

Mild & Moderate Traumatic Brain Injury

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Who ^{REALLY} needs a repeat Head
CT scan in TBI?

Traumatic Brain Injury

- 1.7 million head injuries per year (USA)
- 1.4 million ED visits
- 275,000 patients hospitalized
- 53,000 deaths annually

Traumatic Brain Injury

- Most at risk groups
 - 0-4 years
 - 15-19 years
 - Over 65 years old
- Estimated DIRECT costs over \$76 billion

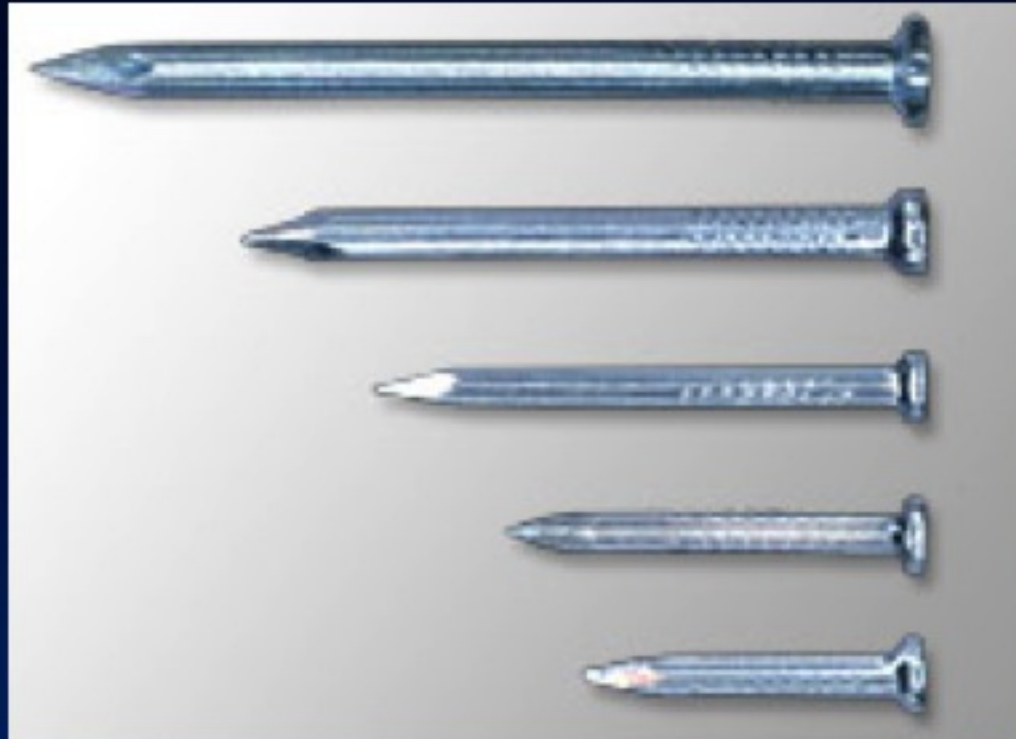
The problem

- If the only tool that you have is a hammer....



The problem

- Then everything will look like a nail....



