Northwest States Trauma Conference

Top Ten papers 2013 -2014

Papers 5 through 1

Richard J Mullins, MD

5 ACCURATELY MEASURING THE OUTCOME OF INJURED PATIENTS REQUIRE LONG TEM FOLLOW UP.

From 9-1-1 call to death: Evaluating traumatic deaths in seven regions for early recognigition of high-risk patients Dean D, Wetzel B White N Newgard CD and the WESTRN investigators. *J Trauma Acute Care Surg.* 2014; 76:846-853.

Are all death recorded equally? The impact of hospice care on risk-adjusted mortality. Kozar RA, Holcomb JB, Xiong W, Nathers AB. *J Trauma Acute Care Surg.* 2014; 76: 634-41.

Evaluating the time points for measuring recovery after major trauma in adults. Gabbe BJ, Biostat GD, Simpson PM et al. *Ann Surg* 2013; 257: 166-172.

4 DISTRACTED DRIVERS AND RISK OF CRASH.

Distracted driving and risk of road crashes among novice and experienced drivers. Klauer SG, Guo F, Simons-Morton BG, Ouimet MC, Lee SE, Dingus TA. *N Eng J Med* 2014: 370: 54-8.

3 ROUTINE REPEAT BRAIN CT IN GCS 14-15 IS NOT NECESSARY AND CARRIES RISK ESPECIALLY IN CHILDREN

The value of scheduled repeat cranial computed tomography after mild head injury: single center series and meta-analysis. Almenawer SA, Borza I, Yarascavitch B, Sne N, et al. *Neurosurgery* 2013; 72: 56-62

Neurological outcome of minimal head injury patients managed with or without a routine repeat head computed tomographys Nayak NV, Medina B, Patel K et al. *J Trauma Acuter Care Surg.* 2013; 75:273-78.

Routine repeat brain computed tomography in all children with mild traumatic brain injury may result in unnecessary radiation exposure. Howe, Jarett; Fitzpatrick, Colleen M.; LaKam, Dana Rachel et al. *J Trauma Acute Care Surg.* 2014; 76(2):292-296.

2 TO TRACH OR NOT TO TRACH THAT IS THE QUESTION

Effect of early vs late tracheostomy placement in survival of patients receiving mechanical ventilation. Young D, Harrison DA, Cuthbertson, MD, Rowan K D Phil. *JAMA* 2012; 309: 2121-2129

Safety of bedside percutaneous tracheostomy in the critically ill: evaluation of more than 3,000 procedures. Dennis BM, Eckert MJ Gunter OL et al. *J Am Coll Surg* 2013; 216, 858-867

Tracheostomy timing in traumatic brain injury: a propensity-matched cohort study. Alali AS, Scales DC, Fowler RA et al. *J Trauma Acute Care Surg* 2014; 76:70-78.

1 GROWING CONSENSUS AMONG EXPERTS ON DIAGNOSIS AND MANAGEMENT OF BLUNT CEREBRALVASCULAR INJURIES.

Blunt cerebrovascular injuries: anatomic and pathologic heterogeneity create management enigmas. Fabian TC. *J Amer Coll Surg.* 2013. 216(5):873-85.

Functional outcomes following blunt cerebrovascular injury. DiCocco JM. Fabian TC. Emmett KP. Magnotti LJ. Zarzaur BL. Khan N. Kelly JM. Croce MA. *J Taumar Acute Care Surg*. 2013; 74(4):955-60, 2013 Apr.

Blunt cerebrovascular injury screening with 64-channel multidetector computed tomography: more slices finally cut it. Paulus EM, Fabian TC, Savage SA et al. *J Trauma Acute Care Surg*. 2014; 76: 279-85.

Annotated References

5 ACCURATELY MEASURING THE OUTCOME OF INJURED PATIENTS REQUIRE LONG TEM FOLLOW UP.

From 9-1-1 call to death: Evaluating traumatic deaths in seven regions for early recognigition of high-risk patients Dean D, Wetzel B White N Newgard CD and the WESTRN investigators. *J Trauma Acute Care Surg.* 2014; 76:846-853.

These investigators collected and analyzed date from 94 Emergency Medical Services (EMS) agencies transporting trauma patients to 122 hospitals in severe Western US regions from 2006 to 2008. The population include all of those injured patients to whom EMS units responded based upon a 9-1-1 call, and who subsequently died. The 3,358 decedents were divided into three groups; 37% died in the field (before hospital arrival), 31% survived transport to the hospital but died 2 days of their hospital arrival and the remaining 32% who died late during their hospitalization. These data suggest that a substantial proportion of deaths occur in patients with a fatal injury, and the best intervention would injury prevention programs.

The investigators focused on those 2133 injured patients who were transported to hospitals, and died. The investigator choose to designate 29% of these patients as "talk-and-die" as being patient who had a GCS of $\geq$ 13, were not intubated and had not had a cardiac arrest prior to hospital arrival. This group of patients were transported by EMS to Level I or II trauma centers n =292/612 48%, and non-trauma hospitals n =320/612 52%; thus a majority of the talk-and-die patients were miss-triaged. Among the 1150 decedent patients who did not meet the criteria for talk-and-die, and who the EMS crews identified as seriously injured, 77% died at trauma centers leaving 23% who died at non-trauma centers.

