

Implementation of a universal screening protocol for blunt cerebrovascular injury (BCVI) and incidence of BCVI and BCVI-related stroke at a community level II trauma center

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ABSTRACT

Rare but potentially catastrophic, blunt cerebrovascular injury (BCVI) has been a challenging condition to recognize and treat in trauma patients and requires prompt identification and management to prevent ischemic cerebrovascular compromise or stroke. Over the past few decades, screening criteria, such as the Denver and modified Denver screening criteria, have been developed to identify patients at high-risk for BCVI based on certain clinical and radiographic features at the time of admission. Despite the increase in the rate of BCVI detection with these criteria, recent evidence has emerged that suggests universal screening protocols further increase the rate of BCVI detection among trauma patients without increasing costs and patient radiation exposure when creative imaging methodology is employed.^{1,2} Moreover, concerns of the practicality of the Denver criteria for smaller trauma centers and community hospitals have prevented its widespread use, as was the case at this institution. This project used trauma registry data and retrospective chart review to characterize BCVI detection and associated stroke incidence prior to and after implementation of a universal BCVI screening protocol at a community level II trauma center. These findings so far indicate a significant number of strokes could have been attributable to BCVI in trauma patients prior to the implementation of universal CTA screening. Moreover, preliminary trauma registry data after implementation of universal CTA screening has shown an increase in positive screenings without significant additional cost and radiation burden and has highlighted the need for thorough follow up for equivocal screening results.