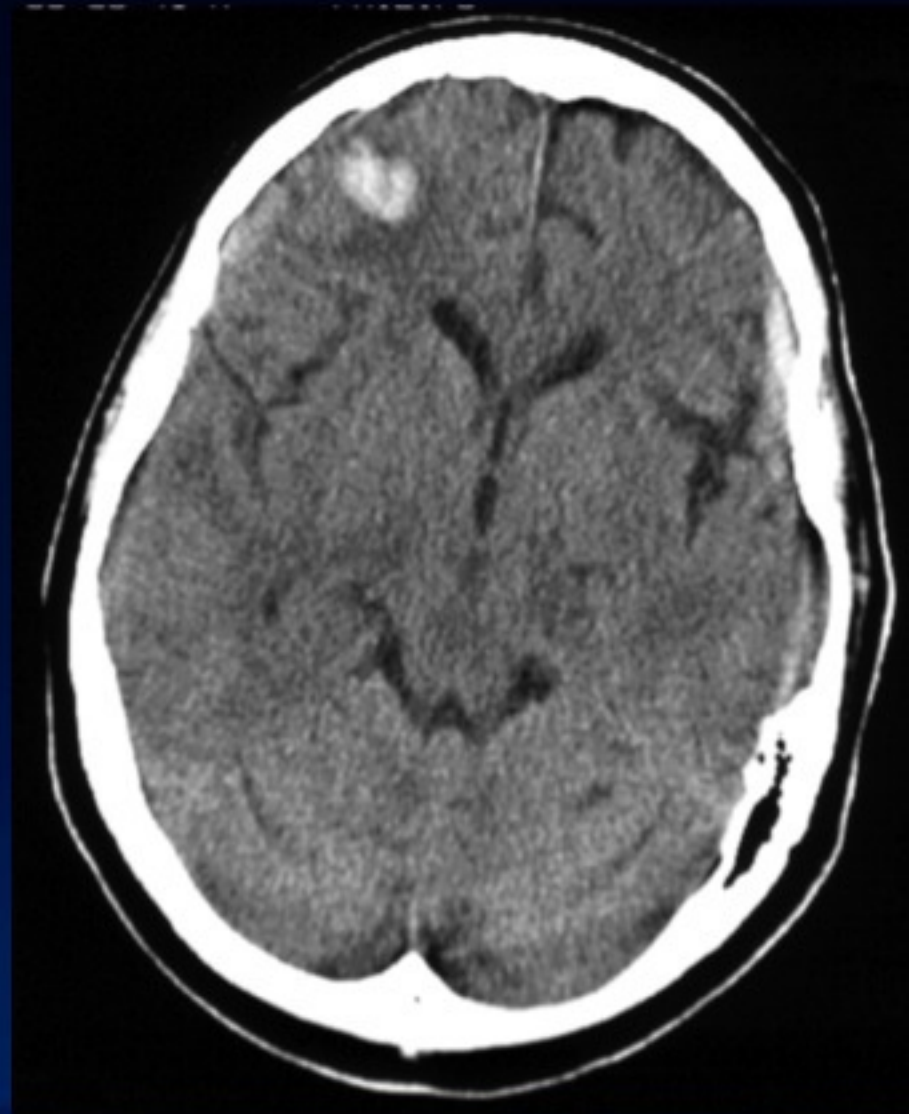
The problem

- The Neurosurgeon's hammer..... CT scanner



The problem

- The nail



The consultation

- Typical Neurosurgical Consult
 - Patient seen by junior doctor
 - Discussed with senior
 - +/- review of CT scan
 - Repeat CT scan ordered for 4-6 hrs

Why do we order so many repeat CT scans?

- Previous experience
- Medicolegal
- Treatment plan not yet clear
- Inexperienced junior doctors
- Patients with severe TBI don't show changes
- Higher risk of progression for some lesions

What are the disadvantages of Repeat CT?

- Cost
- Transportation
- Irradiation
 - Risk of cancer from 1 head CT – 1 in 10,000
- Wasteful and unnecessary

Literature?

- Conflicting
- Depends on the type of lesion
- Majority of studies - little if any benefit

A Prospective Evaluation of the Value of Repeat Cranial Computed Tomography in Patients With Minimal Head Injury and an Intracranial Bleed

Ziad C. Sifri, MD, Adena T. Homnick, MPAS, Artem Vaynman, MD, Robert Lavery, MA, MICP, Wesley Liao, BA, Alicia Mohr, MD, Carl J. Hauser, MD, Allen Manniker, MD, and David Livingston, MD

- 161 patients with minor TBI
- 130 had repeat CT scan

- 99 patients had normal neuro exam
 - Repeat CT scan
 - Showed NO lesions requiring intervention

