allow institutional preparation (e.g., updating CT ordering protocols, notifying clinical staff).

Impact on the Management of Trauma Patients

This study will not have any impact on the treatment of BCVI, once diagnosed. Both antiplatelet (aspirin, clopidogrel) and antithrombotic (heparin, low-molecular weight heparin, direct oral anticoagulant) therapies are deemed acceptable, though antiplatelet-based therapies are more common^{4,14,16}. The type of treatment as well as treatment details (type of agent, dose of agent, time of initiation) will also be substantially impacted by associated traumatic injuries and can therefore not be standardized across institutions, but general institutional practices will be recorded. Most collected variables for this study can be obtained from participating institutions' trauma registry and are part of the National Trauma Data Standard, with EMR review only necessary for patients with BCVI.

Data Collection

Data collection for PRaCTUS BCVI uses three separate REDCap forms. Each participating center has a unique data access group and cannot view other centers' data.

- Form 1 (General Center Questionnaire): Complete one at M0 (study start) before data collection begins
- Form 2 (BCVI Screening Form): Complete one form every two months with batch submission at M2 (which covers M1-M2), M4 (which covers M3-M4), M6 (which covers M5-M6), M8 (which covers M7-M8), M10 (which covers M9-M10), and M12 (which covers M11-M12). Earlier or more frequent submission is encouraged but not required, and may be limited by data completion in each institution's Trauma Registry, which typically occurs with a 30 to 45 days delay.

- Form 3 (Confirmed BCVI or Stroke Form): One form per confirmed patient with BCVI or stroke, to be entered within 30 days of patient discharge or in-hospital death. This form is completed on a rolling basis throughout the study whenever a BCVI or stroke is diagnosed.

Figure 2 below illustrates the three forms, when each is initiated, and the recommended reporting timeline across the 12-month data collection period.

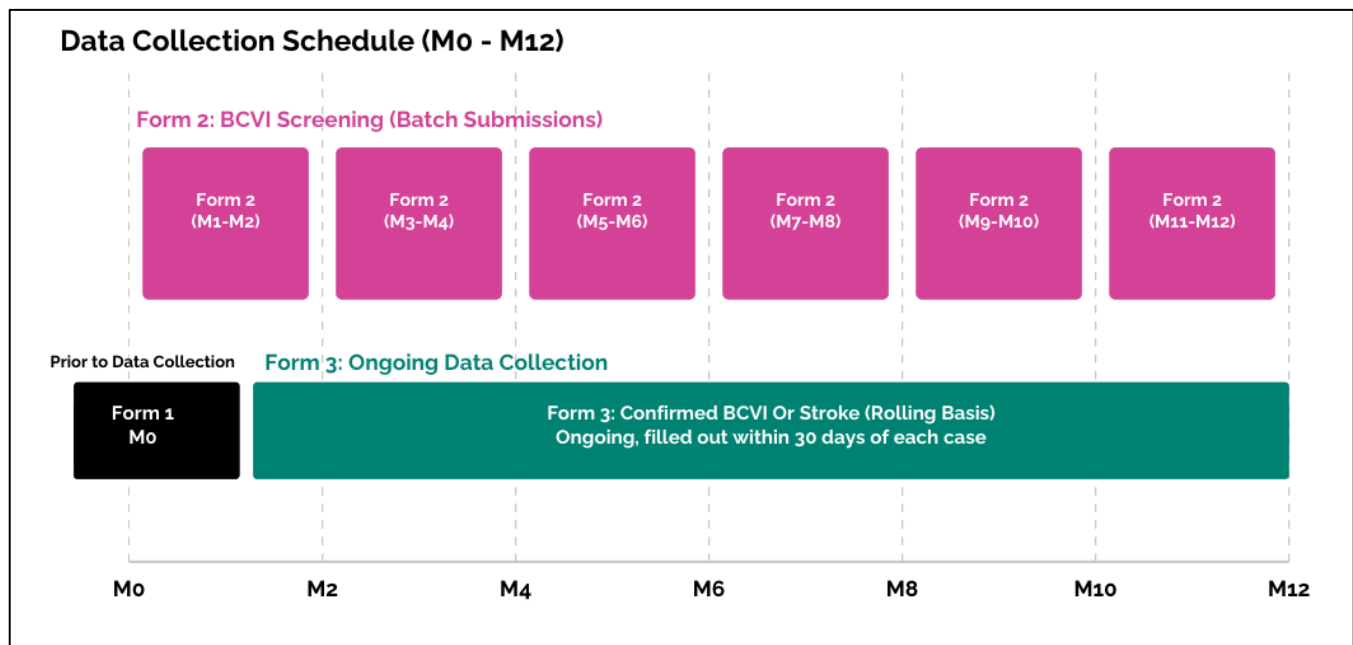


Figure 2: Data Reporting Schedule

1) Form 1: General Center Questionnaire (to be completed at M0, i.e., prior to study start)