Project Timeline of BCVI Universal Screening Implementation at NGMC

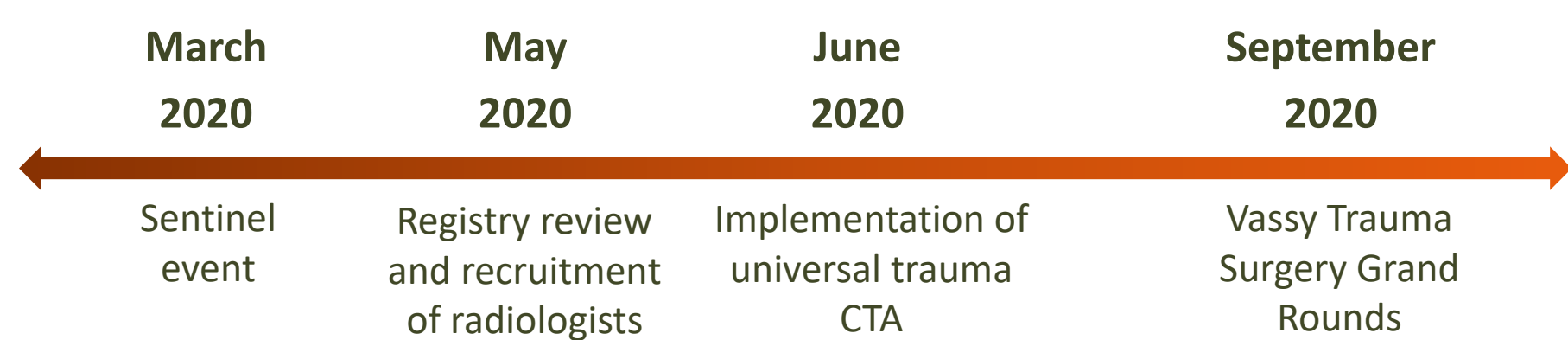
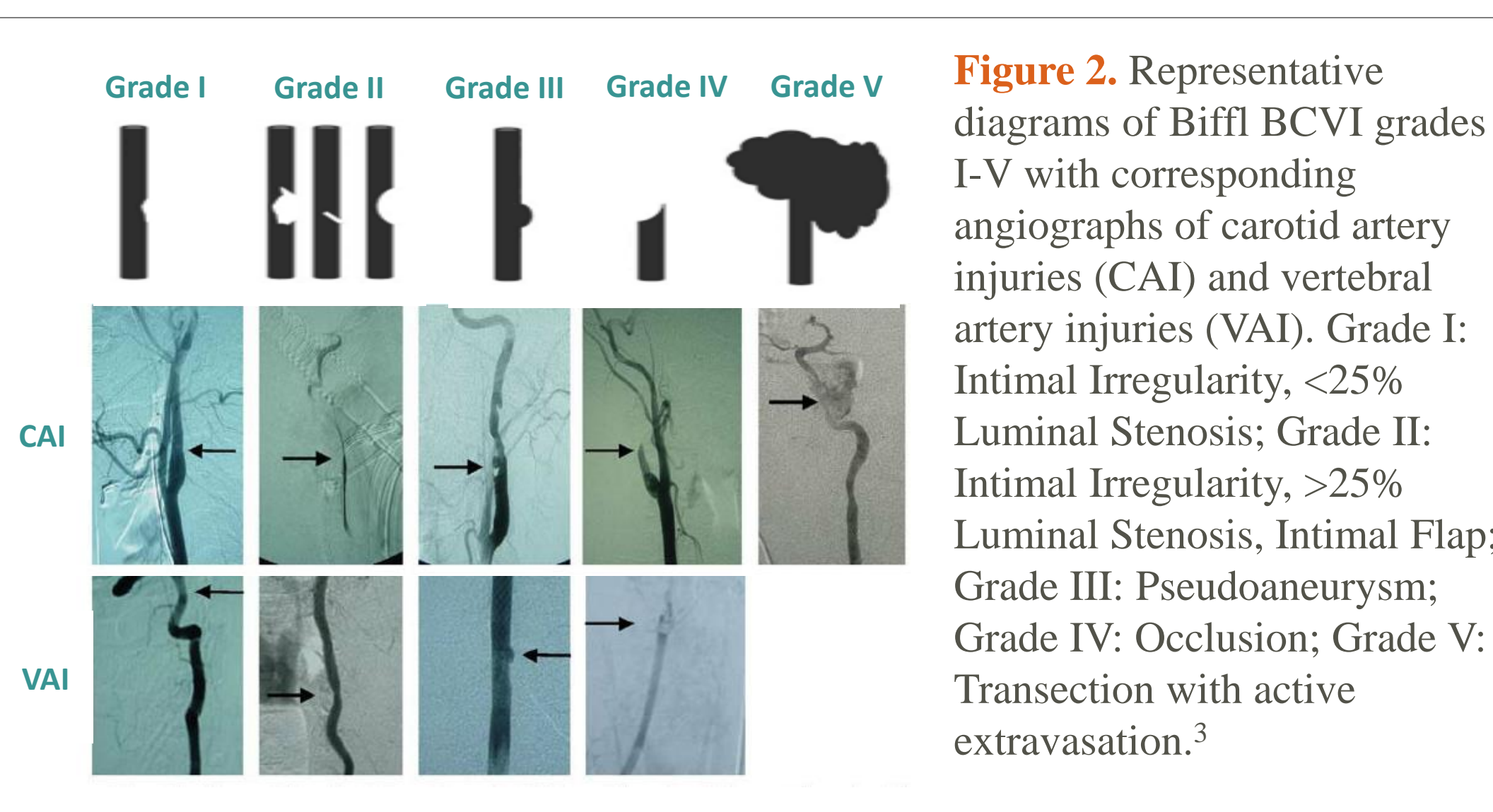