The Role of Early Follow-Up Computed Tomography Imaging in the Management of Traumatic Brain Injury Patients With Intracranial Hemorrhage

Justin S. Smith, MD, PhD, Edward F. Chang, MD, Guy Rosenthal, MD, Michele Meeker, RN, BSN, Cornelia von Koch, MD, PhD, Geoffrey T. Manley, MD, PhD, and Martin C. Holland, MD

- 116 patients with TBI
 - 42% showed progression between CTs
- Only patients with clinical change
 - Needed an operation
- No patient required intervention WITHOUT a change in exam

Indications for Routine Repeat Head Computed Tomography (CT) Stratified by Severity of Traumatic Brain Injury

Carlos V. R. Brown, MD, Gabriel Zada, MD, Ali Salim, MD, Kenji Inaba, MD, Georgios Kasotakis, MD, Pantelis Hadjizacharia, MD, Demetrios Demetriades, MD, and Peter Rhee, MD, MPH

- 274 patients
- 163 patients underwent 241 repeat scans
 - 43% unchanged
 - 22% better
 - 35% worse

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Table 1 Results of the 241 CT Scans Obtained Routinely or for Neurologic Change, Stratified by Severity of Head Injury

Head Injury	Neurologic Change	Intervention	Routine	Intervention
Mild (n = 142)	15 Scans	5 (33%)	80 Scans	0 (0%)
Moderate (n = 42)	9 Scans	3 (33%)	34 Scans	0 (0%)
Severe (n = 90)	21 Scans	9 (43%)	82 Scans	2 (2%)
Total (n = 274)	45 Scans	17 (38%)	196 Scans	2 (1%)

Utility of routine follow-up head CT scanning after mild traumatic brain injury: a systematic review of the literature

Martina Stippler,¹ Carl Smith,² A Robb McLean,² Andrew Carlson,¹ Sarah Morley,³ Cristina Murray-Krezan,⁴ Jessica Kraynik,⁵ George Kennedy²

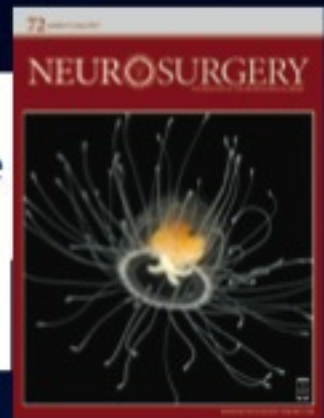
- Review of all available studies
- 1630 patients from 19 papers
- Routine CT scans
 - Showed progression in 20% of patients
- Follow-up CT – intervention in 0.7%
 - In cases with neuro changes – 43%

Background

90% of TBI is NON-OPERATIVE

How Well Do Neurosurgeons Care for Trauma Patients? A Survey of the Membership of the American Association for the Surgery of Trauma

Alex B. Valadka, M.D., Brian T. Andrews, M.D.,
M. Ross Bullock, M.D., Ph.D.



70% agree that Trauma Surgeons can take charge of Non-operative TBI

Background

*Utility of Neurosurgical Consultation for Mild
Traumatic Brain Injury*


The
American
Journal
of
Surgery

NO

DEFINITIVE GUIDELINES

*Management of Patients With Traumatic Intracranial Injury in
Hospitals Without Neurosurgical Service*

*Yoram Klein, MD, Valery Donchik, MD, Dena Jaffe, PhD, Daniel Simon, MD, Boris Kessel, MD,
Leon Levy, MD, Hanoch Kashtan, MD, and Kobi Peleg, PhD*


Acute Care
Surgery

Recent work at Arizona

- Attempt to create guidelines
 - For neurosurgical consultation
 - Repeat Head CT scans

- Retrospective study
 - 3803 patients over 3 years
 - CT scans reviewed, type of injury, anticoagulation

