Modified Brain Injury Guidelines

2022 Trauma Symposium
7 October 2022 – Omaha, NE

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Disclosures

None.

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Learning Objectives

1. Enumerate the mBIG categories.
2. Identify patients who can be stratified using the mBIG criteria.
3. Recognize opportunities for more efficient resource utilization.

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Initial Management of Mild Traumatic Brain Injury

Mild traumatic brain injury:

- Traumatic mechanism.
- GCS 13–15.
- Radiographic (CT) evidence of intracranial hemorrhage.

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A Common Scenario

A 65-year-old man on aspirin presents after a mechanical ground level fall.

GCS 14 with no neurologic deficits.

CT shows a 3 mm SDH.

Admit to ICU. Consult Neurosurgery. Repeat head CT in 6 hours. Keppra.

Discharged home after 24 hours of observation.

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Are all these interventions equally valuable or effective?

1. Routine repeat head CT.
2. Routine ICU admission.
3. Routine neurosurgery consult.

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Repeat Head CT

- Radiographic progression is not uncommon ~ 20%.[1]
- Neurosurgical intervention is rare despite progression.
- Clinical exam has a high negative predictive value for intervention.

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Monitoring and Neurosurgery Consultation

- Patients more likely to require intervention benefit from close monitoring and Neurosurgery involvement.
- How do we identify those who fall into this higher risk category?

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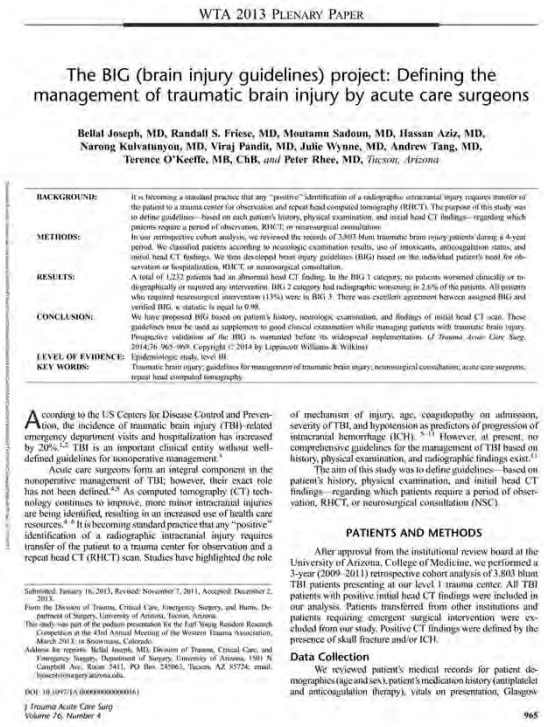

WTA 2013 PLENARY PAPER

The BIG (brain injury guidelines) project: Defining the management of traumatic brain injury by acute care surgeons

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BACKGROUND: It is becoming a standard practice that any "positive" identification of a radiographic intracranial injury requires transfer of the patient to a trauma center for observation and repeat head computed tomography (RHCT). The purpose of this study was to define guidelines—based on each patient's history, physical examination, and initial head CT findings—regarding which patients require a period of observation, RHCT, or neurosurgical consultation.

METHODS: In our retrospective cohort analysis, we reviewed the records of 3,803 blunt traumatic brain injury patients during a 4-year period. We classified patients according to neurologic examination results, use of intoxicants, anticoagulation status, and initial head CT findings. We then developed brain injury guidelines (BIG) based on the individual patient's need for observation or hospitalization, RHCT, or neurosurgical consultation.

RESULTS: A total of 1,232 patients had an abnormal head CT finding. In the BIG 1 category, no patients worsened clinically or radiographically or required any intervention. BIG 2 category had radiographic worsening in 2.6% of the patients. All patients who required neurosurgical intervention (13%) were in BIG 3. There was excellent agreement between assigned BIG and verified BIG, κ statistic is equal to 0.98.