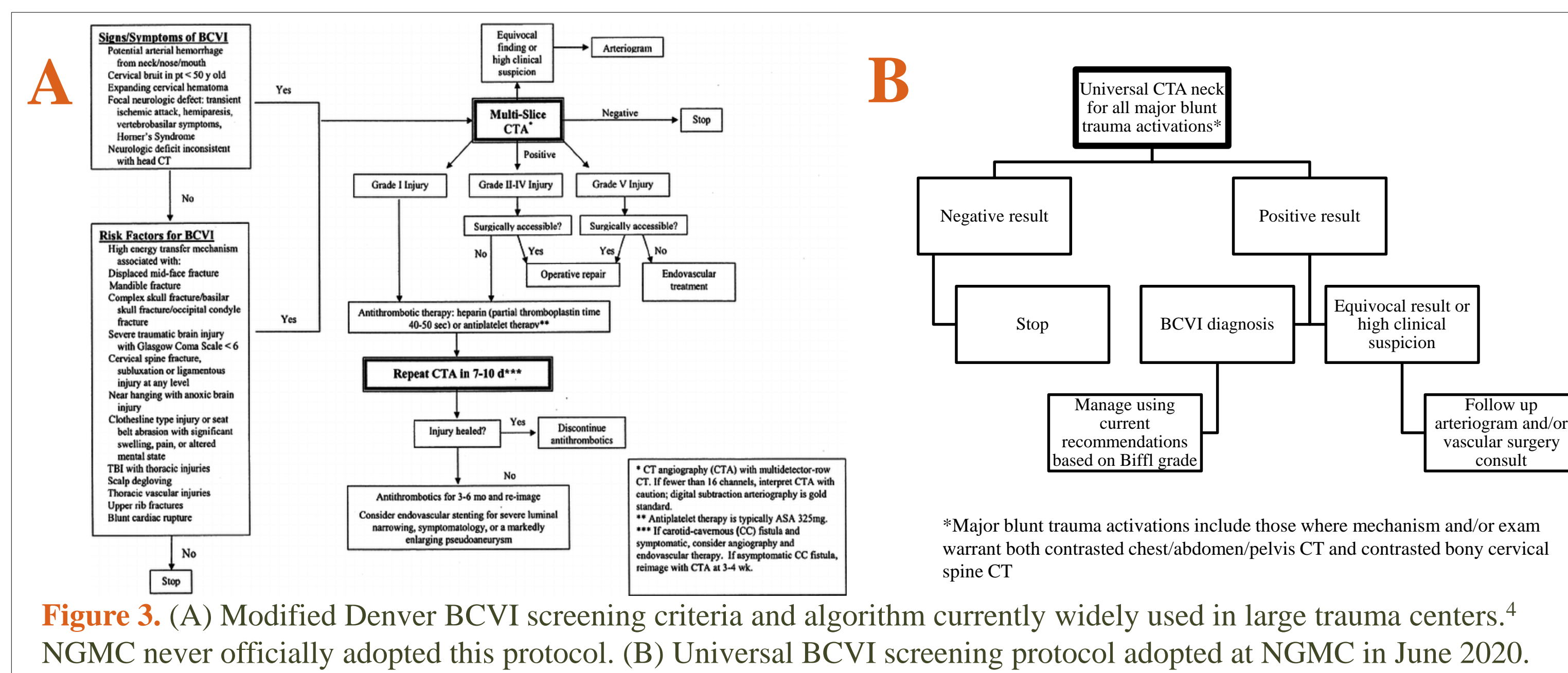
Figure 1. Project timeline of BCVI universal screening implementation at NGMC.

INTRODUCTION & RATIONALE

Disproportionately affecting young adults, BCVI is relatively rare but potentially catastrophic, with a wide range of potential stroke rate (3% to 59%). Improved BCVI screening is critical in recognizing BCVIs in trauma patients and characterizing the incidence of associated ischemic cerebrovascular events. If not resulting in death, these events can have significant impacts on the long-term health and lifestyle of affected patients, frequently warranting extensive rehabilitation. Furthermore, the financial impact, albeit undetermined, on health systems from these events is arguably significant. In order to reduce deaths, other negative health outcomes, and health costs from BCVI-related stroke, screening criteria utilizing clinical features and angiographic data (Fig. 2) have been developed and implemented in many high-volume trauma centers. The Denver screening criteria, developed in the 1990s and later expanded to the modified Denver criteria, is the most widely used.¹ (Fig. 3) However, its use has been somewhat limited to high-volume trauma centers, and its utility in smaller trauma centers and community hospitals has not been well-established. Moreover, the practicality of Denver screening criteria implementation is complicated by institution-specific radiographic screening trauma protocols.