In summary the paper from Dean et al indicate that there is a trimodal distribution of death following injury and a call to 9-1-1. The late deaths may be improved by a high proportion of these patients who were transported to non-trauma centers being admitted to trauma centers. Dean and colleagues identify the subset of injured patients who fatal outcome is related to miss tirage of them because they had a high GCS and were ambulatory. The authors describe these occult risk patients as "elderly, were injured by ground-level falls, had relatively normal initial vital signs, and frequently had complaint related to extremity injuries." The authors propose that deaths could be prevented by improved triage guidelines that led to a higher proportion of patients being transported to trauma centers, where the authors assume some deaths may have been prevented.

Are all death recorded equally? The impact of hospice care on risk-adjusted mortality. Kozar RA, Holcomb JB, Xiong W, Nathers AB. *J Trauma Acute Care Surg.* 2014; 76: 634-41.

The authors of this paper analyzed the trauma quality improvement data base, which contains data from 167 trauma centers on 126,259 injured hospitalized patients. The authors report that while 8,862 patients were designated at hospital deaths, there were another746 designated as discharged alive whose hospital discharge disposition was to hospice. If these hospice deaths are added to the the other deaths, the authors examined how recalculating an individual hospitals ratio of observed to expected deaths would change. The authors hypothesized that some trauma centers considered to have significantly lower, or higher, observed to expected death rates would have their outcome status change if these "survivors" discharged to hospice properly designated at death. There was a wide range among the hospitals of the proportion of the deaths that were attributed to after discharge because the patients were discharged to hospice; 40% had hospitals had no hospice discharges, and among those with hospice discharges most had hospice death percentage of 3 to 35%.

In the table below, the authors summarize the influence that recalculating the observed to expected death rates on ranking of hospital performance.

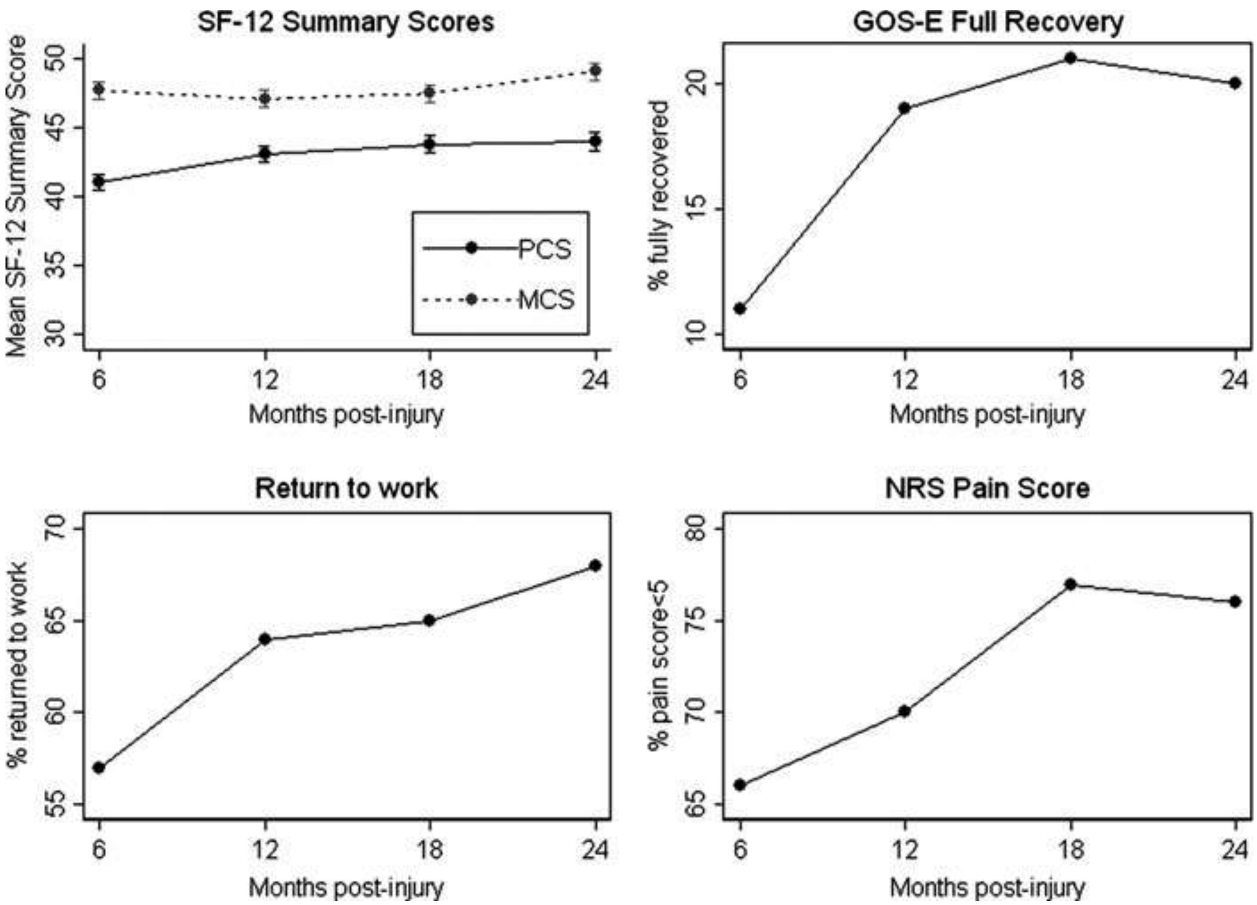
Initial hospital status	Total number of centers	Number up staged to superior	Number changed to average	Number changed to inferior
Superior survival	23		8	
Average survival	120	7		10
Inferior survival	24		9	
For elderly subset				
Superior survival	12		6	
Average survival	135	7		19
Inferior survival	20		11	

The authors concluded that given the growing emphasis on categorizing trauma center performance based upon the observed to expected survival, and given the wide variation in trauma center practice to transfer patients alive to hospice for comfort care, the authors are concerned there will be distortions in the evaluation of a trauma center's performance unless the hospice discharge is categorized as a death. In addition the authors propose "better methods to capture preexisting conditions and preferences at the end of life are needed to accurately risk-adjust for mortality in these patients."