CONCLUSION: We have proposed BIG based on patient's history, neurologic examination, and findings of initial head CT scan. These guidelines must be used as supplement to good clinical examination while managing patients with traumatic brain injury. Prospective validation of the BIG is warranted before its widespread implementation. (*J Trauma Acute Care Surg.* 2014;76: 965–969. Copyright © 2014 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Epidemiologic study, level III.

KEY WORDS: Traumatic brain injury; guidelines for management of traumatic brain injury; neurosurgical consultation; acute care surgeons; repeat head computed tomography.

According to the US Centers for Disease Control and Prevention, the incidence of traumatic brain injury (TBI)–related emergency department visits and hospitalization has increased by 20%.[1,2] TBI is an important clinical entity without well-defined guidelines for nonoperative management.[3]

Acute care surgeons form an integral component in the nonoperative management of TBI; however, their exact role has not been defined.[4,5] As computed tomography (CT) technology continues to improve, more minor intracranial injuries are being identified, resulting in an increased use of health care resources.[4–6] It is becoming standard practice that any "positive" identification of a radiographic intracranial injury requires transfer of the patient to a trauma center for observation and a repeat head CT (RHCT) scan. Studies have highlighted the role of mechanism of injury, age, coagulopathy on admission, severity of TBI, and hypotension as predictors of progression of intracranial hemorrhage (ICH).[5–11] However, at present, no comprehensive guidelines for the management of TBI based on history, physical examination, and radiographic findings exist.[11]

The aim of this study was to define guidelines—based on patient's history, physical examination, and initial head CT findings—regarding which patients require a period of observation, RHCT, or neurosurgical consultation (NSC).

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This study was part of the podium presentation for the Earl Young Resident Research Competition at the 43rd Annual Meeting of the Western Trauma Association, March 2013, in Snowmass, Colorado.

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PATIENTS AND METHODS

After approval from the institutional review board at the University of Arizona, College of Medicine, we performed a 3-year (2009–2011) retrospective cohort analysis of 3,803 blunt TBI patients presenting at our level 1 trauma center. All TBI patients with positive initial head CT findings were included in our analysis. Patients transferred from other institutions and patients requiring emergent surgical intervention were excluded from our study. Positive CT findings were defined by the presence of skull fracture and/or ICH.

Data Collection

We reviewed patient's medical records for patient demographics (age and sex), patient's medication history (antiplatelet and anticoagulation therapy), vitals on presentation, Glasgow

Retrospective cohort study.[2]

3803 patients over 4 years at a level 1 TC.

Factors identifying need for:

- Hospitalization.
- Repeat CT head.
- Neurosurgical consultation.

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Brain Injury Guidelines

Variable	BIG 1	BIG 2	BIG 3
Neurologic examination	Normal	Normal	Abnormal
CAMP	No	No/Yes	No/Yes
Skull fracture	No	Non-displaced	Displaced
SDH	≤ 4 mm	5–7 mm	≥ 8 mm
EDH	≤ 4 mm	5–7 mm	≥ 8 mm
IPH	≤ 4 mm, 1 location	3–7 mm, 2 locations	≥ 8 mm, multiple locations
SAH	Trace	Localized	Scattered
IVH	No	No	Yes
Hospitalization	6 h observation	Yes	Yes
Repeat CT head	No	No	Yes
Neurosurgery consult	No	No	Yes

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AAST PODIUM 2021

Validating the Brain Injury Guidelines: Results of an American Association for the Surgery of Trauma prospective multi-institutional trial

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INTRODUCTION: Brain Injury Guidelines (BIG) was developed to effectively use health care resources including repeat head computed tomography (RHCT) scan and neurosurgical consultation in traumatic brain injury (TBI) patients. The aim of this study was to prospectively validate BIG at a multi-institutional level.

METHODS: This is a prospective, observational, multi-institutional trial across nine Levels I and II trauma centers. Adult (16 years or older) blunt TBI patients with a positive initial head computed tomography (CT) scan were identified and categorized into BIG 1, 2, and 3 based on their neurologic examination, alcohol intoxication, antiplatelet/anticoagulant use, and head CT scan findings. The primary outcome was neurosurgical intervention. The secondary outcomes were neurologic worsening, RHCT progression, postdischarge emergency department visit, and 30-day readmission.

