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Annual Scientific Meeting**

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Thursday, Apr. 7 to Friday, Apr. 8, 2011

Abstracts

Trauma Association of Canada Annual Scientific Meeting abstracts

The impact of shorter prehospital transport times on outcomes in patients with abdominal vascular injuries. *J.-F. Ouellet,* C. Ball,† G.S. Rozycki,‡ A. Kirkpatrick,§ D.D. Feliciano.‡* From the *Division of Trauma Surgery, the †Department of Surgery, University of Calgary, Calgary, Alta., the ‡Grady Memorial Hospital and Emory University School of Medicine, Atlanta, Ga., and the §Foothills Medical Centre, Calgary, Alta.

Background: Most deaths in patients with abdominal vascular injuries are caused by exsanguination. Time to definitive hemorrhage control is the most important factor affecting survival. The goals of this study were to document patient outcomes associated with abdominal vascular injuries and to compare these outcomes with those from the era preceding improvements in prehospital transport times. **Methods:** A retrospective chart review of all injured patients who presented with an abdominal vascular injury to Grady Memorial Hospital was completed. Patients injured before prehospital transport improvements were compared with those following a reduction in transport times. **Results:** Of 388 patients, 70 (18%) arrived before the improvements. Patient demographics were similar in both groups. The number of patients presenting with abdominal vascular injuries per year increased with a reduction in transport times (23 v. 35 per year, $p < 0.05$). Improved transport times (27 v. 20 min, $p < 0.05$) resulted in patients who arrived with worse base deficits (-9 v. -11, $p < 0.05$) and more frequent hemodynamic instability (63% v. 91%, $p < 0.05$). The mortality rate increased (from 37% to 67%) following the improvements. Regardless of the specific abdominal vessel injury, the increases in mortality remained consistent across eras. **Conclusion:** Reduction in urban transport times resulted in an increase in the number of patients arriving with abdominal vascular injuries as well as the proportion in extremis. The impact of shorter transport times, and therefore of patients who previously would have died at the scene or en route, must be taken into account when evaluating patient outcomes.

Are injury prevention efforts failing our rural communities? *N. Bell,* R. Simons,† N. Lakha,† M. Hameed.†* From the *Department of Surgery, University of British Columbia, and †Trauma Services, Vancouver Coastal Health, Vancouver, BC

Background: As greater publicizing of the reduction in intentional and unintentional injury across Canada becomes increasingly widespread, the need to address rural and urban variations becomes a critical objective. **Methods:** Variations in hospital length of stay (LOS), in-facility and prehospital mortality, injury severity and alcohol-related injury among persons involved in a motor vehicle-related collision were assessed using trauma registry and coroner records from British Columbia (2001–2008). Data were also linked with demographic, socio-economic and geographic data from the 2001 and 2006 censuses. Age-standardized incidence rates were reported for the years 2001 and

2006. **Results:** Although 15% of the population in BC is considered rural, 28% of all hospital admissions for severe injury and 58% of all prehospital deaths occur in rural areas. Hospitalization rates among rural populations were higher in 2006 (60.3 per 100 000) than in 2001 (49.3 per 100 000), whereas prehospital mortality in rural jurisdictions was lower in 2006 (47.4 per 100 000) than in 2001 (54.9 per 100 000). The prehospital mortality rate among rural populations was 9 times higher than that with urban jurisdictions. **Conclusion:** Motor vehicle-related hospitalization and death in British Columbia remains a problem, but rural populations are disproportionately at risk of hospitalization and death. Provincial and national injury prevention reports typically do not address rural and urban differences in hospitalization or death from motor vehicle injury. Improving data collection practices and addressing geographic determinants of injury are required to improve provincial injury surveillance efforts.

Focus on pediatric intentional trauma. *I. Bratu,* L. Phillips,† N. Avdimiretz.** From the *University of Alberta, Edmonton, Alta., and †Concordia University, Montréal, Que.