Hospital Information

- Level of Trauma Center (ACS Level 1, ACS Level 2, State Level 1, State Level 2) [select all that apply]
- Hospital Type (Community, Academic / University, Hybrid) [select one]
- Hospital Region (West, SW, Midwest, NE, SE) [select one]
- Hospital Location (Rural, suburban, urban) [select one]
- Trauma center volume (average trauma admissions per year)
- Trauma CT scanner type (model, slices) [free text]

BCVI Information

- BCVI Screening Criteria Used (Denver, Expanded Denver, Memphis, ACS Best Practices) [select one]
[will also request actual form / protocol with criteria]
- Treatment for BCVI (based on protocol or common practice)

- Grade 1 (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC) [select all that apply]
- Grade 2 (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC) [select all that apply]
- Grade 3 (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC) [select all that apply]
- Grade 4 (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC) [select all that apply]
- Grade 5 (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC) [select all that apply]

2) Form 2: BCVI Screening Form (one form every two months completion at M2, M4, M6, M8, M10 and M12)

Reporting period (M1-M4, M5-M8, M9-M12)

Study Assignment (selective screening, universal screening, switch selective to universal during quarter) [select one]

Information for all major blunt trauma patients seen by trauma team each month:

- Number of patients: 0 to 1,000
- Age (median and IQR)
- Gender (% female)
- ISS (median and IQR)
- AIS head (median and IQR)
- AIS chest (median and IQR)
- Number of patients who received CTA neck: 0 to 1,000
- Number of grade 1 BCVI cases (based on radiology read stating number or appropriate description): 0 to 1,000
- Number of grade 2 BCVI cases (based on radiology read stating number or appropriate description): 0 to 1,000
- Number of grade 3 BCVI cases (based on radiology read stating number or appropriate description): 0 to 1,000
- Number of grade 4 BCVI cases (based on radiology read stating number or appropriate description): 0 to 1,000
- Number of grade 5 BCVI cases (based on radiology read stating number or appropriate description): 0 to 1,000
- Number of grade unknown/unclear BCVI cases: 0 to 1,000
- Number of patients with ischemic stroke: 0 to 1,000

- Number of patients with ischemic stroke in vascular territory suggestive of cervical arterial injury or in patients with confirmed BCVI: 0 to 1,000
- Number of patients with death due to BCVI-related stroke: 0 to 1,000
- Number of deaths overall: 0 to 1,000
- Cases of AKI (total)
- Number of CTA neck performed for trauma during this time: 0 to 1,000

3) Form 3: Confirmed BCVI or Stroke Form (one form for each patient with BCVI or stroke)

Are any exclusion criteria present? Younger than 18 years old, transfer patient, pregnant patient, prisoner (y/n) *[if y, do not proceed]*

Patient admitted during reporting period (M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12) [select one]

Study Assignment at time of patient admission (selective screening, universal screening) [select one]

If in universal screening period, would the patient have fulfilled any selective screening criteria? (y/n)

Patient information

- Age
- Sex
- ISS
- AIS head
- AIS chest
- Admission GCS
- TBI with ICH on admission (y/n)
- Stroke present on admission imaging (y/n)
- BCVI grade on 1st CTA neck (1,2,3,4,5,unknown) [if performed]
- BCVI grade on 2nd CTA neck (1,2,3,4,5,unknown) [if performed]
- BCVI grade on 3rd CTA neck (1,2,3,4,5,unknown) [if performed]
- BCVI grade on 4th CTA neck (1,2,3,4,5,unknown) [if performed]
- BCVI grade on 5th CTA neck (1,2,3,4,5,unknown) [if performed]
- Initial treatment (Aspirin 81mg, Aspirin 325mg, Plavix or similar platelet inhibitor, Heparin gtt, Lovenox, DOAC, no treatment) [select all that apply]
- Treatment stopped due to extracranial bleeding complication (y/n) [if performed]
- Treatment restarted and patient discharged alive with medication (y/n) [if performed]
- Patient developed AKI (y/n)
- Progression of ICH (y/n)
- Any stroke during hospital stay (y/n)
- Presumed BCVI-related stroke during hospital stay (y/n)

- Death due to BCVI-related stroke (y/n)
- Death due to other cause (y/n)
- Discharge disposition (home, rehab, SNF, hospice, other: ____)