RESULTS: A total of 2,432 patients met the inclusion criteria, of which 2,033 had no missing information and were categorized into BIG 1 (301 [14.8%]), BIG 2 (295 [14.5%]), and BIG 3 (1,437 [70.7%]). In BIG 1, no patient worsened clinically, 4 of 301 patients (1.3%) had progression on RHCT with no change in management, and none required neurosurgical intervention. In BIG 2, 2 of 295 patients (0.7%) worsened clinically, and 21 of 295 patients (7.1%) had progression on RHCT. Overall, 7 of 295 patients (2.4%) would have required upgrade from BIG 2 to 3 because of neurologic examination worsening or progression on RHCT, but no patient required neurosurgical intervention. There were no TBI-related postdischarge emergency department visits or 30-day readmissions in BIG 1 and 2 patients. All patients who required neurosurgical intervention were BIG 3 (280 of 1,437 patients, [19.5%]). Agreement between assigned and final BIG categories was excellent ($\kappa = 99\%$). In this cohort, implementing BIG would have decreased CT scan utilization and neurosurgical consultation by 29% overall, with a 100% reduction in BIG 1 patients and a 98% reduction in BIG 2 patients.

CONCLUSION: Brain Injury Guidelines is safe and defines the management of TBI patients by trauma and acute care surgeons without the routine need for RHCT and neurosurgical consultation. (*J Trauma Acute Care Surg.* 2022;93: 157–165. Copyright © 2022 American Association for the Surgery of Trauma.)

LEVEL OF EVIDENCE: Therapeutic/Care Management; Level III

KEY WORDS: Management of traumatic brain injury; Brain Injury Guidelines; neurosurgical consultation; neurosurgical intervention; trauma and acute care surgeon.

Traumatic brain injury (TBI) is associated with high morbidity and mortality,[1] it places significant burden on health care resources,[2] and its management accounts for a large proportion of emergency surgical, neurosurgical, and critical care practice.[3] Beyond the significant loss of life and long-term disability, TBI management also accounts for nearly 10% of annual total health

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This study was presented at the 80th Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery, September 29–October 2, 2021, in Atlanta, Georgia.

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Prospective observational trial.[3]

2,033 patients across 10 level 1 and 2 TCs.

Primary outcome:

- Neurosurgical intervention.

Secondary outcomes:

- Neurologic worsening.
- RHCT progression.
- Post-discharge ED visit.
- 30-day readmission for TBI.

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TABLE 3. Analysis of Study Outcome Measures Among the Patient Cohort

	BIG 1 (n = 301)	BIG 2 (n = 295)	BIG 3 (n = 1,437)
Neurologic examination deterioration, n (%)	Nil	2 (0.7)	230 (16.0)
Progression of hemorrhage on RHCT, n (%)	4 (1.3)	21 (7.1)	311 (21.6)
Neurosurgical intervention, n (%)	Nil	Nil	280 (19.5)
Postdischarge ED visit, n (%)	13 (4.3)	19 (6.4)	146 (10.2)
30-d Readmissions, n (%)	1 (0.3)	6 (2.0)	85 (5.9)

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Modifications[4]

Aspirin 81 and 325 mg not considered an antiplatelet agent.

EDH classified as mBIG 3.

Specific guidance for intoxication and characterization of SAH.

Guidelines for management of mBIG 2 and 3.

Open access Original research

Trauma Surgery & Acute Care Open

Multicenter assessment of the Brain Injury Guidelines and a proposal of guideline modifications

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ABSTRACT

Background The Brain Injury Guidelines provide an algorithm fortreating patients with traumatic brain injury (TBI) and intracranial hemorrhage(ICH) that does not mandate hospital admission, repeat head CT, orneurosurgical consult for all patients. The purposes of this study are toreview the guidelines' safety, to assess resource utilization, and to proposeguideline modifications that improve patient safety and widespreadreproducibility.