Background: The purpose of this study is to understand differences between urban and rural pediatric intentional trauma in order to plan for prevention and supportive strategies. **Methods:** Data were extracted from the Alberta Pediatric Trauma Database on pediatric patients (0–17 yr) with Injury Severity Scores (ISS) of 12 or higher, treated from 1996 to 2010 at the Stollery Children's Hospital. Statistical analysis was made comparing U versus R groups using the t test and χ^2 , with $p < 0.05$ considered significant. **Results:** There were 170 pediatric patients who had intentional injuries (U = 58.3%, R = 41.8%, NS), with a majority of patients being male (72.4%). Patients of all ages were affected, but 2 groups were predominant: the very young (< 1 yr), at 17.1% of all injuries, and the teens (≥ 15 yr), at 54.1%. The home was the most common place of injury at 72.4%. The cause of intentional injury was child abuse (31.2%), assault with a blunt object (24.6%), assault with a sharp object (22.9%) and suicide (18.2%). No significant difference was noted for the cause of injury between U and R. The mean ISS was 22.9 (SD 7.8). Forty-two patients required at least 1 operation: craniotomy or laparotomy were the most common. The mean LOS was 13 (SD 25) days. Tragically, 29 patients (17.1%) died. **Conclusion:** An important pattern of intentional injuries can be seen where preventative efforts can be strengthened in both U and R settings: the very young, at 0–1 years, as shaken baby cases, and the teens, who unfortunately, accounted for the majority of suicide attempts.

A comparison of the Kampala Trauma Score with the Revised Trauma Score in a cohort of Colombian trauma patients. *C. Clarkson, A. Rubiano, M. Borgaonkar.* From Memorial University of Newfoundland, St. John's, NL

Background: To date, no trauma scoring system has emerged as the gold standard for use in developing countries, where limited

resources for data collection are a major issue. The purpose of this study is to compare the relatively recently developed and simply calculated Kampala Trauma Score (KTS) with the more widely used Revised Trauma Score (RTS) within a cohort of Colombian trauma patients. **Methods:** Data on over 2200 patients were derived from a newly developed trauma registry in Colombia. Statistical analysis was done using SPSS software and included simple linear and logistical regression, as appropriate. **Results:** Both the KTS and RTS were statistically significant in terms of their ability to predict death and length of stay in hospital, with the KTS being a better predictor of both. The simplest model predicting death used only the neurologic component of the KTS. However, none of these 3 scores explained the very large amount of the variation in the data set. **Conclusion:** Although statistically significant, neither the KTS nor the RTS performed well at predicting death or length of hospital stay. However, the simpler KTS did perform somewhat better than the slightly more complex RTS. Using the extremely simple neurologic component of the KTS on its own proved to be the best predictor of length of hospital stay, and also outperformed the RTS in predicting death. It is clear from this study that the optimal injury scoring system for use in under-resourced environments remains elusive, with further research warranted.

Trauma team leader training and its effect on patient outcomes. *J.D. Pasternak, S.A. Sallam, K. Kahn moui.* From McMaster University, Hamilton, Ont.

Background: Traditionally, a general surgeon has led acute care trauma teams caring for patients with multisystem injuries. The current literature is undecided on the importance of surgeons as part of a trauma team. The trauma patient outcomes of subspecialist surgeons (i.e., those with training in intensive care and/or trauma) have not been assessed in large scale studies. We assessed the outcomes of patients cared for by trauma team leaders (TTL) trained in different specialties, including emergency medicine (ER), anesthesia/orthopedics (other) and general surgery with and without intensive care/trauma subspecialty fellowships. **Methods:** A retrospective cohort study using a Canadian trauma registry database was used to examine all multiorgan trauma with an ISS greater than 15 at a single tertiary trauma centre from January 2000 through January 2009. Demographic, trauma classification, investigations and interventions were examined. Mortality was the primary outcome, and association with training background of the TTLs as well as leaders' caseload were assessed. Length of stay and interventions/investigations initiated were also analyzed. **Results:** We reviewed 2654 patients. No significant difference was seen in mortality of differently trained TTLs' patients. Mortality rates for patients of ER physicians, others, general surgeons with and those without subspecialty were 12.5%, 16.2%, 13.7% and 13.8%, respectively, and not statistically significant. Patient length of stay (LOS) was significantly different, with ER, other, general surgeons with and without subspecialty at 10, 9, 11 and 11 days, respectively. **Conclusion:** Trauma team leader training did not appear to alter the mortality of trauma patients; however, LOS was influenced. Further examination into trauma team systems must be carried out.