Evaluating the time points for measuring recovery after major trauma in adults. Gabbe BJ, Biostat GD, Simpson PM et al. *Ann Surg* 2013; 257: 166-172.

These investigators from Australia report their observations on the outcome of 662 major trauma patients treated in two Level 1 trauma centers. Because of universal health care in Australia, the investigators were able to evaluate the long term recovery of 93% of the patients. The patients were seriously injured as determined by the criteria that over 90% had an ISS of greater than 15, and 53% had sustained a serious traumatic brain injury (AIS Brain 3-6). The investigators attempted to evaluate recovery at 6, 12, 18 and 24 months after discharge. The investigators evaluated recovery using four measures; SF-12 summary scores were relatively stable from 6 to 24 months, the Glascow Outcome Score showed substantial recovery and improvement from 6 to 18 months, the return to work metric show continuous improvement to 67% by 24 months post injury and numerical rating score for pain showed improvement to 18 months when it stabilized.

The authors conclusion from this study is that "recovery" from major trauma is not a single measure, but different metrics with rates of recovery changing over two years at different rates. The implication of this study is that if an intervention during the acute care phase treating a patient with major trauma is to be realistically evaluated, it is incumbent on the investigator to identify a relevant outcome variable expected from that intervention (for example less long term pain) and then measure that outcome variable over an appropriate time period to achieve a realistic measure of effectiveness.



Babbe et al interpret the above graphs to show “different patterns of recovery were evident for each outcome, and there was a variation in the rate of recovery from some subgroups.”

4 DISTRACTED DRIVERS AND RISK OF CRASH

Distracted driving and risk of road crashes among novice and experienced drivers. Klauer SG, Guo F, Simons-Morton BG, Ouimet MC, Lee SE, Dingus TA. *N Eng J Med* 2014: 370: 54-8.

The U.S. Department of Transportation reported that in 2012 3,328 people were killed in distracted driver crashes. Distracted drivers were those engaged in any activity that diverts their attention away from primarily task of driving. By far the most serious distraction is text messaging on a cell phone while driving. The paper by Klauer and colleagues highlights that younger drivers are at greater risk from injury in crashes associated with distracted driving. “Drivers who are 15-20 years of age constitute 6.4% of all drivers, but they account for 10% of all motor vehicle traffic deaths, and 14% of all police-reported crashes resulting in injuries.” The problem of driving and simultaneously using a cell phone has increased in the past decade. The National Highway Traffic Safety Administration estimated in 2010 that nine percent of drivers in one observational study during daylight hours in 2010 were observed to be dialing, talking or even texting on a cell phone

The authors of this study sought to evaluate the role of distracted driving in a range of adverse events that occurred to drivers. The methods the authors used was to recruit drivers who gave permission to have cameras, accelerometers and other sensors installed in cars, and record events. Two groups were studied. 42 newly licensed drivers (ages 16-17) and 109 adults (ages 18-72) with more driving experience (a mean driving experience of 20 +/- 14 years). Data was collected for 18 months from the new drivers and for 12 months from the more experienced drivers.

“Highly trained analysts” evaluated the data collected. Crash was defined as contact of the vehicle with an object for which the driver was at fault. “None of the crashes involved a death or serious injury”. A near crash was defined as a sudden physical maneuver to avoid a crash for which the driver was at fault. The analysts recorded in new driver group 31 crashes and 136 near-crashes, and in the experienced driver group 42 crashes and 476 near-crashes. The authors defined ten secondary tasks that drivers might engage in while driving; these included talking, dialing, reaching for cell phone, adjusting auto heating ventilation, AC, eating or drinking or looking at roadside objects.

For novice drivers involved in a crash or near crash, the odds ratio of activities being observed are presented in this table.

Event	Odds ratio	95% Confidence interval
None of the events	1.0	NA
Dialing cell phone	8.32	2.83 - 24.42
Reaching for cell phone	7.05	2.64 – 18.83
Send/receiving text messages	3.87	1.62 – 9.25
Reach for object other than cell	8.00	3.67 – 17.50
Looking at roadside object	3.90	1.72 – 8.81
Eating	2.99	1.30 – 6.91

For experienced drivers involved in a crash or near-crash, the odds ratio of activities being observed are presented in this table, and reveal a different pattern of risk factors.

Event	Odds ratio	95% confidence interval
None of the events	1.0	NA
Dialing cell phone	2.49	1.38 – 4.54
Reaching for cell phone	Not significant	
Reach for objects other than cell	Not significant	
Looking as roadside object	Not significant	
Eating	Not significant	

The authors’ conclusions are that Novice drivers are more susceptible than experienced drivers to be distracted to the point of having a crash by a wide range of activities. This suggests that novice drivers should be encouraged to avoid any distractions in the initial period of driving experience. For both groups cell phone use was a risk factor associated with experiencing a crash.