Timing Data (for patients with BCVI or stroke)

- Time from hospital admission to first CTA neck (hours)
- Time from BCVI diagnosis (first positive CTA neck) to initiation of antithrombotic/antiplatelet treatment (hours)
- Time from hospital admission to onset of stroke symptoms (hours) [if applicable]

Data Dictionary

The following definitions apply uniformly across all forms and all participating sites:

- BCVI: Injury to the carotid or vertebral artery resulting from blunt trauma, diagnosed on CTA neck and graded per Biffel scale¹⁹
 - Grade 1: Luminal irregularity or dissection with <25% luminal narrowing
 - Grade 2: Dissection or intramural hematoma with ≥25% luminal narrowing, intraluminal thrombus, or raised intimal flap
 - Grade 3: Pseudoaneurysm
 - Grade 4: Occlusion
 - Grade 5: Transection
- Grade assignment should be based on the attending radiologist's final interpretation. If the radiology report does not explicitly state a Biffel grade but provides a description consistent with one of the above, assign the most appropriate grade. If the description does not clearly correspond to any grade, grade will be designated "unknown."
- BCVI-related Stroke: Any ischemic stroke in a vascular territory suggestive of cervical arterial injury occurring during the hospital stay in a patient with confirmed BCVI (or before discharge or patient death). Hemorrhagic strokes and strokes present on admission imaging are excluded from this definition, as these may represent progression of concomitant TBI/ICH or a complication of antithrombotic therapy.
- Stroke-Related Mortality: Any in-hospital death deemed by the clinical treatment team to be primarily a consequence of a BCVI-related stroke. This includes patients who die following transition to comfort care/comfort measures only as a result of BCVI-related stroke.
- Extracranial Bleeding Complication (BCVI therapy-related): Any cessation of antiplatelet or antithrombotic therapy due to clinically significant bleeding, as determined by the treating clinical team, with the exception of progression of TBI/ICH on follow-up imaging, which is recorded separately.

- Progression of ICH/TBI: Any increase in size or volume of intracranial hemorrhage on follow-up imaging compared to the most recent prior study.
- Acute Kidney Injury (AKI), based on institutional criteria for AKI diagnosis
- Discharge Disposition: The patient's disposition at the time of hospital discharge:
 - Home (includes home with home health services)
 - Rehab (inpatient rehabilitation facility)
 - SNF (skilled nursing facility)
 - Hospice
 - Other (specify)

Regulatory Framework and Ethical Considerations

Compliance Statement

This study will be conducted in full accordance with all applicable federal, state, and local laws and regulations governing the protection of human research participants. All episodes of noncompliance will be documented and reported per institutional and federal requirements.

The investigators will perform the study in accordance with this protocol and will report unanticipated problems involving risk to participants or others in accordance with their institutional policies and all federal requirements. Collection, recording, and reporting of data will be accurate and will ensure the privacy, health, and welfare of research participants during and after the study.

The trial will be registered with ClinicalTrials.gov

Justification for Cluster Randomized Trial Design (Ottawa²⁰ Statement Domain 1, Recommendations 1-2):

This study uses a cluster randomized trial (CRT) design. The intervention, i.e., the decision whether to screen blunt trauma patients for BCVI using defined criteria (SS) or universally with neck CTA is one made on the level of the trauma center, not the individual patient, and both US and SS are considered standard of care¹⁴. The unit of randomization, the cluster, is the trauma center itself. Inova Fairfax Medical Campus (IFMC) is the coordinating institution but will not participate in the randomization process, because IFMC already employs a US approach.

The stepped-wedge variant of the CRT design was selected for the following reasons:

- (a) Feasibility: The stepped-wedge design allows all clusters to contribute data to both the control and intervention conditions over a period of time, improving statistical efficiency with a smaller number of clusters.
- (b) Acceptability to gatekeepers: Because all centers eventually cross over to US, the design enhances recruitment by ensuring no center is permanently assigned to the control condition. This is particularly important given that US has been increasingly employed over the last several years, while its benefits remained debated.

(c) Logistical constraints: The one-at-a-time crossover allows the coordinating center to monitor compliance and troubleshoot implementation issues at each center before the next center crosses over. This is critical for a pilot study/feasibility study evaluating the practicality of implementing a protocol change.

(d) Ethical justification: True clinical equipoise exists between selective and universal screening. Both strategies are supported by current guidelines. The stepped-wedge design ensures that all centers eventually receive the intervention, which is ethically preferable when there is a reasonable expectation (though not certainty) that the intervention may be beneficial.