Methods A multi-institutional review of TBI patients wasconducted. Patients with ICH on CT were classified as BIG 1, 2, or 3 based onthe guidelines. BIG 3 patients were excluded. Variables collected includeddemographics, Injury Severity Score (ISS), hospital length of stay (LOS), intensive care unit LOS, number of head CTs, type of injury, progression ofinjury, and neurosurgical interventions performed.

Results 269 patients met inclusion criteria. 98 were classifiedas BIG 1 and 171 as BIG 2. The median length of stay (LOS) was 2 (2,4)days and the ICU LOS was 1 (0,2) days. Most patients had a neurosurgeryconsultation (95.9%) and all patients included had a repeat head CT. 370repeat head CT scans were performed, representing 1.38 repeat scans perpatient. 11.2% of BIG 1 and 11.1% of BIG 2 patients demonstratedworsening on repeat head CT. Patients who progressed exhibited a higherISS (14 vs. 10, p=0.040), and had a longer length of stay (4 vs. 2 days;p=0.015). After adjusting for other variables, the presence of epiduralhematoma (EDH) and intraparenchymal hematoma were independent predictors ofprogression. Two BIG 2 patients with EDH had clinical deteriorationrequiring intervention.

Discussion The Brain Injury Guidelines may improve resourceallocation if utilized, but alterations are required to ensure patientsafety. The modified Brain Injury Guidelines refine the originalguidelines to enhance reproducibility and patient safety while continuing toprovide improved resource utilization in TBI management.

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INTRODUCTION

Traumatic brain injury (TBI) is responsible for the utilization of vast healthcare resources, with an estimated cost of $76.5 billion in 2010 in the USA.[1] In 2013, TBI was diagnosed in more than 2.8 million emergency department (ED) visits and 282 000 hospital admissions.[2] Most protocols governing patient care for TBI with intracranial hemorrhage (ICH) mandate an inpatient or intensive care unit (ICU) admission, a neurosurgery consult, and at least one repeat head CT scan.[3–11] The allocation of resources is at the forefront of the current discussion regarding healthcare. Decreasing unnecessary hospital and ICU admissions, reducing consults of questionable utility and minimizing CT scans of limited clinical relevance are all potential sources for dramatic cost savings.

The Brain Injury Guidelines (BIG) provide a method to stratify and treat mild TBI. BIG 1 injuries are <4 mm subdural hematomas (SDH), <4 mm epidural hematomas (EDH), <4 mm intraparenchymal hemorrhages (IPH) or "trace" subarachnoid hemorrhages (SAH). Patients with BIG 1 injuries are observed for 6 hours in the emergency department (ED) and do not receive a planned neurosurgery consultation or repeat head CT. BIG 2 injuries are 4 to 7 mm SDH, 4 to 7 mm EDH, 4 to 7 mm IPH or "focalized" SAH. These patients are admitted to the hospital, but do not receive a neurosurgery consultation or a repeat head CT. BIG 3 injuries are >8 mm SDH, >8 mm EDH, >8 mm IPH, or "scattered" SAH and are managed with admission, a neurosurgery consultation and at least one scheduled repeat head CT.[12 13] The complete criteria by which patients are categorized as BIG 1, 2, or 3 are outlined in the definitions section below.

This algorithm represents a departure from the standard practice at most centers. The potential cost savings for a healthcare system that adopts this strategy is immense. In addition to the direct financial benefits, reallocating hospital beds, optimizing neurosurgeon time-utilization, and increasing CT availability divert limited healthcare resources toward patients who are more likely to benefit from their use.

The BIG do have some drawbacks. The guidelines have only been validated at the institution at which they were developed. Although both prospective and retrospective analyses have been completed, further independent validation is required before the guidelines can be widely implemented.[14 15] The BIG are often vague in defining specific aspects of the management algorithm. Any attempt to implement these guidelines would require speculation regarding several of the pertinent components making uniform, widespread, utilization impossible.