3 ROUTINE REPEAT BRAIN CT IN GCS 14-15 IS NOT NECESSARY AND CARRIES RISK ESPECIALLY IN CHILDREN

The value of scheduled repeat cranial computed tomography after mild head injury: single center series and meta-analysis. Almenawer SA, Borza I, Yarascavitch B, Sne N, et al. *Neurosurgery* 2013; 72: 56-62

For thirty years, neurosurgeons have recommended a routine follow-up CT of the brain be obtained within 24 hours in all patients who sustain blunt trauma to their head and meet the criteria of having a minimal traumatic brain injury. Minimal traumatic brain injury is defined as having on arrival at the hospital's emergency department a GCS of 13, 14 or 15, and having on their first brain CT a "small" brain injury, defined as findings consistent with acute hemorrhage but not sufficient hemorrhage volume to produce a large mass lesion. In addition to obtaining a second CT, the standard of care for minimal traumatic brain injured patients in most trauma centers also included always admitting these patients to an intensive care unit for frequent neurological examinations. The rationale for this policy is that deterioration in neurological function would be promptly identified and neurosurgical interventions would be immediately implemented and this timeliness would result in preservation of brain function. However, in recent publications, neurosurgeons have questioned the mandated practices of ICU admission and mandatory follow up brain CT, observing that deterioration in neurological function of this group of patients rarely occurs, and findings on follow up CT rarely change management. Two factors may be incentives driving neurosurgeons to reconsider routine management protocols; the shortage of ICU beds and the risk that exposure to radiation during brain CTs is potentially carcinogenic.

Almenawer and colleagues conduced a two phase study to evaluate the practice of routine follow up CT. They analyzed the clinical course of 445 of their patients with minimal trauma brain injury who had been routinely admitted to an ICU and all had follow up brain CT within 24 hours. Almenawer and colleagues also conducted a review of the published literature, and assembled data from 15 studies published in the medical literature that provided information on the clinical course of 2248 patients with minimal traumatic brain injury. These authors focused on determining how many of these patients deteriorated and had a management change, i.e. neurosurgical procedure, infusion of drugs, and what prompted the management change. Almenawer summarized their data in the table below.

	Total patient	Patients needed management changes	Changes prompted by neurological changes	Changes prompted by second CT findings
Almenawer's patients	445	25	23	2
Published in 15 manuscripts	2248	70	55	15

The authors concluded that less than 5% of patients with minimal traumatic brain injury needed interventions, and among those who did require management changed, in the majority their "deterioration" in status following admission was evident by a neurological examination. The authors concluded that their experience, and the published literature, confirms that it is unnecessary to schedule a repeat CT scan after minimal traumatic brain injury when the patients are neurologically improving to a GCS of 15. Almenawer and colleagues emphasized that "simple yet important neurological examination is the predictive factor" best and most practical for guiding follow up evalution of this cohort of patients.

Neurological outcome of minimal head injury patients managed with or without a routine repeat head computed tomographys Nayak NV, Medina B, Patel K et al. *J Trauma Acuter Care Surg.* 2013; 75:273-78.

In a study of patients categorized as having minimal head injuries defined as "loss of consciousness and /or retrograde amnesia with a Glasgow Coma Scale of more than 12". In this study, a cohort of 360 patients who met the criteria of minimal brain injury had on their initial brain CT a range of abnormalities; 64% had subarachnoid hemorrhage, 57% had intraparentchymal hemorrhage, and 40% had a subdural. This group of patients were not intubated (patients intubated for other reasons than TBI were not included in this study). Characteristics of the patients in this study was a mean age of 41, 90% admission GCS of 15, with GCS of 14 or 13 in the remaining patients. The patients sustained blunt trauma, including 27% motor vehicle related crashes, 27% falls and 33% assaults.

The author's policy at their trauma center was a variance with the standard of care in most trauma centers; these neurosurgeons did not always obtain a routine follow up head CT on patients whose GCS was 15. The decision to obtain routine follow up or second brain CT was a decision determined by the discretion of the faculty neurosurgeon. Thus in their cohort of 321 patients Nayak et al were able to compare the clinical course of 142 patients who had a routine follow up brain CT to 179 patients managed without the second brain CT. Patients in both groups had satisfactory clinical courses, and none of the patients required neurosurgical intervention, and 97% were discharge home, all had a discharge GCS of 15. The authors report an improved outcome occurred in the none routine CT cohort because they had a shorter length of stay (2.2 +/- 2 days in patients who did not have a repeat, versus 4.3 +/- 6.0 days in those who did have a repeat.)

While these patients did not have a significant deterioration in neurological function, it is important to point out that 13% of cases who had routine follow brain CT had “worse findings on CT”, including an increase in size of the previous hemorrhages or appearance of new hemorrhages. However the authors report that none of these patients required a management change or neurosurgical intervention. The majority of findings on repeat CT showed no change (56%) or improved (30%). Among those with “worse findings” none had neurological deterioration and no patient required neurosurgical intervention. The authors emphasize in the discussion several caveats. They excluded patients who are taking anticoagulants or had an acquired coagulopathy. They admitted patients with minimal brain injury to a special intermediate care unit where routine neurological checks were dependably performed; in fact 12 of their patients initially categorized as having minimal traumatic brain injury were noted to have neurological deterioration within the first 12 hours of admission to the observation unit, and their follow up brain CT was considered not scheduled by signaled by neurological deterioration. Five of these patients who had deterioration in neurological examination had neurosurgical intervention.

In summary, Navak et al concluded the results of this review are evidence in support of that their policy was justified to stop performing routine follow up brain CT in patients who have minor traumatic brain injury but do not demonstrate neurological deterioration. In this large cohort the “vast majority of patients did well, were discharged home” with those who did not have the second brain CT benefiting by shorter length of stay and less radiation exposure. The authors of this study advocate that serial neurological examination is the preferred method for evaluating patients admitted with minimal traumatic brain injury.