Recent work at Arizona

- 1232 with abnormal head CT

History and Physical Findings				
BIG score	LOC	Neuro Exam	ETOH or drugs	Anticoagulation
1 N=112	YES	NORMAL	NO	NO
2 N=330	YES	NORMAL	YES OR NO	NO
3 N=790	YES	ABNORMAL	YES OR NO	YES

BIG guidelines

CT scan Findings						
BIG score	Skull fracture	SDH	EDH	IPH/Contusion	SAH	IVH
1 N=112	NO	≤3mm	≤3mm	≤3mm single location	Trace	NO
2 N=330	SIMPLE NON-DISPLACED	3-10mm	3-10mm	3-10mm ≤2 locations	Localized	NO
3 N=790	COMPLEX DISPLACED	≥10mm	≥10mm	≥10mm multiple locations	Scattered	YES

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2.7% of patients in BIG2 had worsening of CT scans

BIG guidelines

CT scan Findings						
BIG score	Skull fracture	SDH	EDH	IPH/Contusion	SAH	IVH
1 N=112	NO	≤3mm	≤3mm	≤3mm single location	Trace	NO
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NO patients required an intervention

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ALL patients who required an intervention (13%) were in BIG3

The acute care surgery model: Managing traumatic brain injury without an inpatient neurosurgical consultation

Bellal Joseph, MD, Hassan Aziz, MD, Moutamn Sadoun, MD, Narong Kulvatunyou, MD, Andrew Tang, MD, Terence O'Keeffe, MB ChB, Julie Wynne, MD, Lynn Gries, MD, Donald J. Green, MD, Randall S. Friese, MD, and Peter Rhee, MD, Tucson, Arizona



CONCLUSION

ACS can independently care for mild TBI with ICH without obtaining a formal NC. Given the rarity of neurosurgical intervention in this subset of patients, ACS are trained and currently care for these patients. The difficulty will be setting the standard that ACS are the leading provider for patients with mild TBI even in the presence of ICH. Prospective evaluation of strict guidelines will help support this change in practice.

**NO
PROSPECTIVE
ASSESSMENT**

Prospective Study

Therapeutic plan			
BIG Score	Hospitalization	Repeat Head CT	Neurosurgical consultation
1	NO	NO	NO
2	YES	NO	NO
3	YES	YES	YES

AIM and HYPOTHESIS

- **AIM:** Validate Brain Injury Guidelines (BIG 1) for managing patients with TBI without neurosurgical consultation (NC).
- **HYPOTHESIS:** Trauma surgeons can safely manage TBI patients meeting BIG 1 criteria.

METHODS - INCLUSION

- Implemented BIG in March 2012
- IRB Approved
- Prospective cohort analysis - level 1 trauma center (1st March 2012 - 31st December 2013)
- **Inclusion:**
 - TBI with ICH on initial head CT
 - Examinable patients with normal neuro-exam
 - No anti-platelet or anti-coagulation therapy
 - ICH \leq 4 mm and No skull fracture

METHODS - EXCLUSION

- **Exclusion:**
 - Transferred from other institution
 - Unexaminable (altered mental status, intubated)
 - Abnormal neuro-exam on presentation
- **Abnormal Neuro-Exam:**
 - Altered mental status
 - Focal neurological deficits
 - Abnormal pupillary examination

STUDY POPULATION

- Post BIG1 (No-NC) matched retrospectively to patients Pre-BIG 1 (NC)
- Propensity score matching in a 1:1 ratio
 - Demographic and injury variables