The purpose of this study is to analyze accuracy of the BIG at identifying ICH with low risk of progression and to assess the resource savings that may follow implementation of these guidelines. Additionally, a modified version of the BIG that

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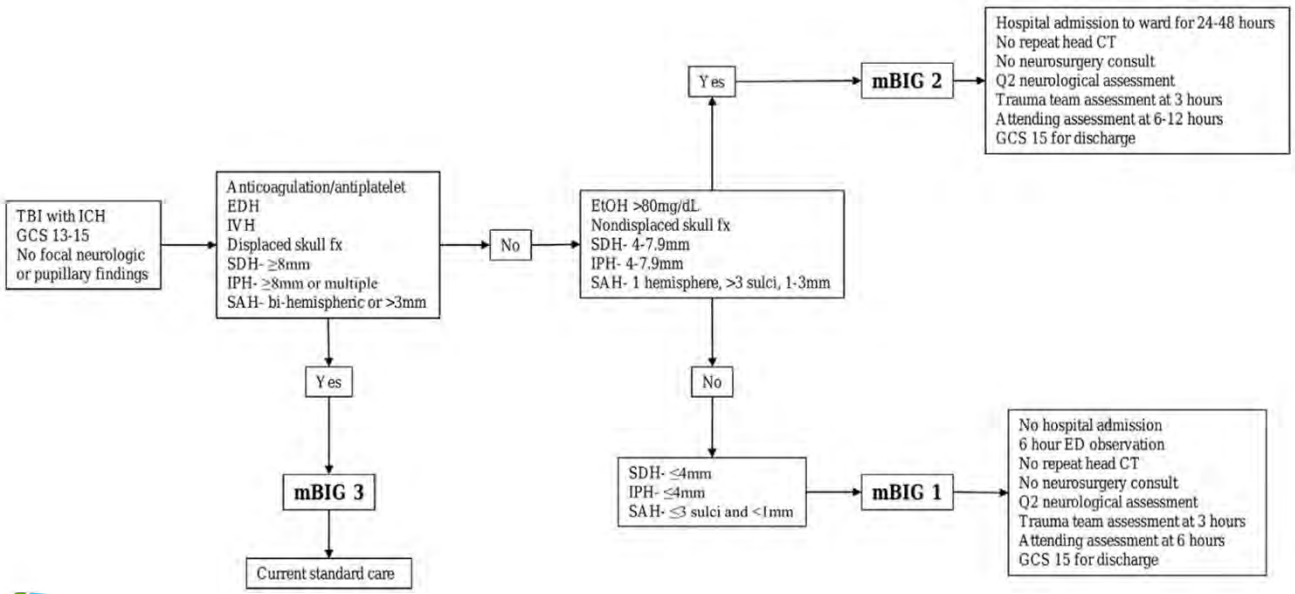

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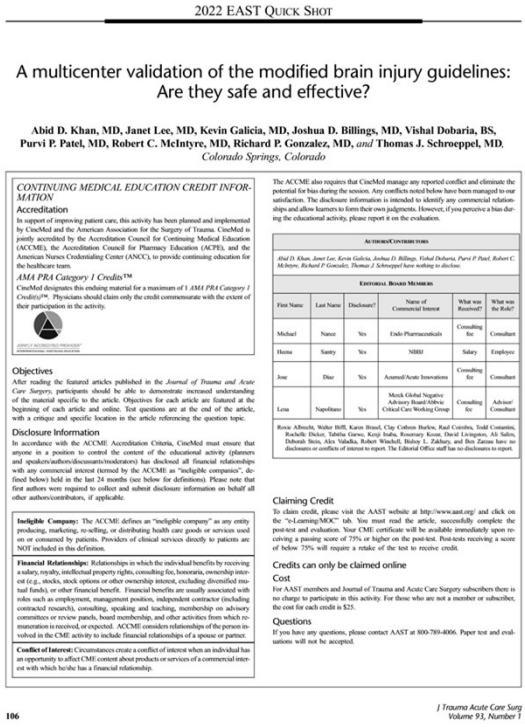
Further Validation[5]

mBIG implemented at 3 level 1 trauma centers.