The antiexsanguination room: resuscitation with angiography percutaneous techniques and operative repair (RAPTOR):

the technology selection, technique development and human factors development of a new hybrid operative trauma room. *S. Chisholm,* K. Khan,* J. Kortbeek,† C. McAuley-Gilmore,‡ L. Webster,‡ K. Rea,‡ D. Sadler,‡ C. Ball,‡ R. Puls,§ J. Wong,§ D. Teoh,§ D. Archer,§ A. Kirkpatrick.‡* From the *Alberta Health Services, the †Departments of Surgery and Critical Care Medicine, Foothills Medical Centre and University of Calgary, the ‡Department of Surgery, University of Calgary, and the §Foothills Medical Centre, Calgary, Alta.

Background: Bleeding to death is the posttraumatic syndrome that offers the greatest potential for preventing loss of life. Such opportunities in high-functioning centres require multidisciplinary approaches to hemorrhage control that fuse surgery with interventional angiographic procedures (IAPs). As current facilities are physically separate, deaths occur during transport between in-hospital sites of care. As no purpose-designed facility exists, we undertook a program to create the ultimate antiexsanguination room (RAPTOR) that was purpose-designed to provide all surgeries and IAPs within 1 space. **Methods:** Trauma providers partnered with community philanthropists (Calgary Health Trust). A multidisciplinary committee reviewed the vision, design and technology. Vendors submitted customized plans to adapt existing technology to support the concept, and the construction team was engaged at design to ensure constructability. Existing trauma quality assurance committees were adapted to provide clinical oversight of the care paradigm. Human-factors analyses were conducted during dress rehearsals in a full-scale model within the physical space. **Results:** Over Can\$3 million was raised, with further government contributions totalling Can\$5 million. The vision of a surgical/resuscitative suite, able to support emergent or coincident IAPs, led to selection of a ceiling-mounted uniplanar C-arm system combined with ultrasound and a hybrid operating/imaging table. Human-factors analyses proved enormously helpful in guiding design modifications and clinical protocol development. **Conclusion:** Developing a purpose-designed hybrid trauma operating room has proven complex in many domains (economics, design, technology integration, human factors analysis, operational model and clinical guidance). Nevertheless, the hypothesis that this will save lives warrants project completion to allow full evaluation.

Chest tube drainage in trauma: Does size matter? *K. Inaba,* T. Lustenberger,* G. Recinos,* C. Georgiou,* G. Velmahos,† C. Brown,‡ A. Salim,§ P. Rhee,¶ D. Demetriades.** From the *Division of Trauma and Surgical Critical Care, University of Southern California, Los Angeles, Calif., the †Massachusetts General Hospital, Boston, Mass., the ‡University Medical Center, Brackenridge, Pa., the §Cedars-Sinai Medical Center, Los Angeles, Calif., and the ¶University of Arizona, Tucson, Ariz.

Background: Traditionally, large-calibre chest tubes have been recommended for the treatment of a traumatic hemothorax. The purpose of this study was to prospectively examine the efficacy of a small (S) versus large (L) chest tube for the treatment of traumatic hemothorax. **Methods:** All trauma patients admitted to a level 1 trauma centre over a 3-year period ending in December 2009 requiring tube thoracostomy were followed prospectively for tube-related complications. Patients who died within 48 hours

of tube insertion were excluded. A chest tube size of 32-French or less (S) was compared with tubes greater than 32-French (L). **Results:** During the study period, 293 patients had 144 S (52.3%) and 131 L tubes inserted. Both groups were similar in age, sex and mechanism of injury; however, L tubes were more frequently placed in patients with a Glasgow Coma Scale score of less than 8 (16.8% v. 8.3%, $p = 0.033$), a severe head injury (25.2% v. 8.3%, $p < 0.001$), a systolic blood pressure lower than 90 mmHg (15.5% v. 5.6%, $p = 0.013$) and an ISS of greater than 25 (35.1% v. 22.9%, $p = 0.026$). The duration of tube placement was similar for both groups (S: 6.3 [SD 3.9] d v. L: 6.2 [SD 3.6] d; adj. $p = 0.427$). After adjustment, no statistically significant difference in tube-related complications, including pneumonia (4.9% v. 4.6%, adj. $p = 0.282$), empyema (4.2% v. 4.6%, adj. $p = 0.766$) or retained hemothorax (11.8% v. 10.7%, adj. $p = 0.981$), were found when comparing S and L chest tubes. The need for tube reinsertion, image-guided drainage, video-assisted thoracoscopic surgery and thoracotomy was likewise no different between tube sizes (10.4% v. 10.7%, adj. $p = 0.719$). **Conclusion:** For patients sustaining chest trauma requiring chest tube drainage, in this prospective observational study, there was no difference in clinically significant tube-related complications requiring intervention whether a small- or large-calibre chest tube was used.