Routine repeat brain computed tomography in all children with mild traumatic brain injury may result in unnecessary radiation exposure. Howe, Jarett; Fitzpatrick, Colleen M.; LaKam, Dana Rachel et al. *J Trauma Acute Care Surg.* 2014; 76(2):292-296.

In this paper Howe and colleagues report a cohort of children who had a minimal traumatic brain injury, high GCS, and brain hemorrhage on initial CT. As in adults the majority of patients who had routine follow up second brain CT did not show a change. However the authors warn that one subset of patients with minimal traumatic brain injury did show an dangerous deterioration based upon second CT findings; that was children with epidural hematomas. Two of the five children with an enlarging epidural picked up on routine follow up CT had surgery. Two points deserve emphasis from this study; the children whose epidurals increased had a GCS of 14 to 15 and by other criteria had not deteriorated; thus the routine follow up may have picked up these two expanding mass lesions before there was a catastrophic change, and second the only lesion that seemed to be a problem was an epidural.

In conclusion these studies suggest that a substantial proportion of patients with minimal traumatic brain injury who are admitted for serial neurological examination do not benefit from routine second brain CT, and may be put at risk for later health problems from the second dose of radiation. It will likely be a manner of time before most trauma centers will endorse a policy of selective follow up brain CT in patients with minimal traumatic brain injury. Furthermore, it may be a matter of time before patients seen in remote rural hospitals with minimal traumatic brain injury will be managed locally without mandatory transfer to the level 1 trauma center.

2 TO TRACH OR NOT TO TRACH THAT IS THE QUESTION

Effect of early vs late tracheostomy placement in survival of patients receiving mechanical ventilation. Young D, Harrison DA, Cuthbertson, MD, Rowan K D Phil. *JAMA* 2012; 309: 2121-2129

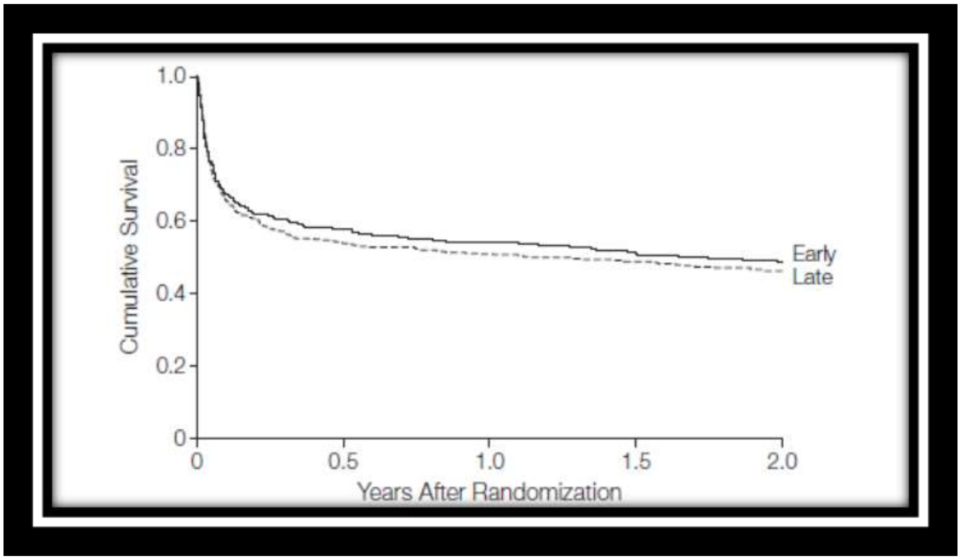
Young and colleagues in England conducted a tracheostomy study in a wide range of ICU patients with an oral endotracheal tube; the authors set out to determine if a policy of performing an early-defined as ~ 5 days-tracheostomy would have a measureable benefit for patients compared to waiting about ten days to see if the patient could be extubated. This was a robustly conducted, multicenter randomized control trial of adult patients treated in 72 intensive care units in the United Kingdom. The study was conducted between 2004 and 2011. Patients were recruited into the randomization if they had been mechanically ventilated for less than 4 days, and the medical team providing care “guessed” that they would likely need more than 7 days of mechanical ventilation. Patients agree to be randomized to either an early tracheostomy (within 1-2 days of randomization) or late tracheostomy (after a wait of 10 days, and then only if still mechanically ventilated). The randomization process was successful in that the two groups had a similar baseline characteristics: average age 64, 58% were male, 79% were categorized as medical patients, and the most common principle clinical syndrome was pulmonary failure (69%) including pneumonia, aspiration, and ARDS associated with sepsis, pancreatitis and other systemic inflammatory response. Thus for the trauma surgeon wondering what to do with their patients, the patient profile is this study is a limitation.

The patients were managed differently according to the protocol.

Among 455 patients assigned to early tracheostomy group, 92% received an early tracheostmy, and they had an “all-cause mortality rate at 30 days after randomization” of 30.8% (95% CI 26.7-35.2).

Among the 454 patients assigned to late tracheostomy, 45% received a trach and they had an “all-cause mortality rate at 30 days after randomization” of 31.5% (95% CI 27.73-35.9).

Not just the early but also the two year mortality was not different (~52%). The majority (89%) of patients in this study who had a tracheostomy, whether early or late, had a percutaneous dilator assisted bedside tracheostomy. The authors report that the procedure had a 6.3% complications rate, most commonly bleeding, but no deaths.