These reasons, along with increasing evidence showing that the most recent modified Denver screening criteria still misses a significant portion of potential BCVIs, have prompted recent evidence supporting the implementation of expanded universal screening for trauma patients.² In context of this ongoing conversation in the academia and after a local sentinel event in March 2020 of BCVI detection with CTA in a trauma patient, trauma surgeons and radiologists at Northeast Georgia Medical Center initiated this project and developed a universal BCVI screening protocol using CTA for trauma patients. (Fig. 1) Initial goals of this project were to better characterize the incidence of BCVI-related stroke in trauma patients from 2015 to mid-2020 and, using a universal BCVI screening protocol, to gain insight into the true incidence of BCVI and BCVI-related stroke incidence at NGMC.

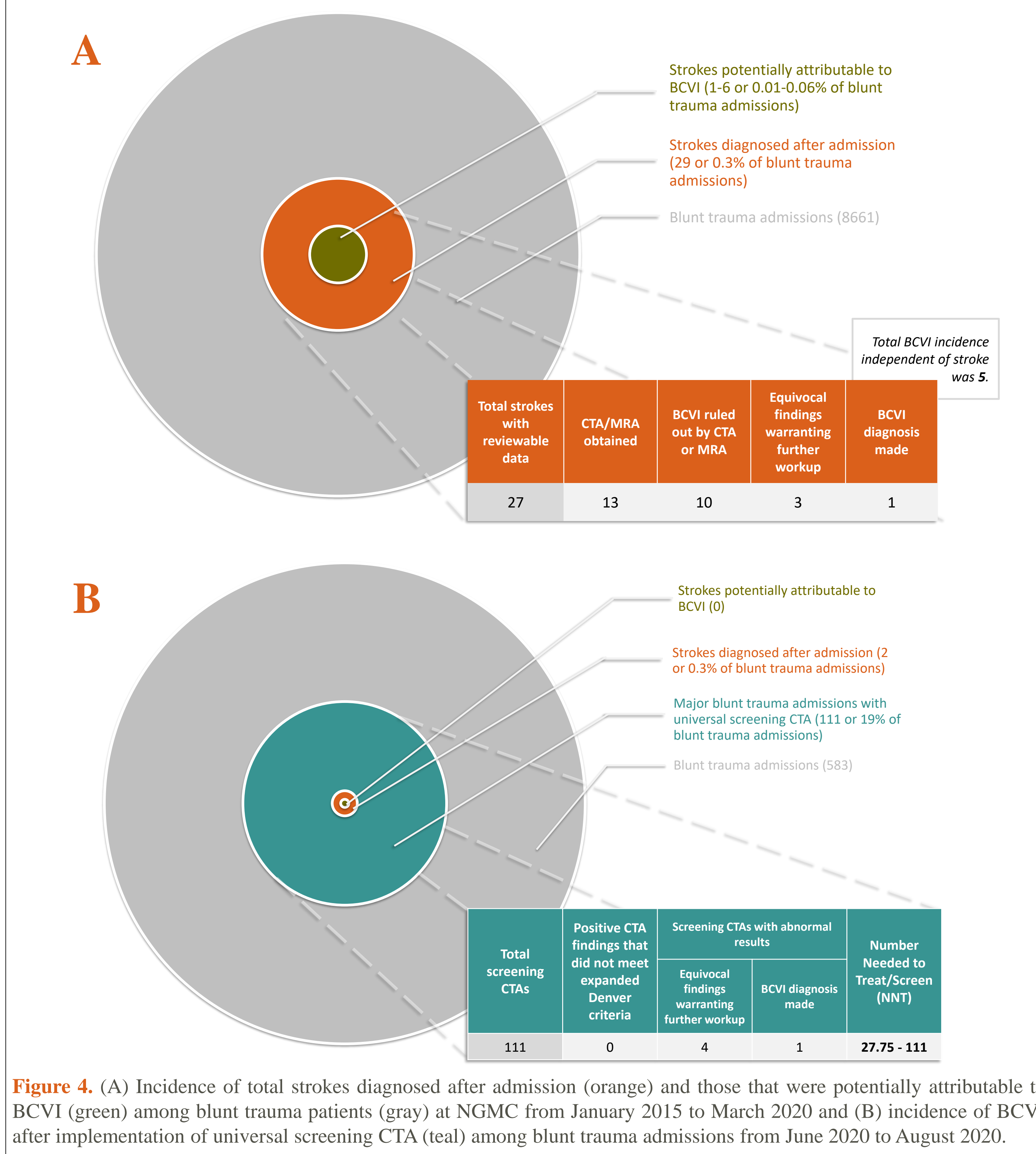


METHODS

In March 2020, NGMC trauma registry was used to pull data from January 2015 to March 2020 for patients with a diagnosis of stroke during admission after sustaining blunt trauma. (Fig. 1) A subsequent registry data report was compiled to capture any documented BCVI diagnoses during this same time period. Manual chart review on each patient was performed and data points for each patient were collected and deidentified. Data points for each patient collected included: if CTA or MRA of head/neck vessels was obtained, if BCVI was formally diagnosed, and if findings of CTA/MRA either ruled out BCVI as cause of stroke or warranted further workup (i.e., equivocal findings). In June 2020, a universal BCVI screening protocol (Fig. 3B) using CTA was implemented, staff were educated, and the same data points have since been collected and analyzed as above in addition to capturing total screening CTAs, those with abnormal results, and number needed to treat/screen (NNT).

RESULTS

Incidence of BCVI and BCVI-Related Stroke at NGHS



DISCUSSION

- The incidence of BCVI in patients presenting with blunt trauma from 2015-2020 at NGMC was determined to be 5, and the incidence range of stroke caused by BCVI during this time period was determined to be 1-6 (0.01-0.06%) of blunt trauma admissions. Including equivocal CTA results, the true incidence of BCVI during this time period could have been as high as 8.
- Equivocal CTA results were found in 23% of those diagnosed with stroke after blunt trauma from 2015-2020, warranting further clinical investigation that never occurred. Moreover, 10 patients were diagnosed with stroke from 2015-2020 never received a CTA. Using the universal screening protocol, it is anticipated in future to capture more BCVIs and have more thorough follow up with arteriogram and/or vascular surgery consult for equivocal CTA results potentially allowing BCVI treatment and avoidance of stroke.