Classification as Research (Ottawa Statement Domain 2, Recommendations 3-4:

Consistent with the Ottawa Statement and Hemming et al.²¹, this stepped-wedge CRT is classified as research for the purpose of ethical review, even though both screening strategies (selective and universal) are, by definition, standard of care. The systematic assignment of clusters to different screening strategies at different time points, combined with the collection of outcome data to evaluate the comparative effectiveness of these strategies, constitutes research. All participating sites are required to obtain IRB approval before beginning data collection.

Identification of Research Participants (Ottawa Statement Domain 3, Recommendations 5-7)

In CRTs, the identification of research participants requires a functional analysis of who is exposed to study interventions and/or data collection procedures, consistent with the Ottawa Statement framework.

Patients: The screening protocol change (selective vs. universal) is a cluster-level intervention, i.e., it modifies institutional policy rather than individual patient care decisions. Patients do not choose which screening protocol (or Trauma Center management guidelines) their Trauma Center uses. By enrolling only ACS-verified and/or State-designated Level 1 and 2 Trauma Centers, adherence of participating centers to the highest standards of care and current evidence is supported¹⁷. Under the Ottawa Statement framework, patients who are indirectly affected by a cluster-level practice change are not research participants with respect to the intervention itself, provided the practice change is evidence-based and physicians continue to make individualized treatment decisions. However, patients are research participants with respect to data collection, because their clinical data are accessed at the site level for research purposes. This classification informs the consent approach.

Healthcare providers (trauma surgeons, emergency physicians, radiologists): The intervention changes the institutional screening protocol that providers must follow but does not deviate from the standard of care. However, the study does not target providers as the subject of evaluation, does not collect provider-level identifiable data, and does not assess provider behavior as an outcome. Providers continue to exercise individualized clinical judgment regarding treatment decisions for detected BCVIs. Providers are therefore classified as research collaborators, not research participants.

Gatekeepers (Ottawa Statement Domain 5, Recommendations 11-12)

In CRTs, gatekeepers are individuals or organizational bodies who have legitimate authority to act on behalf of cluster members and can provide organizational permission for the cluster to participate in the study. Gatekeeper permission is distinct from individual informed consent and from ethics committee review; it does not replace either.

In PRaCTUS BCVI, the Trauma Medical Director at each participating site serves as the gatekeeper. The Trauma Medical Director has the institutional authority to modify the trauma screening protocol and is the individual who releases the updated protocol at the time of crossover from selective to universal screening. The Site PI may or may not be the same individual as the Trauma Medical Director.

Gatekeeper responsibilities:

- Provide written organizational permission (letter of support) for the trauma center to participate in the study, including agreement to adopt universal screening per the randomized crossover schedule
- Support the Site PI in communicating protocol procedures and all amendments to all relevant clinical staff (trauma surgeons, emergency physicians, radiology, nursing) with adequate lead time prior to crossover
- Act in the best interests of the cluster members (patients and providers) and confirm that participation does not conflict with institutional policies or patient welfare

Gatekeeper permission does not constitute proxy consent for individual patients. The ethical justification for proceeding without individual patient consent is addressed separately.

Documentation: A signed letter of support from the Trauma Medical Director at each participating site will be obtained and filed at the coordinating center prior to site activation. If the Trauma Medical Director and Site PI are different individuals, both must provide written agreement.

Clinical Equipoise and Risk-Benefit Assessment (Ottawa Statement Domain 6, Recommendations 13-14)

The rationale for this study is that genuine equipoise exists between SS and US. Below we summarize why, based on current evidence, neither strategy can be considered superior and why the risks of the SS approach deserve the same weight as the risks of the US approach.

(a) SS is not without risk. Every published institutional experience with US has found that established screening criteria fail to identify a substantial proportion of BCVI. A 2026 systematic review reported that SS missed 16% to 37% of injuries detected by US, including high-grade injuries¹². Single-center series from the Level 1 Trauma Centers at the University of Alabama at Birmingham², Virginia Commonwealth University³ and Ascension St Vincent Hospital-Indianapolis¹¹, as well as a multi-center series from several University of Colorado and

University of Tennessee hospitals¹³ all demonstrate this risk. Stroke occurs in 7% to 10% of patients with BCVI^{4,12}, typically within 72 hours of injury^{4,5} and antithrombotic therapy is only effective if started before symptom onset. A BCVI that is not detected cannot be treated. The harm of SS is therefore a missed injury followed by a stroke, with permanent neurologic deficit or death. This harm is not obvious in routine quality data, because it presents as a stroke in a patient who was never diagnosed with BCVI as opposed to being attributed to a screening policy.