Additional outcome measures evaluated whether early tracheostomy changed the duration and intensity of ICU care. There was no difference between the two groups in the critical care unit length of stay (~13 days). There was a difference in the two groups in the amount and duration of sedation medication administration. "In survivors at 30 days after randomization the median number of days on which any sedatives were received was 5 (Interquartile range 3-9) days in the early group and 8 (interquartile range 4-12)days in the late group (P,0.01)." Thus, the early tracheostomy group did appear to need less sedation with a tracheostomy tube in their neck rather than an endotracheal tube through their mouth. Young and colleagues concluded this reduction in sedation use was "modest" and because the duration of mechanical ventilation did not change duration of respiratory support.

The authors conclude that because early tracheostomy was not associated with improved outcome. An additional conclusion is predicting duration of need for mechanical ventilation is difficult. Specifically the authors determined that those intubated patients whom the medical team guessed were likely to need 7 more days, in fact 45% of the patient could be extubated and not need a tracheostomy group. The authors emphasize that part of the problem is identifying within the first few days those who are intubated and will need prolonged ventilation. In summary the authors concluded that given there was no measurable benefit from the early tracheostomy at about 4-5 days, best practice is to wait for about 10 days of mechanical ventilation through an oral endotracheal tube before considering performing a tracheostomy. This recommendation should be framed by the fact that most of the patients in this study were medical patients whose primary admission diagnosis was respiratory failure. The authors add in their concluding statement, that if an "accurate prediction rule for an individual patient's length of need for ventilation can be developed" the role of early tracheostomy in those who will need the prolonged ventilation should be re-examined in new studies.

Safety of bedside percutaneous tracheostomy in the critically ill: evaluation of more than 3,000 procedures. Dennis BM, Eckert MJ Gunter OL et al. *J Am Coll Surg* 2013; 216, 858-867

Dennis and colleagues reported one of the largest published series of 3,162 percutaneous dilational tracheostomy procedures at the bedside in the ICU, performed on critical ill patients over the ten year period. The authors report a very low complication rate of 12/3162 (0.38%), although they inform the reader that five deaths occurred that were linked to a complication of the tracheostomy procedure. The authors further categorized the complications; early major complications include airway loss (cannulation of a false passage) and one bleeding event. Intermediate major complications include 2 episodes of tube displacement or occlusion. Late complications were five cases of clinically significant tracheal stenosis. The authors emphasize in their conclusion that they have developed a specific protocol for performing the procedure which includes routine participation in the procedure of a nurse who is experienced and assures the procedure performed by trainees is according to a strict protocol.

Tracheostomy timing in traumatic brain injury: a propensity-matched cohort study. Alali AS, Scales DC, Fowler RA et al. *J Trauma Acute Care Surg* 2014; 76:70-78.

The authors set out to determine if there was evidence of early tracheostomy in patients with traumatic brain injury having an influence on outcome. The authors elected to study patients with isolated traumatic brain injury because they wanted their analysis of tracheostomy influence to be focused primarily on whether the definitive airway of a tracheostomy benefited seriously brain injured.

The study was observational and used data from 135 trauma centers that submitted in the years 2009-2011 to a quality improvement data base maintained by the American College of Surgeons (Trauma Quality Improvement Program) information on treatments and outcome of injured patients treated in designated trauma centers. For the purpose of their analysis the authors arbitrarily divided the patients who had a tracheostomy based upon the ICU LOS before the tracheostomy was performed. The early tracheostomy group had the procedure in less than 8 days of admission to ICU, and the late tracheostomy group had the procedure in 8 or more days.

Because the patients who had an early tracheostomy may be substantially different than those who had a late tracheostomy the investigators used a statistical technique called propensity-matching, and developed a study group of ET (873) and LT (938). Their baseline characteristics showed little differences, indicating the propensity score manipulation achieved the goal.

Baseline characteristic	Early Trach. N= 571	Late Trach. N+571
Age, median	51	52
Preexisting COPD / smoker	6.7% / 10.9%	6.7%/ 10.9%
Head AIS Score: 4 or 5	93%	93%
Admission GCS, median	6 (IQR 3-11)	6 (IQR 3-12)
Craniotomy	36.1%	35.7%
Days to tracheostomy	6 (IQR 4-7)	12 (IQR 10 – 15)

Three outcomes of interest were evaluated; survival and use of resources. These were evaluated using risk adjusted propensity models, and the ventilator, ICU and Hospital length of stay was shorter in those who had a tracheostomy.

Outcome	Early Tracheostomy	Late Tracheostomy
Ventilator, median days	10 (IQR 7-15)	16 (IQR 12-21) *P* <.0001
ICU, median days	13 (IQR 10-18)	18 (IQR 15 – 25) *P* <.0001
Hospital LOS, median days	20 (IQR 15-29)	27 (IQR 20-38) *P* <.0001
Pneumonia %	41.3%	53% *P* <.001
Mortality %	8.4%	6.8% NS

In additional analysis of subsets of the population, the investigators found that the following groups of patients benefitted from early tracheosotomy; Under age 65 as much as over age 65, and by type of brain injury subdural, intra-cerebral mass lesion, subarachnoid hemorrhage, but not epidural hematoma patients.

In conclusion, the authors have provided a sophisticated analysis of patients with isolated TBI, who were treated at designated Level 1 and 2 trauma centers, and they provided evidence that among those who had a tracheostomy, early timing of the procedure (~6 days) led to superior outcomes compared to those who had the tracheostomy at ~12 days. The authors emphasize that their analysis does not help decide who should have a tracheostomy, versus a trial of weaning to extubate, because patients who had that mode of treatment were not included in the data. In summary this study adds to the debate regarding use of tracheostomy, and indicates that in patients who have isolated TBI and who will need a tracheostomy, they best have the procedure early.