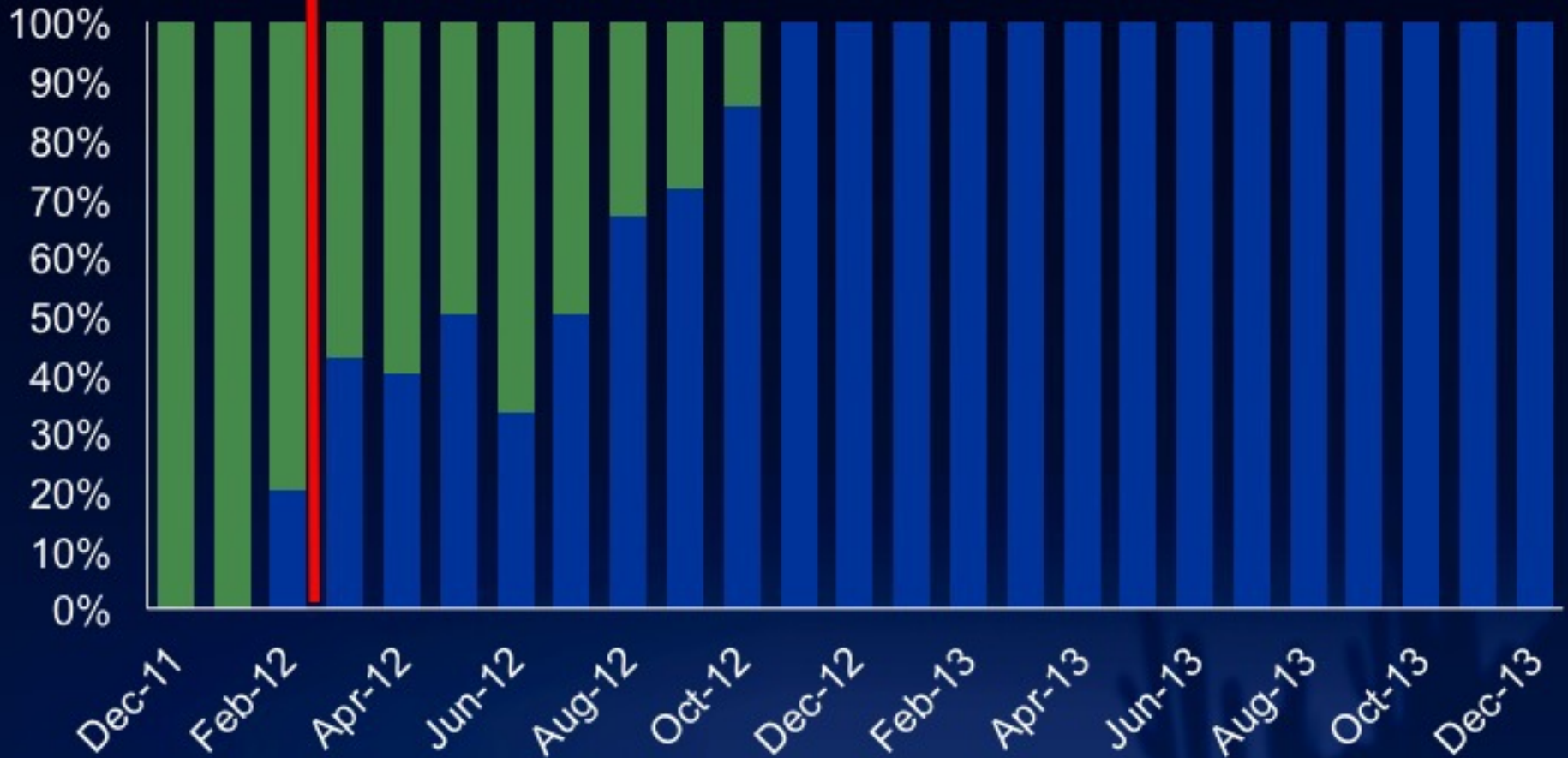
METHODS – OUTCOME

- **Primary outcome:**
 - Need for neurosurgical intervention
- **Secondary outcome:**
 - Repeat head CT scan requirement
 - Hospital and ICU admissions
 - In-hospital mortality
 - 30 day re-admission.