(b) Additional imaging. The study population is restricted to major blunt trauma patients who are already undergoing whole-body trauma CT or at least CT cervical spine and/or CTA chest. In these patients, neck CTA is acquired in the same run as the cervical spine CT without additional radiation exposure, and the incremental contrast volume is small relative to the contrast already administered for the chest CTA. Imaging-related complications in published US cohorts are low, with acute kidney injury reported in approximately 1.4% of screened patients in the 2026 systematic review¹², and a Markov cost-effectiveness analysis found US to be cost-effective at conventional willingness-to-pay thresholds²². None of the published comparisons of US and SS^{2,3,11,12} have identified an increase in complications attributable to US. Nonetheless, because these data are retrospective, CTA utilization and AKI are pre-specified outcomes of this study (Aim 2) and will be reported for both arms.

(c) Overtreatment and bleeding. This study does not alter the treatment of BCVI once diagnosed; therapy remains at the discretion of the treating clinicians according to institutional practice and current guidelines^{14,16}. Two observations in the existing literature argue against the premise that US leads to clinically meaningful overtreatment:

- 1) US increases detection of both low- and high-grade injuries and the stroke rate per diagnosed BCVI has remained stable over two decades despite rising detection rates¹⁰. This would not be the case if US were detecting mostly clinically irrelevant lesions but suggests that US detects clinically relevant lesions for which treatment is indicated.
- 2) Most patients with BCVI are treated with antiplatelet agents rather than therapeutic anticoagulation^{4,14,16}. Early antithrombotic therapy did not increase progression of intracranial hemorrhage or solid organ injury in a large single-center series²³ and in an EAST multicenter study of patients with concomitant TBI²⁴. Treatment-related bleeding (cessation of therapy due to bleeding; progression of TBI/ICH) is nevertheless a pre-specified safety outcome of this study (Aim 2).

Aggregate safety data will be reviewed by the Lead PI at the four-month interim analysis and at study completion, and any signal of excess harm will be reported to participating site IRBs and may prompt protocol modification. Detection and reporting of these events relies on the participating sites rather than on direct oversight by the coordinating center, which is appropriate for this study design: each participating site is an ACS-verified and/or state-designated Level 1 or 2 TC and is therefore required to maintain a robust performance improvement and patient safety (PIPS) program with a dedicated Trauma Registry, mandatory review of all major complications, and multidisciplinary peer review¹⁷. Bleeding complications, progression of intracranial hemorrhage, and in-hospital strokes in trauma patients are complications PIPS programs review as a condition of verification. The

study therefore does not introduce a new monitoring burden but relies on surveillance infrastructure that is already in place and independently audited at every participating site.

(d) Current guidelines endorse both strategies. The 2024 ACS Best Practices Guidelines for the Management of Traumatic Brain Injury provide selective screening criteria while explicitly stating that US is supported by the ACR Appropriateness Criteria for major blunt trauma^{14,15}. No guideline designates either strategy as the sole standard of care, and no guideline has been able to recommend one over the other on the basis of patient outcomes because comparative outcome data do not exist. That is the definition of equipoise.

(e) Current practice. US is already in routine clinical use at a growing number of Level 1 and 2 TCs in the United States. This includes Inova Fairfax Medical Campus, the coordinating center for this study, where US was adopted as institutional trauma program policy on the basis of the literature cited above. Participating sites crossing over to US will therefore be adopting a practice that is already standard care at the coordinating institution, rather than an experimental intervention. The adoption of US across the country is occurring in the absence of prospective comparative data; a controlled, prospective comparison is the ethically preferable alternative to continued uncontrolled diffusion of one strategy or the other. The scientific rationale and design of this study were peer-reviewed and funded by the AAST Multi-Institutional Trials Committee.

Summary. Both US and SS approaches are associated with practical and theoretical risks and benefits. The available evidence, which is exclusively retrospective, does not allow this question to be answered. Every published comparison has favored US on detection without demonstrating harm. The study introduces no intervention that is not already standard care at Trauma Centers in the United States, does not alter treatment once BCI is diagnosed, and aims to measure the very risk and benefits associated with both strategies. The incremental risk to patients is therefore minimal, and a prospective, randomized comparison is the only means of resolving the question.