The role of tracheostomy use in TBI patients is not identical to the role that procedure has in the patient with severe respiratory failure who needs sustained mechanical ventilation during a period of slowly being weaned from the ventilator. In the TBI patients, the tracheostomy enables safe less traumatic (then through the nose) suctioning of a patient who with neurological impairment does not follow commands. Patients fail extubation in some circumstances because of airway edema and have an obstructed airway; in those patients a tracheostomy enable the patient's larynx and subglottic trachea to recover without being continually traumatized. The variation in specific indications for tracheostomy is the reason it is complex analysis problem to evaluate whether patients benefit from an early tracheostomy.

In summary over these three studies, it can be concluded that the majority of trauma surgeons in 2014 perform percutaneous tracheostomy procedure when a tracheostomy is needed, and that in the subset of major trauma patients with a traumatic brain injured, early tracheostomy may reduce ICU length of stay. The value of tracheostomy in patients with slow recovery from pulmonary infection and chest wall trauma is less clear. Trauma surgeons need additional data on the influence that patient's preferences for a tracheostomy versus prolonged oral-endotracheal intubation.

1 GROWING CONSENSUS AMONG EXPERTS ON DIAGNOSIS AND MANAGEMENT OF BLUNT CEREBRALVASCULAR INJURIES.

Abbreviations:

BCVI Blunt cerebral vascular injury

DSA Digital subtraction angiography

CT angio Computed tomography angiography

Blunt cerebrovascular injuries: anatomic and pathologic heterogeneity create management enigmas. Fabian TC. *J Amer Coll Surg.* 2013. 216(5):873-85.

Dr Timothy C Fabian, a leading trauma surgeon and published scholar on several topics including on blunt cerebrovascular injuries (BCVI), was invited to deliver to the American College of Surgeons the 2012 Scudder Oration. Fabian elected to summarize in his Scudder Oration the status of evaluation and treatment of blunt cerebrovascular injury. Dr Fabian summarized his conclusions presented as a series of statements.

Blunt Cerebral vascular injury (BCVI) is a rare but potentially lethal injury because the arterial injuries can cause strokes. BCVI, which involve both the internal carotid and vertebral arteries is rare: prevalence in most published series report 1-2% of blunt trauma patients admitted to a trauma center have BCVI. Two mechanisms of injury account for the majority of BCVI. Patients have an acute stretch of the cerebrovascular arteries when they sustain a blunt force to their head, neck or face and that force results in hyperextension and rotation of the head. A second mechanism is that fractures of skull base or the transverse process of the cervical spine fragment bone adjacent to the bone canals through which the carotid and vertebral arteries pass, and the bone fragments directly traumatize the artery.

Most experts accept that BCVI can be divided into five categories of severity. A Grade 1 BCVI is an isolated focal tear of the intima, Grade 2 is a tear with > 25% narrowing due to subitimal dissection or a hematoma, Grade 3 is a pseudo-aneurysm of the arterial wall at the site of intimal disruption, Grade 4 is arterial occlusion and Grade 5 is a divided artery with hemorrhage. The internal carotid is injured by a violent stretch typically within 3 cm pf the base of skull, an inaccessible anatomical location for surgeons. A second mechanism of arterial injury is direct arterial puncture by bone fragments of a fracture; this mechanism is most commonly observed in the portion of the vertebral artery passing through the vascular foramen located in lateral transverse process of the cervical spine. The short segment

Most experts consider that cerebral angiography, with digital subtraction images (DSA = Digital subtraction angiography), is the gold standard diagnostic test for establishing the diagnosis and category of BCVI. However, DSA is a procedure that carries risk of causing stroke, is expensive and is time consuming, involving transporting seriously injured patients to the angiography suite. As an alternative diagnostic test, most trauma surgeons in the US depend upon Computer Tomography Angiography (CT angio) of the extracranial cerebral vessels. While stroke complications are negligible with CT angio, and the test can be readily obtained within minutes of the patient's ED arrival, the CT angio images can be obscured by artifact and motion and thus are not as accurate as DSA. Fabian proposes in his 2012 publication that CT angio has a sensitivity of 60 +/-20% in most published series, and a specificity that is over 95%, but nonetheless has a consistent false positive rate. Fabian and colleagues have concluded that CT angio is useful as an immediate screening test; Fabian insists that patients with positive CT angio for BCVI or patients with high risk physical findings have confirmatory DSA as the definitive diagnostic test. The majority of US trauma surgeons do not agree with Fabian's insistence of angiography as essential; most experts publishing on the problem of BCVI recommend that if the CT angio is positive, the patient should be treated, and if the CT angio does not reveal a BCVI, the patient does not have an injury.

The risk to patients who have BCVI is development of a stroke. Fabian reports that in his experience approximately 20% of patients who sustain a BCVI experience an immediate stroke that has occurred before they arrive in the Emergency Department. Fabian predicts that patients with a BCVI who are not anticoagulated have a 20 to 40% likelihood of developing a stroke in the first 7 days after injury. Fabian emphasizes that because most of these strokes are delayed, the surgeons evaluating a blunt trauma patient have an opportunity to perform the diagnostic tests needed to confirm or rule out if there is a BCVI. Many patients whose BCVI is identified with first CT s scans, have anticoagulation therapy a short time after admission, when risk of bleeding from their other injuries has decreased. Fabian's experience with early onset of anticoagulation before stroke in patients with BCVI is that the therapy is highly effective, and prevents strokes. A majority of the strokes that occur develop from embolization of small clumps of platelet and coagulation proteins forming clots adherent at the site of the intimal disruption. These clots break off embolized into the brain's arterial circulation and cause in the patient who is alert and awake (i.e. not intubated) sudden onset of stroke symptoms such as hemiplegia or aphasia. A majority of the vertebral artery injuries associated with significant cervical spine fractures present with occlusion of one or both of the vertebral arteries. Not all occlusions cause ischemic stroke because as Dr. Fabian points out the Circle of Willis enables blood flow to continue to the cerebral hemispheres following occlusion of a carotid or vertebral because of collateral vessels.