- In only three months, implementation of the universal BCVI screening protocol has already identified one BCVI and potentially three others pending further investigation. This suggests the NNT is as low as 27 and as high as 111. Better follow-up is anticipated in the future, and with increased *n*, can narrow this range.
- Implementation of the universal BCVI screening protocol using neck CTA was not only logistically feasible but also seemed to keep contrast and radiation exposure nearly identical to what it was previously without universal screening. In this system, trauma chest/abdomen/pelvis CT currently includes chest/abdomen/pelvis CTA with abdominal/pelvis venous phase with delays through renal collecting system via a single contrast bolus. With spine CT added, CTA neck was easily performed without additional radiation or contrast.
- This project had a few notable limitations:
 - Methodology used only captured a total of 27 patients with stroke after blunt trauma and only captured one stroke-related BCVI after blunt trauma over a span of approximately 5 years. A larger *n* could yield more statistically significant results.
 - Results are subject to the Hawthorne effect as there was one human chart reviewer, who may have had indirect bias looking for evidence supporting the potential for BCVI diagnosis.

Future Work

In addition to continuing to collect registry data on patients who present with blunt trauma and who receive screening CTA via the recently implemented universal BCVI screening protocol, there is intent to further investigate contrast and radiation exposure and to complete short-term and long-term local cost analyses of implementation of the universal screening protocol. Also, it is believed that existing screening criteria can be further challenged after acquiring additional data to further validate a universal screening protocol among trauma patients for better identification and management of BCVI.

Acknowledgements & Disclosures

Trauma registrars and other Trauma and Acute Care Surgery staff helped capture and provide registry data. The patience and combined efforts of clinical staff including those from Radiology, Emergency Department, and PM&R in making the universal BCVI screening possible is appreciated. Graduate Medical Education provided this poster template and scholarship infrastructure guide for this ongoing project. There are no financial or other conflicts of interest to disclose.

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