RESULTS – COMPLIANCE

TRAINING

IMPLEMENTATION

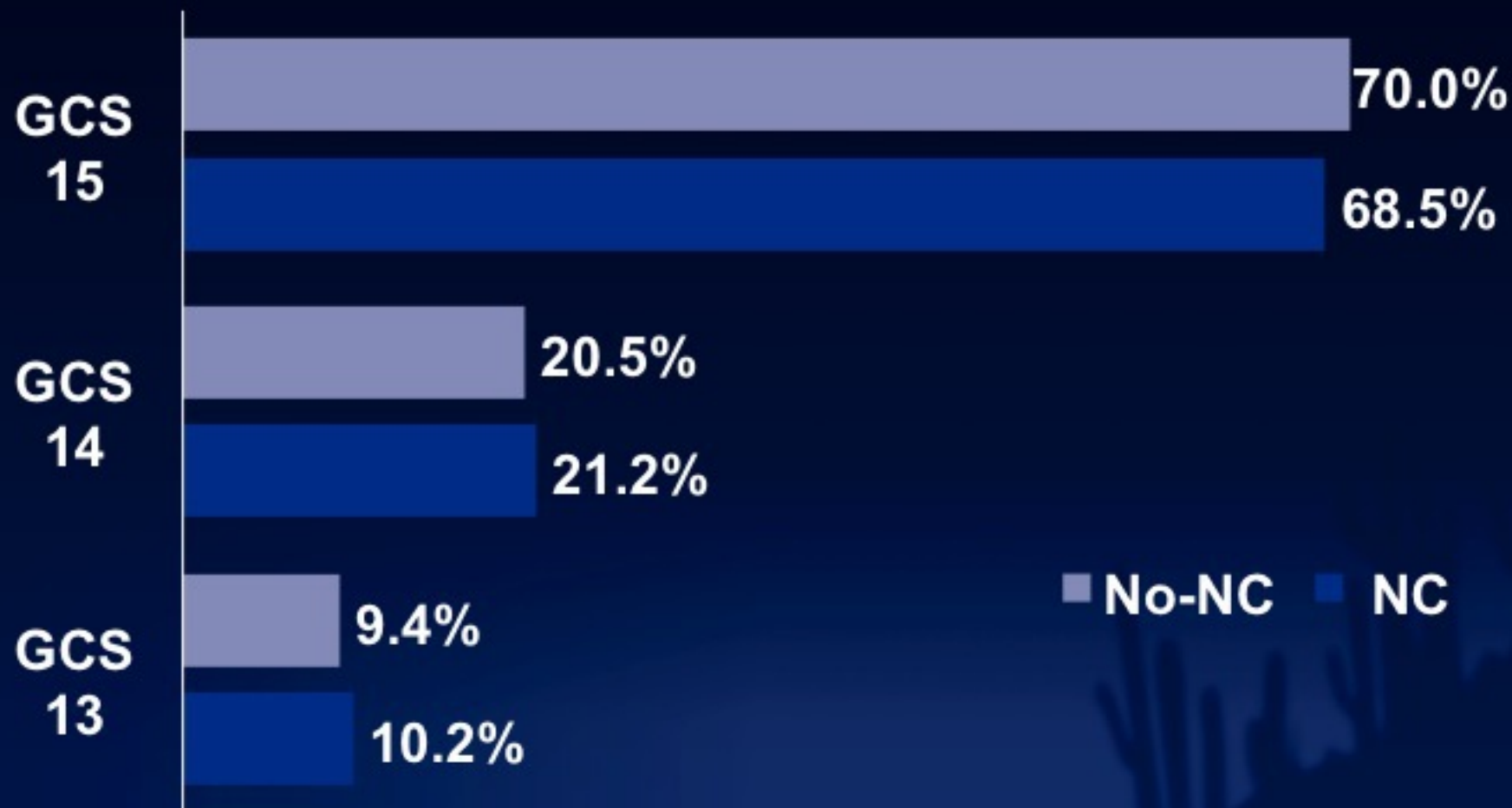


RESULTS

	No-NC (n=127)	NC (n=127)	p
Age	41.2 ± 21.6	39.4±24.8	0.71
Male	64.6%	62.2%	0.69
GCS	15 [13-15]	15 [13-15]	0.84
ED SBP	132.5 ± 28.1	136.1 ± 22.4	0.89
ED GCS	15 [13-15]	15 [13-15]	0.84
Mechanism of injury			
MVC	46.5%	42.5%	0.52
Fall	33.8%	36.2%	0.68
ISS	14 [8-16]	14 [9-17]	0.91
Head AIS	2 [2-3]	2 [2-3]	0.94