764 patients from 2014–2016 and 2017–2021.



2022 EAST QUICK SHOT

A multicenter validation of the modified brain injury guidelines: Are they safe and effective?

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TABLE 1. Comparison of Patient Characteristics and Outcomes Before and After mBIG Implementation

	Total Study, N = 764	Pre-mBIG, Implementation, n = 268	Post-mBIG Implementation, n = 496	*p*
Age	53.7 (±20.9)	54.7 (±20.2)	59.1 (±15.5)	0.544
Female	44.0% (336)	44.4% (119)	43.8% (217)	0.086
BIG 1/mBIG 1	42.2% (322)	36.9% (99)	45.0% (223)	0.032
BIG 2/mBIG 2	57.9% (442)	63.1% (169)	55.0% (273)	0.032
EtOH Level	80.3 (±123.1)	86.7 (±128.5)	77.2 (±)	0.458
ISS	12.1 (±6.7)	11.9 (±6.8)	12.2 (±6.7)	0.630
ICU LOS	0 (0,2)	1 (0,2)	0 (0,1)	<0.0001
LOS	2 (1,4)	2 (2,4)	2 (1,4)	0.013
Admit GCS	15 (15,15)	15 (15,15)	15 (14.5,15)	0.746
D/C GCS	15 (15,15)	15 (15,15)	15 (15,15)	0.510
NSG Consult	73.8% (564)	95.9% (257)	61.9% (307)	<0.0001
OR NSG	0.5% (3)	1.1% (3)	0.2% (1)	0.127
Total Head CTs	2 (1,2)	2 (2,3)	2 (1,2)	<0.0001
SDH	52.5% (263)	51.5% (138)	53.0% (263)	0.686
SAH	51.1% (390)	51.5% (138)	50.8% (252)	0.856
EDH	0.9% (7)	2.6% (7)	0	0.0006
IPH	16.0% (122)	17.2% (46)	15.3% (76)	0.507
Skull Fx	18.2% (139)	21.6% (58)	16.3% (81)	0.069
Midline shift	2.1% (16)	3.0% (8)	1.6% (8)	0.206
Clinical Prog	1.2% (9)	0.4% (1)	1.6% (8)	0.172
Rad Prog	12.6% (71)	11.9% (30)	13.2% (41)	0.650
Mortality	0.1% (1)	0	0.2% (1)	0.999

EtOH, blood alcohol; D/C, discharge; NSG, neurosurgery; OR NSG, neurosurgery operation; Fx, fracture; Prog, progression; Rad, radiographic.

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Special Populations

Populations not examined in the original BIG:

- Transfer patients.
- Pediatrics.

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Pediatrics

Prospective study following implementation of of BIG 1 propensity-matched to historical cohort.[6]

Patients aged ≤ 21 years.

No different in mortality.

Fewer head CTs in post-implementation group.

EAST 2017 PLENARY PAPER

Big for small: Validating brain injury guidelines in pediatric traumatic brain injury

Asad Azim, MD, Faisal S. Jehan, MD, Peter Rhee, MD, Terence O'Keeffe, MD, Andrew Tang, MD, Gary Vercruysse, MD, Narong Kulvatunyou, MD, Rifat Latifi, MD, *and* **Bellal Joseph, MD**, *Tucson, Arizona*

BACKGROUND: Brain injury guidelines (BIG) were developed to reduce overutilization of neurosurgical consultation (NC) as well as computed tomography (CT) imaging. Currently, BIG have been successfully applied to adult populations, but the value of implementing these guidelines among pediatric patients remains unassessed. Therefore, the aim of this study was to evaluate the established BIG (BIG-1 category) for managing pediatric traumatic brain injury (TBI) patients with intracranial hemorrhage (ICH) without NC (no-NC).

METHODS: We prospectively implemented the BIG-1 category (normal neurologic examination, ICH ≤ 4 mm limited to one location, no skull fracture) to identify pediatric TBI patients (age, ≤ 21 years) that were to be managed no-NC. Propensity score matching was performed to match these no-NC patients to a similar cohort of patients managed with NC before the implementation of BIG in a 1:1 ratio for demographics, severity of injury, and type as well as size of ICH. Our primary outcome measure was need for neurosurgical intervention.