Epidemiology and characteristics of traumatic aortic injuries presenting in the city of Calgary: a population-based study. S. AlSheikh,* C. Ball,† M. Mercado,‡ E. Dixon,‡ C. Tiruta,‡ J.-F. Ouellet,‡ K. Laupland,§ M. Nutley,§ A. Kirkpatrick.‡ From the *University of Calgary, the †Department of Surgery, the ‡Division of Trauma Surgery, University of Calgary, and the §Foothills Medical Centre, Calgary, Alta.

Background: Traumatic thoracic blunt aortic injuries (BAI) necessitate prompt diagnosis and potentially complex treatments not available in all hospitals. Associated injuries typically complicate management priorities. The primary goal of this study was to determine the overall prevalence of thoracic BAI, as well as define the associated injury characteristics in a population-based analysis. **Methods:** The Alberta Trauma Registry was used to identify all patients presenting with traumatic thoracic BAI within southern Alberta. Patient demographics, injury characteristics, treatment strategies and outcomes were analyzed. **Results:** Over a 14-year period (1995–2009), 87 patients (0.007% of all patients with an ISS ≥ 12) presented to the Foothills Medical Centre with a thoracic BAI (mean age 41 yr, 70% male, hemodynamic instability 38%, mean ISS 38, mean length of stay 24 d). Comorbidities were present in less than 14% of patients. Motor vehicle collisions comprised 87% of all mechanisms. All patients had concurrent associated injuries (82% pulmonary injuries, 55% extremity fractures, 40% spine injuries, 37% brain injuries, 35% liver lacerations, 34% facial fractures, 33% pelvic fractures, 28% spleen lacerations and 20% cerebrovascular accidents). Conflicting management goals existed for patients with concurrent BAI and traumatic brain injuries. Operative procedures were performed on 73.56% of all patients (26% laparotomies, 16% thoracotomies, 21% open reduction and internal fixation, 20% vascular procedures). Overall mortality was 34%, with the disposition of the remaining patients being home (40%), an acute care facility (40%) or a rehabilitation facility (20%). **Conclusion:** This is the first

population-based study to examine the epidemiology of traumatic aortic injuries in a large, populous region. Although uncommon, traumatic aortic injuries do not occur in isolation.

Needle decompression for tension pneumothorax in tactical combat casualty care: Do catheters in the midaxillary line kink more often than those in the midclavicular line? A. Beckett,* E. Savage,* D. Pannell,* S. Acharya,* A. Kirkpatrick,† H. Tien.‡ From the *Canadian Forces Health Services, Ottawa, Ont., the †Foothills Medical Centre, Calgary, Alta., and the ‡Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: Tactical combat casualty care (TCCC) is a system of prehospital trauma care designed for the combat environment. Needle decompression is a critical TCCC intervention, as previous data suggest that up to 33% of all preventable deaths on the battlefield result from tension pneumothoraces. There has recently been increased interest in performing needle decompression at the fifth intercostal space in the midaxillary line, to prevent complications associated with the second intercostal space in the midclavicular line site. **Methods:** To simulate needle decompression, we secured segments of porcine chest walls over volunteer soldiers' chests and placed 1.5-inch, 14-gauge angiocatheters in midaxillary line and midclavicular line sites. We then assessed for occlusion and kinking by flow of normal saline through the angiocatheter in situ. The opening pressures were then converted to mm Hg. **Results:** We observed there was a significant pressure difference required to achieve free flow through the angiocatheter between the fifth intercostal space midaxillary line versus the second intercostal space midclavicular line site (13.1 [SD 3.6] mm Hg v. 7.9 [SD 1.8] mm Hg). A pressure of 12.8 mm Hg has been documented in animal models as the point at which hemodynamic instability develops. **Conclusion:** This study suggests that angiocatheters used for needle decompression in the midaxillary line may partially and temporarily occlude in patients who will be transported on military stretchers. This may contribute to the reaccumulation of tension pneumothoraces and ultimate patient deterioration in military transport.