Consent Process (Ottawa Statement Domain 4, Recommendations 8-10)

Informed Consent and Waiver of Consent:

The determination of whether individual patient consent is required at each participating site is the responsibility of that site's local IRB. The coordinating Center recommends seeking waiver of consent based on:

- A waiver of consent is appropriate under 45 CFR 46.116(f) because:
 - The research involves no more than minimal risk to participants. Both screening strategies are standard of care, endorsed by current guidelines, and in clinical equipoise. The study does not introduce any experimental intervention and the risks and benefits of either SS or US are experienced by all patients presenting to TCs across the United States outside the context of research. See "Clinical Equipoise and Risk-Benefit Assessment" above for a detailed evaluation of the risks of both strategies.
 - The research could not practicably be carried out without the waiver. Obtaining individual informed consent from every blunt trauma patient admitted to a participating center is not feasible because: (i) the intervention is a cluster-level institutional protocol

change, not an individual-level intervention — patients cannot meaningfully consent to or refuse the screening strategy in effect at their center; (ii) many blunt trauma patients present with altered mental status, intubation, or hemodynamic instability, precluding timely consent; (iii) requiring consent would introduce selection bias that would undermine the validity of the pragmatic trial design; and (iv) the volume of patients (estimated 1,000–4,000 per center per year) makes individual consent logistically impracticable.

- The waiver will not adversely affect the rights and welfare of participants. Both screening strategies are guideline-endorsed standard of care. Patients receive the same clinical care they would receive outside of the study. The only research activity affecting patients is the extraction of clinical data from their medical records for inclusion in a de-identified data set. A Data Use Agreement (DUA) between each participating site and the coordinating center — provides appropriate safeguards for participant privacy.
- Because the study involves the collection of clinical data from routine clinical care, and because the coordinating center does not have access to direct patient identifiers, there is no practical mechanism to provide post-hoc information to individual patients. Aggregate study results will be disseminated through peer-reviewed publication and presentation at national meetings. Individual participating sites may, at their discretion and in accordance with IRB and institutional policies, make aggregate results available to their patient populations.

HIPAA Research Authorization

The coordinating center will receive a de-identified data set.

For participating sites: the IRB of record will determine whether a waiver of HIPAA Authorization is appropriate for that site's data collection activities (i.e., the site's access to PHI in their own medical records to extract data for the de-identified data set). The coordinating center recommends that participating sites request a waiver of HIPAA Authorization under 45 CFR 164.512(i)(2)(ii), as the research involves minimal risk to privacy, the research could not practicably be conducted without the waiver, and an adequate plan to protect identifiers is in place.

Documentation of Consent

No informed consent will be obtained or documented for this study (waiver of consent requested). No consent forms will be used.

Vulnerable Populations (Ottawa Statement, Domain 7, Recommendation 15)

- Both men and women of all races and ethnic groups are eligible for this trial.
- Monthly aggregate data (Form 2) may incidentally include pregnant women, cognitively impaired individuals, adults unable to consent, and individuals with limited English proficiency will not be targeted but may be incidentally included. Patient-level data collection (Form 3) will exclude pregnant patients. Cognitively impaired individuals, adults unable to consent, and individuals with limited English proficiency will be included.
- Cognitively impaired individuals: Patients with traumatic brain injury (TBI) or altered mental status may be included. The cluster-level nature of the intervention mitigates vulnerability concerns: the screening protocol change applies uniformly to all eligible patients at a given center regardless of cognitive status, and both screening strategies are standard of care. No additional safeguards beyond standard clinical care are required.
- Adults unable to consent: The study involves a cluster-level intervention (screening protocol change) that does not require individual patient consent. The waiver of consent (Section 6) applies equally to all patients regardless of capacity.
- Individuals with limited English proficiency: Because no informed consent is being obtained (waiver of consent requested), language proficiency does not affect study participation. All patients meeting eligibility criteria are included regardless of language.

Data Collection and Management:

Data Collection

Data will be collected by research personnel at each participating site from their institutional Trauma Registry and supplemented by limited chart review. Data will be entered directly into a centralized REDCap database maintained by the coordinating center (IFMC). No data collection will be done by Inova Research members directly.

The data transmitted to the coordinating center will constitute a de-identified data set as defined by the HIPAA Privacy Rule Safe Harbor method (45 CFR §164.514(b)). All 18 categories of direct identifiers will be removed prior to transmission, including names, addresses (other than state), telephone numbers, fax numbers, email addresses, Social Security numbers, medical record numbers, health plan beneficiary numbers, account numbers, certificate/license numbers, vehicle identifiers, device identifiers, web URLs, IP addresses, biometric identifiers, full-face photographs, and all dates directly related to an individual (including dates of admission, discharge, and procedures) other than year. Because specific dates are not transmitted, all time-dependent outcome adjudications (e.g., whether a stroke occurred within 7 days of admission) will be performed at the participating site prior to data submission. Only the adjudicated outcomes, the reporting month, and the study period assignment (selective or universal screening) will be transmitted to the coordinating center. Date of birth will not be collected; age will

be recorded in years only. A unique study ID will be assigned at the participating site; the key linking the study ID to the patient's medical record number will be maintained solely at the participating site and will not be shared with the coordinating center.