RESULTS: A total of 405 pediatric TBI patients were enrolled, of which 160 (NC, 80; no-NC, 80) were propensity score matched. The mean age was 9.03 ± 7.47 years, 62.1% (n = 85) were male, the median Glasgow Coma Scale score was 15 (13–15), and the median head Abbreviated Injury Scale score was 2 (2–3). A subanalysis based on stratifying patients by age groups showed a decreased in the use of repeat head CT ($p = 0.02$) in the no-NC group, with no difference in progression ($p = 0.34$) and the need for neurosurgical intervention ($p = 0.9$) compared with the NC group.

CONCLUSION: The BIG can be safely and effectively implemented in pediatric TBI patients. Reducing repeat head CT in pediatric patients has long-term sequelae. Likewise, adhering to the guidelines helps in reducing radiation exposure across all age groups. (*J Trauma Acute Care Surg.* 2017;83: 1200–1204. Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/care management, level III.

KEY WORDS: Brain Injury Guidelines; traumatic brain injury; head injury; intracranial hemorrhage; pediatric; neurosurgical consultation; repeat head CT scan.

Traumatic brain injury (TBI) is a leading cause of death and disability in children worldwide. In individuals of 18 years or younger, TBI results in about 7,400 deaths, over 60,000 hospital admissions, and over 600,000 emergency department (ED) visits every year.[1] In the past decade, the incidence of TBI in the pediatric population has dramatically risen by 57% due to accidents related to sports and recreational activities. Although rates of TBI-related ED visits increased by 70%, the hospitalization rates only have increased by 11%. This is because 75% of patients visiting ED for head injuries only have mild TBI,[2] which do not require hospital admission for observation or any intervention. The present standard of care for patients with traumatic intracranial hemorrhage (ICH) is neurosurgical consultation (NC) or transfer of the patient to trauma centers where neurosurgical services are available.

Currently, the neurosurgical workforce in the United States is overburdened.[3] Concomitantly, 25% of the country's population lives in a county without even one neurosurgeon.[4] Multiple studies have shown that there is a crucial role for the acute care surgeon in the initial management of TBI. Moreover, studies have also demonstrated that routine head computed tomography (CT) scan in not required in TBI patient until unless neurologic deterioration is observed.[5] To limit injudicious use of health resources i.e. NC and repeat head CT (RHCT) scan as well as to define the role of acute care surgeon in management of nonoperative TBI, at our institution, we have developed and validated brain injury guidelines (BIG) for the management of TBI patients with an ICH. We demonstrated that there is no difference in patient outcomes among patients managed by acute care surgeons based on BIG guidelines as compared with a similar cohort of patients managed by neurosurgeons, however, significant decrease in RHCT scan was observed.[6] A long-term (5 years) analysis of our data also demonstrated that there was no difference in outcomes. Though, a significant decrease in NC, RHCT scans, and hospital costs was recorded.[7] Considering high incidence of mild TBI in pediatric population multiple studies have been performed defining the need of initial head CT scan however, no guidelines exist to define the need of NC and RHCT scan

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Quick Shot Presentation at 30th Annual Scientific Assembly, Eastern Association for The Surgery of Trauma, January 12th, 2017, Hollywood, Florida.

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Transfer Patients

Implementation of the BIG at a level 3 TC reduced secondary overtriage.[7]

Preliminary data at a level 1 TC suggests transfer patients in BIG 1 have the same outcomes as non-transfer BIG 1 patients:

- No Neurosurgical interventions.
- Low radiographic progression rate (8%).
- Most discharge home.

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Conclusions

Most mild TBIs do not require intervention or prolonged observation.

Safety and efficacy of the BIG and mBIG seem robust across different practice environments.

Significant potential to change practice patterns and decrease resource utilization.

Still more work to be done!

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Thank You

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