Clotting factor deficiencies and appropriate fresh frozen plasma use in trauma patients. P. Engels,*† J. Rezende-Neto,‡ J. Pacher Hoffmann,† H. Tien,† L. Tremblay,† A. Beckett,*§ D. Paton-Gay,*§ S. Rizoli.*§ From the *University of Alberta Hospital, Calgary, Alta., the †Sunnybrook Health Sciences Centre, Toronto, Ont., the ‡Universidade Federal de Minas Gerais, Brazil, and the §Canadian Forces Health Services, Ottawa, Ont.

Background: Twenty-five percent of all trauma patients arrive coagulopathic to hospital and could benefit from fresh frozen plasma (FFP) transfusion. Fresh frozen plasma is used to replace clotting factors (CF), and its early use in trauma has greatly increased with the advent of damage-control resuscitation and massive-transfusion protocols. We hypothesize that many trauma patients are inappropriately transfused FFP, whereas others in need are not. We proposed to investigate how many patients have critical CF deficits ($< 30\%$ activity) and are appropriately transfused FFP. **Methods:** Three-hundred and nine severely traumatized patients (ISS ≥ 16) admitted to Sunnybrook Tory Regional

Trauma Centre had their CF measured on admission over a 9-month period. Associated demographic, physiologic, coagulation profile and transfusion data were prospectively collected. **Results:** Sixty-five patients (21%) had critically low CF levels on admission, but only 28% of them received FFP during the first 24 hours. Of those receiving FFP, only 36% received enough to correct the CF deficit. Multiple logistic regression analysis showed that factors determining FFP administration were international normalized ratio values greater than 1.5 (OR 7.02) and penetrating mechanism (OR 8.44), despite the lack of difference in physiologic and coagulation profiles between patients with different mechanisms. In fact, victims of blunt trauma had higher Injury Severity Scores (27 v. 16) than victims of penetrating trauma, but were less likely to receive FFP. **Conclusion:** Trauma surgeons are not correctly identifying coagulopathic patients with critical CF deficits, thus in need of FFP. They also fail to transfuse enough FFP to correct the deficit and are biased toward transfusing FFP to penetrating instead of blunt trauma victims who are coagulopathic.

Induced hypothermia following traumatic arrest: case series. *M. Tuma, D. Stein, K. McQuillan, T. Scalea.* From the R. Adams Cowley Shock Trauma Center, University of Maryland, Baltimore, Md.

Background: Induced hypothermia (IH) use has wide acceptance following cardiac arrest; however, its role in posttraumatic arrest is not yet defined. Many factors like hemorrhage, coagulopathy, initial hypothermia and wounds hinder its use following trauma. Whereas promising data have come from animal studies, there are no human trials that address the effects of IH following traumatic arrest, whether blunt or penetrating. **Methods:** A retrospective review of the trauma registry at the R. Adams Cowley Shock Trauma Center, between July 1, 2008, and June 30, 2010, was done to identify all patients over 18 years of age with multi-trauma who underwent IH following cardiac arrest. All cases were managed following a predefined IH protocol that calls for the core body temperature to be reduced to 34°C–32°C for 24 hours. **Results:** Twelve patients were identified; 3 were excluded as they had no trauma initially. The remaining 9 patients are described in the table below. All injuries were blunt; the most frequent mechanism of injury was motor vehicle collision. All those who died had arrested before admission to the trauma centre. One of them had a sudden drop in temperature to about 30°C, which led to ventricular tachycardia: his family decided to withdraw care. All survivors had a favourable neurologic outcome. **Conclusion:** Mild, induced hypothermia is beneficial in a select group of posttraumatic cardiac arrest patients. Prospective controlled trials in this field are needed.

Table. Characteristics of adult patients with multitrauma who underwent induced hypothermia after cardiac arrest

No. pts.	Sex, M:F	Age, yr*	ISS*	Arrest duration, min*	Arrest location, in prehospital	Pre-arrest GCS*	No. deaths	Survivors, 30-d GCS*
9	6:3	53	26	8	6:3	15	3	11T

F = female; GCS = Glasgow Coma Scale; ISS = Injury Severity Score; M = male; Pts. = patients.
*Reported as median value.

Introducing ASSET to Canada. *J. Ali,* A. Sorvari,* D. Haskins,† F. Luchette,‡ M. Bowyer.§* From *St. Michael's Hospital, Toronto, Ont., the †American College of Surgeons, Chicago, ‡Loyola University Medical Center, Maywood, and the §Unifor-med Services University, Maryland, Ill.