RESULTS

DISTRIBUTION of GCS



RESULTS – CT SCANS

	No-NC (n=127)	NC (n=127)	p
SDH	28.3%	30%	0.76
Size (mm)	3.1 ± 2.9	3.3 ± 3	0.62
EDH	5.5%	7.9%	0.45
Size (mm)	2.9 ± 2.5	3.1 ± 2.8	0.59
SAH	37.8%	35.4%	0.69
IPH	26.7%	24.4%	0.67
IVH	7%	9.4%	0.48

RESULTS – OUTCOMES

	No-NC (n=127)	NC (n=127)	p
RHCT	9.4%	51.2%	0.001
Progression on RHCT	1%	2.3%	0.64
Neurosurgical intervention	0%	0%	0.9
Hospital admission	56%	74%	0.02
ICU admission	6.3%	25.2%	0.01

RESULTS – NO OF RHCT



RESULTS – 30 DAY OUTCOMES

	No-NC (n=127)	NC (n=127)	p
30 day readmission	0%	0%	0.9
30 day ED visits	3.9%	4.7%	0.75
30 day RHCT	1.5%	2.3%	0.64
30 day mortality	0%	0%	0.9

RESULTS –OUTCOMES

	No-NC (n=127)	NC (n=127)	p
Length of Stay			
Hospital LOS	1.3 ± 1.1	3 ± 2.8	0.041
ICU LOS	1 ± 0.9	1.2 ± 1.1	0.85
Cost			
Hospital Cost	11,615 ± 10,291	16,238 ± 11,019	0.02
Hospital Charges	41,528 ± 26,810	48,780 ± 28,140	0.042

CONCLUSIONS

- Prospective validation of the BIG 1 guidelines
- Better clinical and hospital resource utilization
- Acute care surgeons can independently manage patients with ICH <4 mm

Special Circumstances Severe TBI

- Patients who are comatose ($GCS \leq 8$)
 - Not able to manifest clinical changes
 - Up to 50% will have progression on head CT
 - Highest likelihood for intervention
- Unknown HOW lesion itself is important
 - 6-20% of epidurals ultimately require intervention
 - Difficult to predict at initial CT

Special Circumstances Anticoagulation

- Patients on anticoagulation – repeat Head CT
 - Aspirin
 - Plavix (Clopidogrel)
 - Warfarin
 - Dabigatran (direct thrombin inhibitors)

Special Circumstances Acquired Coagulopathy

- Platelet count
 - less than 100,000
- Abnormal INR (≥ 1.3), PTT (≥ 35 secs)
 - Have all been associated with progression
 - Progression of lesion increased odds of death

ORIGINAL ARTICLE

Abnormal Coagulation Tests Are Associated With Progression
of Traumatic Intracranial Hemorrhage

Unanswered questions?

- Children
- Elderly
- Type of bleed – epi/subdural/subarachnoid
 - Size of bleed
- Very early CT scans

Who SHOULD you scan again?