Data Use Agreement

A Data Use Agreement (DUA) between Inova Health Systems and each participating site is required under 45 CFR §164.514(e)(4) prior to any data transmission. The DUA will specify that the coordinating center will: (a) use the data only for the purposes of this study; (b) not attempt to re-identify any individual; (c) not disclose the data to any party not authorized under the DUA; (d) use appropriate safeguards to prevent unauthorized use or disclosure; and (e) report any unauthorized use or disclosure to the providing site. DUAs will be executed through the Inova Office of Research, Office of Sponsored Research Projects.

Data Security

Data security measures include:

- REDCap is hosted on a HIPAA-compliant, encrypted server maintained by Inova Health Systems Information Technology
- All data transmission between participating sites and the REDCap server occurs via HTTPS (TLS 1.2 or higher encryption)
- Access to REDCap requires individual user credentials (username and password) with role-based access controls
- Multi-factor authentication is required for all users
- Audit trails within REDCap automatically log all data entry, modifications, and access events

Data Safety Monitoring Plan

No Data Safety Monitoring Board (DSMB) will be formed for this feasibility study because it is not powered to deliver clinical outcomes data. Risk assessment: Both selective and universal screening are guideline-endorsed standard of care. The study does not introduce any experimental intervention, investigational product, or deviation from standard clinical practice. The incremental risk to participants is minimal. (See "Clinical Equipoise and Risk-Benefit Assessment" above.) REDCap is password-protected and each site is responsible for ensuring data security and accuracy.

The following monitoring procedures will be implemented:

- Participating sites will inform the Coordinating Center about any deviations from the study protocol within 7 days of detection, and to their local IRB per institutional requirements
- The coordinating center will maintain a log of all reported events

- The Lead PI will assess whether any reported event requires a CAPA plan, notification to all sites, or modification of the study protocol
- Aggregate clinical data (including any reported bleeding complications, AKI events, or strokes) will be reviewed by the Lead PI at the interim analysis (Month 4) and at study completion

Retention and Access

Access to the REDCap database will be restricted to the coordinating center PI, biostatistician, study coordinator(s), study co-investigator(s), and data manager(s). Site PIs and other site study personnel will have access only to their own site's data within REDCap via role-based access controls. No participating site will have access to another site's data. The coordinating center will have access to the full dataset for analysis.

Data will be stored in the REDCap database at IFMC for the duration of the study and for a minimum of 3 years following study closure, consistent with federal record retention requirements (45 CFR 46.115). Data may be used for future analyses related to BCVI screening, treatment, and outcomes, subject to additional IRB approval or determination of exemption. The REDCap database is hosted on Inova Health Systems' HIPAA-compliant server infrastructure, which includes automated daily backups, redundant storage, and disaster recovery capabilities maintained by Inova Information Technology.

Confidentiality

All data and records generated during this study will be kept confidential in accordance with HIPAA and each participating institution's policies on participant privacy. Safeguards include:

- The coordinating center will receive and store only de-identified data. No direct identifiers will be transmitted to or stored at the coordinating center.
- Each participating site maintains a master list linking study IDs to patient medical record numbers. This master list is stored on a password-protected, encrypted computer or secure institutional server at the participating site, separate from the REDCap database.
- The master list will not be shared with the coordinating center or any other participating site under any circumstances.
- The DUA explicitly prohibits the coordinating center from attempting to re-identify any individual.

Statistical Analysis

All analyses will be performed following the intention-to-screen principle. The incidence of BCVI-related stroke and stroke-related mortality will be calculated. A generalized linear mixed model (GLMM) will be used to evaluate the impact of the intervention while accounting for the clustered stepped-wedge study design.

For the primary outcomes (stroke and mortality), mixed-effects logistic regression models will be applied with intervention status and study period included as fixed effects and centers as a random intercept to account for

within-center clustering. The study period will be modeled as a categorical fixed effect to adjust for secular trends over time. The intervention effect will be reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs) and two-sided p-values. Statistical significance will be assessed at .05 significance level. Pre-specified subgroup analyses will be performed according to baseline BCVI prevalence at participating centers to evaluate potential heterogeneity in the intervention effect across centers with differing baseline BCVI burdens. Sensitivity analyses may be conducted to assess the robustness of the findings, including adjustment for relevant patient-level and center-level covariates and alternative specifications of time effects. Analyses will be performed with SPSS.