Thrombosis and embolization are prevented by anticoagulation therapy. Fabian's recommendation for anticoagulation of a patient with BCVI is intravenous infusion of heparin, adjusting the infusion rate to achieve an aPTT of 40 to 60seconds. A common dilemma encountered in seriously injured patients with a BCVI is that they have other injuries i.e traumatic brain injury or bleeding visceral organs, that make anticoagulation risky. As a compromise of risks and benefits of anticoagulation in these patients with BCVI, Fabian recommends aspirin. Aspirin has an antiplatelet effect that makes it an effective anticoagulant.

Fabian reports that at his trauma center, patients with persistent (still present 7-10 days post injury) of Grade 2 and 3 BCVO lesions, the patients have a bare metal stent deployed across the area of injury, always associated with three months of dual antiplatelet therapy I.e. aspirin and clopidogrel. Fabian's admits his recommendation of bare metal stents may be overly aggressive. Other centers have reported serious complications with the stents, and it is clear that endovascular teams that deploy these stents must be skilled and experienced to achieve optimal benefit.

The optimal screening for BCVI is the first step in effective stroke prevention. Trauma surgeon seek to identify among the population of blunt trauma patients the small minority who have a BCVI, and thus would likely benefit from anticoagulation. The critical question thus becomes who should have the screening tests. For over a decade experts writing about BCVI have reported the following group of signs and symptoms are high risk findings that justify a CT angio to evaluate the carotid and vertebral arteries: a basilar skull fracture, neck soft tissue injuries (i.e. seat belt sign), aniosocaria, neurologic deficits such as hemiplegia inconsistent with traumatic brain injury, or major facial bone fractures of the mandible or maxilla (i.e. LeFort II or III). Another option is to virtually screen every patient who has sustained blunt trauma and is evaluated in a trauma center by routinely performing a diagnostic CT that is programmed to have the IV contrast given, and the images from the circle of willis to the chest acquired during a time when there is optimal contrast content in cerebral vessels.

Functional outcomes following blunt cerebrovascular injury. DiCocco JM. Fabian TC. Emmett KP. Magnotti LJ. Zarzaur BL. Khan N. Kelly JM. Croce MA. *J Taumar Acute Care Surg*. 2013; 74(4):955-60, 2013 Apr.

In a paper based upon follow up after hospital discharge of 79 patients who had sustained a BCVI, DiCocco and coauthors were able to obtain a mean follow up of 35 months. The investigators conducted an over the phone interview. They determined that eleven patients had died after hospital discharge. The investigators used a standardized functional independence measurement-functional activity measurement questionnaire that consisted of 30 questions regarding the patients daily activities (i.e. mobility, locomotion, sphincter control). A maximum score of 210 was considered fully functional. Patients with BCVI who had sustained a stroke had a score of 173. Patients with BCVI who had not sustained a stroke had a mean score of 189, and the authors explained their score less than 210 was a reflection of their other injuries. The authors conclude that “prevention of stroke in patient with BCVI lead to near-normal functional outcomes.”

Blunt cerebrovascular injury screening with 64-channel multidetector computed tomography: more slices finally cut it. Paulus EM, Fabian TC, Savage SA et al. *J Trauma Acute Care Surg*. 2014; 76: 279-85.

The Memphis group with this paper in 2014 finally decided that CT angio screening was appropriate. Over one year 594 high risk blunt trauma patients had both CT angio and DSA. Using DSA as the gold standard, the positive rate for BSVI in this group was 21% of patients, divided into 13% of patient had a carotid lesion, and 10% had a vertebral injury, and a small number of patients had simultaneous injuries in two or more vessels. The sensitivity of the CT angio for BCVI in a patients was 84%. However the false negatives (i.e. missed injuries were 62% Grade I, and 17% Grade II) the authors concluded were not high risk for stroke, and so were acceptable misses. The miss rate for Grade III was only 15% and the authors calculated the added risk of routine DSA exceeded. Also the Paulus et al reports significant complications in 1% of the patients who had DSA including strokes and femoral artery injuries. Thus Fabian revised his earlier insistence on DSA and agreed that screening for BCVI with CT angio was appropriate clinical practice.

In this paper Fabian states what he thinks based upon best available data, the stroke risk for BCVI based upon grade; Grade 1 to 4 carotid injuries are 6%, 10%, 17%, and 55%. For vertebral artery injuries, based upon grade, stroke risk is Grade 1 to 4 are 3%, 30%, 22%, and 18%.

In addition to discussion of the work up with this paper, Fabian revealed a change from his earlier management of identified BCVI. He advocates treatment tailored to individual patients, which means in part recognizing the risk of anticoagulation in seriously injured patients. The report that “antiplatelet therapy for small dissections and occluded vessels, while pseudoaneurysms and complex dissections were anticoagulated with heparin (PTT goal of 40-50 seconds) followed by endovascular stenting on follow up DSA after one week. Two stented patients had strokes associated with the procedure. It is reasonable to conclude that the aggressive use of stents in Memphis has not been confirmed by long term follow up.