Background: The Advanced Surgical Skills for Exposure in Trauma (ASSET) course is a fresh frozen cadaver-based course from the surgical skills subcommittee of the American College of Surgeons (ACS). We conducted the first course outside of the United States to determine the feasibility of introducing it in Canada and to survey surgeons' attitudes toward its introduction. **Methods:** PowerPoint and video instructions followed by hands-on surgical exposures were used. Twelve experienced Canadian trauma surgeon instructors participated in this special course directed by ACS faculty. Pre- and postcourse multiple choice questionnaires on surgical techniques, self-efficacy scores (1–5), questionnaires on the desirability of introducing the course and the ideal level of participant training were completed. **Results:** Mean pre- and posttest scores were statistically similar (pre 82.9%, post 77.1%). Other mean scores (maximum 5) were self-efficacy for neck (pre 3.2, post 4.3), chest (pre 3.3, post 4.4), abdomen (pre 4.5, post 4.7), genitourinary and pelvis (pre 3.9, post 4.6) and extremities (pre 3.1, post 4.2). Course evaluation scores (maximum 5) ranged from 4.46 to 4.92 for improvement in knowledge, technique, strategy, appropriateness, faculty:student ratio and recommendation to colleagues. Ratings for most valuable areas were neck and extremity (each 67%); chest and abdomen were the lowest (24%), reflecting general surgery background. Participants recommended Canada-wide propagation for trauma surgeons, fellows and possibly senior residents. All felt enthusiastic and confident to be ASSET instructors. **Conclusion:** Our data suggest that we have enough well-trained instructors to introduce ASSET throughout Canada.

Tension pneumothoraces: clinical features and overall frequency in spontaneously breathing and mechanically ventilated adults: a systematic review. *D. Roberts,* C. Ball,* E. Dixon,† A. Kirkpatrick,† B. Dingley,‡ J. Kortbeek,§ S. Leigh-Smith.¶* From the *Department of Surgery, University of Calgary, the †Foothills Medical Centre, the ‡University of Calgary, the §Departments of Surgery and Critical Care Medicine, Foothills Medical Centre and University of Calgary, Calgary, Alta., and the ¶Defence Medical Services and Royal Infirmary, Edinburgh, Scotland

Background: Tension pneumothoraces (TPTXs) are pneumothoraces that result in the lateral shift of a patient's mediastinum concurrent to respiratory distress (or difficulty ventilating) and/or hypotension. The true frequency of these events, as well as their clinical symptoms/signs, is unclear in both spontaneously breathing and mechanically ventilated patients. The goal of this study was to perform a systematic review of these issues. **Methods:** Electronic database searches (PubMed, MEDLINE, EMBASE, CENTRAL) were completed. Bibliographies of all articles (randomized controlled trials, observational studies, case reports) that reported the clinical features, diagnosis and treatment of TPTXs were screened and evaluated by 2 independent reviewers. **Results:** In total, 1799 unique citations were identified. Of these, 313 (17%) were determined to be appropriate for full-text review.

Studies had been published between 1958 and 2010. The majority of articles were case reports (75%). Significant differences were noted in the TPTX symptoms/signs between adults who were spontaneously breathing versus mechanically ventilated. Spontaneously breathing patients universally noted chest pain and respiratory distress, with less than 25% displaying tracheal deviation and/or hypotension. These 2 signs were reported for the majority of mechanically ventilated patients, however. The frequency of TPTXs varied substantially across reports, with more cases described in mechanically ventilated patients. **Conclusion:** Significant differences exist in the clinical features as well as the relative frequency of reported TPTXs among spontaneously breathing and mechanically ventilated patients. This finding has important implications with respect to diagnosing this life-threatening injury.

Are general surgery residents placing enough chest tubes? *Z. Parr, V. Lee, J. Mckee, D. Kolthoff, S. Widder.* From the University of Alberta Hospital, Calgary, Alta.