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Appendix A: Responsibilities of the Coordinating Center

Role and Responsibilities of the Coordinating Center

Inova Fairfax Medical Campus will serve as the coordinating center for this multi-site study.

- Coordinating Center PI: Stefan W. Leichtle, MD, MBA, FACS
- Institution: Inova Fairfax Medical Campus, 3300 Gallows Road, Falls Church, VA 22042

The coordinating center PI is the same individual as the overall study PI. The study will not be conducted at Inova; Inova's role is to serve as the coordinating center only. Five ACS-verified Level 1 or Level 2 TCs currently using SS for BCVI will be recruited as data-collecting sites. Site recruitment will be facilitated through the AAST membership network. Specific sites will be identified and listed by protocol amendment once confirmed.

For each participating site, the coordinating center will verify:

- The Site PI is qualified (board-certified surgeon with trauma privileges)
- The institution has an active Federalwide Assurance (FWA) registration with OHRP
- Local IRB approval has been issued before the site begins participation
- A signed gatekeeper permission letter from the Trauma Medical Director is on file
- A fully executed Data Use Agreement (DUA) between Inova Health Systems and the participating institution is in place before data is shared with Inova Health Systems, but participating sites may be randomized and begin implementing the study procedures after they have received IRB approval.

The coordinating site will collect contact information and documentation verifying qualifications for each site PI as described above. The coordinating center will also be to ensure that all sites have the most current version of the protocol and that amendments are communicated to all sites.

The coordinating center will maintain the following plan:

Protocol Version Control

- All participating sites will receive the most current version of the study protocol at the time of site activation and all amendments throughout the course of their participation

- Site PIs or designee are responsible for submitting amendments to their local IRBs and obtaining approval as required.

Data Collection and Management

- Data will be entered by site personnel directly into the centralized REDCap database
- The coordinating center will perform data review quality checks and communicate data quality reports to site PIs
- Sites with data completeness below 80% will be contacted within 2 weeks for remediation
- Each site will be responsible for ensuring data quality and accuracy. As part of trauma center designation requirements, all trauma centers are required to monitor registry data entry for accuracy.

Reporting of Problems and Protocol Deviations

- Site PIs are required to report protocol deviations to the coordinating center within 7 days of identification and to the IRB of record per the IRB's reporting requirements
- Site PIs are required to report any unanticipated problems involving risk to participants or others to the coordinating center within 48 hours and to the IRB of record per the IRB's reporting requirements
- The coordinating center will maintain a log of all reported deviations and unanticipated problems and will report to the IRB of record per institutional policies

Interim Results

- An interim analysis will be performed by February 2027 for abstract submission to the AAST 2027 Annual Meeting
- Interim results will be shared with site PIs via a written summary distributed by email
- No formal stopping rules are planned for the pilot study

Study Closure

- A final data lock will be performed after all sites have completed data entry and quality checks are resolved
- Final study results will be shared with all site PIs prior to publication

Regular Communication

- Conference calls with all site PIs at study initiation, with quarterly emails between all site PIs and coordinating PI, and more frequently as needed
- A shared secure communication platform for ad hoc communication about logistics, no patient data
- The coordinating center PI will be available for urgent site PI inquiries via phone and email

Quality Management Plan

The coordinating center will implement the following quality management procedures to prevent, detect, and correct protocol deviations, data discrepancies, and non-compliance across all participating sites:

Prevention

- Standardized variable definitions (see Data Dictionary section) distributed to all sites prior to data collection
- Study-specific training for all site personnel prior to site activation
- REDCap data validation rules (range checks, branching logic, required fields) to prevent erroneous data entry at the point of capture

Detection

- Quality reviews by the Data Manager
- Sites with data completeness below 80% will be contacted within 2 weeks for remediation
- Conference calls with all Site PIs to review enrollment, data quality, and protocol adherence ad hoc

Correction

- Protocol deviations will be classified as major or minor by the Lead PI
- Major deviations will be reported to the Inova IRB and the site's local IRB per institutional requirements

Site Monitoring Plan:

Data monitoring will consist of reviewing REDCap for inconsistencies and incomplete data. As part of TC designation requirements, all trauma centers are required to monitor registry data entries for accuracy. This is reviewed during the recurrent TC re-verification process by the American College of Surgeons. Therefore, no source data verification will be conducted.

Appendix B: IFMC Team Roster

The CRCC and DCC functions are co-located at IFMC. The address for the Division of Trauma and Acute Care Surgery at Inova Fairfax Medical Campus is 3300 Gallows Road, Falls Church, Virginia 22042. No responsibilities are delegated to external institutions or agencies.

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