- MENTAL STATUS CHANGES
- Severe TBI – unable to assess
- Anticoagulated patients
- Coagulopathic patients
- Specific lesions e.g. epidural

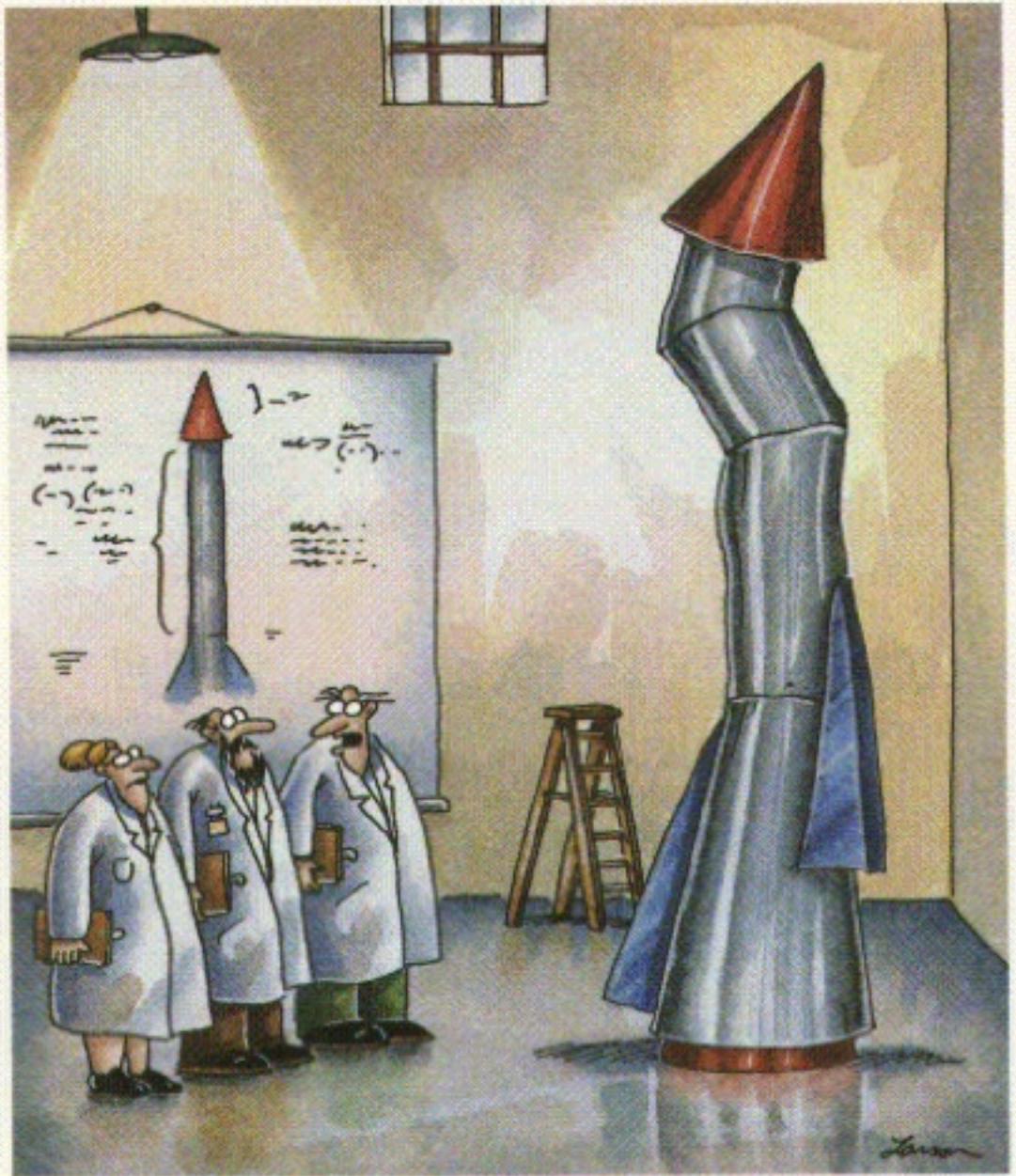
DON'T scan

- GCS 13-15
- Minor TBI
 - Small subdural
 - Minimal Subarachnoid
 - Small intraparenchymal hemorrhage

Summary

- Repeat Head CT scans not often indicated
- Clinical exam changes are most important
- Special circumstances ARE important
- Need multicenter validation of “BIG”

Questions ?



"It's time we face reality, my friends. ... We're not exactly rocket scientists."