Background: The morbidity rate for chest tube placement in trauma patients ranges from 6% to 36%. A recent study suggested that chest tubes placed by junior residents have a higher complication rate. Is this owing to a lack of education or lack of hands-on experience? **Methods:** We performed a 3-year retrospective chart review of adult trauma patients who had a chest tube placed while in the emergency department (ED) of a quaternary hospital. Patient demographics, injury mechanism, program and level of training of the resident who placed the chest tube, effectiveness and associated complications of the chest tubes were identified. **Results:** In 3 years, 156 chest tubes were placed. Patients ranged in age from 18 to 92 years, 79.5% were male and 85% had sustained blunt trauma. Most chest tubes were placed for pneumothoraces (49%). Staff physicians placed 14% of chest tubes, general surgery (GS) residents placed 69% and non-GS residents placed 13%. At least 1 complication occurred in 42% of cases. General surgery residents had the lowest complication rate (37%), compared with staff physicians (45%) and non-GS residents (82%). Junior GS residents had the lowest complication rate (29%), whereas senior GS residents had a complication rate of 53%. **Conclusion:** Chest tube placement in the emergency room setting continues to have high associated morbidity. Whereas procedures done by GS junior residents appear to be no more morbid than those done by staff physicians, chest tubes placed by both GS senior and non-GS residents have a higher associated morbidity. The reasons for this are unclear and warrant further consideration.

Assessment of current quality of care in adult trauma patients transferred from the periphery to a level 1 trauma facility. *M. McCrum, J. Mckee, S. Widder.* From the University of Alberta Hospital, Edmonton, Alta.

Background: The purpose of this study was to determine whether Advanced Trauma Life Support (ATLS) guidelines are followed in the transfer of trauma patients from rural hospitals to a level 1 trauma centre and to identify areas for improvement in resuscitation and transfer practices. **Methods:** We conducted a retrospective review of all adult trauma patients transferred to the University of Alberta Hospital from an outlying hospital more

than 50 km away over a 3-year period (2007–2010). Transfer practices were evaluated using ATLS guidelines for trauma management. **Results:** In all, 129 patients were analyzed: 93% sustained blunt injuries, their mean age was 39.5 years and mean ISS was 24.7. Mode of transport included ground (40%), fixed wing (51%) and helicopter (8.5%). All patients had at least 1 departure from ATLS guidelines: failure to employ rewarming techniques (94.6%), failure to insert an nasogastric/orogastric tube before transport (79.1%) or no documented neurological. **Conclusion:** Key aspects of ATLS resuscitation guidelines are frequently missed during the transfer of trauma patients from the periphery. Increased emphasis on these practices during ATLS courses, and established regional transport protocols, such as a transfer checklist, could improve quality of care.

Adapting a mature Canadian level 1 trauma centre database to participate in the Trauma Quality Improvement Program. Part I. Submitting to the National Trauma Database: challenges and successes. *K. Musselwhite,* C. Vis,* M. Mercado,* S. Lally,* C. Tiruta,* J. Kortbeek,*† A. Kirkpatrick.*†* From *Alberta Health Services and the †Departments of Surgery and Critical Care Medicine, Foothills Medical Centre and University of Calgary, Calgary, Alta.

Background: Traumatic injury remains the leading cause of preventable years of lost life in Canada. Effective prevention and quality assurance requires accurate data and benchmarking to identify trends and areas of concern. The American College of Surgeons Total Quality Improvement Program (TQIP) was created to provide such benchmarking. After learning of this program, Regional Trauma Services (RTS) decided to investigate the feasibility of a Canadian institution submitting data to the National Trauma Data Bank (NTDB), the first step in participating in this American program. **Methods:** The biggest challenge faced by the RTS was to create a memorandum of understanding (MOU) that would allow us to send data to the United States. The MOU had to meet our information and privacy requirements and the NTDB submission requirements. The second challenge was to ensure that any data incompatibilities between the RTS registry and the NTDB would not result in any level 1 or 2 NTDB data validation errors. The RTS data analysts were asked to review data fields that the RTS submits to the National Trauma Registry and the provincial trauma registry (Alberta Trauma Registry) and check for compatibility with the NTDB data fields. **Results:** After over a year of negotiation, an MOU acceptable to everyone was completed. The data field review found that the RTS data fields were 85.4% (70/82) compatible with the NTDB data fields, with no level 1 or 2 errors that would prohibit us from submitting data. **Conclusion:** Canadian registries such as ours that are NTR-compatible are potentially NTDB-compatible, a major step in participating in the TQIP.

A composite process indicator to assess trauma care performance: development and association with mortality. *L. Moore,* A. Lavoie.†* From *Université Laval and the †Unité de recherche en traumatologie-urgence-soins intensifs, Université Laval, Laval, Que.

Background: Process indicators provide essential information for

the evaluation of trauma centre performance. However, multiple indicators are needed to adequately evaluate process performance. We hypothesized that a composite indicator would be a useful tool to evaluate global process performance. The goal of this study was to develop a composite indicator and assess its association with outcome. **Methods:** Thirteen process indicators were identified by literature review and were calculated with data from a Canadian provincial trauma registry (59 centres). Hierarchical regression was used to generate shrinkage estimates for each process indicator. A composite score was derived using the indicator average method. The association between the composite score and risk-adjusted mortality was evaluated with the Spearman correlation coefficient. **Results:** The sample included 19 853 patients with an ISS greater than 15. Average conformity to individual process indicators varied between 6% and 96%. Average conformity across process indicators according to the composite score was 68%. The process score of level 1 and 2 centres was significantly higher than level 3 and 4 centres ($p = 0.005$). The correlation between the composite score calculated in 1998–2002 and 2003–2006 was 0.49 (0.27–0.66). The correlation between composite process indicators and risk-adjusted mortality indicators was -0.2 (-0.46 to 0.04). **Conclusion:** The composite process indicator proposed is simple and intuitive, demonstrates good stability over time and is correlated with level of care and outcome. The indicator can be used to identify hospitals that perform better or worse than average, to compare system performance to a benchmark and to monitor intrahospital performance over time. The association between higher process scores and lower risk-adjusted mortality suggests that improving global process performance may have a positive impact on patient outcome.

A comparison of hospital mortality to mortality evaluated over a fixed period of time: implications for trauma centre profiling. *L. Moore,* A. Lavoie.†* From *Université Laval and the †Unité de recherche en traumatologie-urgence-soins intensifs, Université Laval, Laval, Que.

Background: Trauma centre mortality profiling should be based on mortality evaluated over a fixed period of time, but data constraints often limit analysis to mortality during the initial hospital stay. We aimed to evaluate whether trauma profiling results based on hospital mortality differ to those based on 1-, 3-, 6- and 12-month mortality in an inclusive Canadian trauma system. **Methods:** Analyses were based on adults with major trauma (ISS > 15) admitted to any of the 29 level 1–3 provincial trauma centres (1999–2006, $n = 17\ 064$). Trauma registry data were linked with the provincial mortality file. Mortality profiling was based on risk-adjusted estimates of mortality. Profiling results were compared with Spearman correlation coefficients, stratified for age. Coefficients greater than 0.9 were considered to convey acceptable agreement. **Results:** Hospital mortality was 15.3%. Mortality at 1, 3, 6 and 12 months was 15.0%, 16.3%, 17.2% and 18.3%, respectively. Correlation coefficients between risk-adjusted hospital mortality and mortality evaluated at 1, 3, 6 and 12 months were 0.96 (0.93–0.98), 0.95 (0.90–0.98), 0.93 (0.85–0.99) and 0.90 (0.80–0.95) for patients aged under 65, and 0.81 (0.64–0.91), 0.91 (0.81–0.96), 0.88 (0.75–0.94) and 0.84 (0.69–0.92) for patients aged 65 and older, respectively. **Conclusion:** Hospital mortality may be a reasonable proxy for mortality assessed over a fixed period in young adults, but not in elderly patients. Results suggest that trauma registry data should be augmented with postdischarge

mortality statistics for trauma centre profiling. Information on cause of death is needed to identify the most appropriate period for evaluating death following injury.

Computed tomography scan in the diagnosis of blunt traumatic diaphragmatic rupture. *E. Passos, B. Nascimento, F. Spencer, H. Tien, S. Rizoli.* From the Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: Blunt traumatic diaphragmatic rupture (BTDR) occurs when substantial energy is applied to the torso. It is commonly associated with other injuries and carries both high morbidity and mortality. If misdiagnosed, BTDR may result in herniation of abdominal contents into the chest. Despite being broadly used, CT scans are thought to have limited sensitivity for diagnosing BTDR. We hypothesize that 64-slice CT scanners provide a useful diagnostic test for BTDR. **Methods:** We reviewed the reports of all chest and abdomen CT scans performed during the initial 24 hours of hospitalization for blunt trauma patients at Sunnybrook, since implementation of the 64-slice CT scan (4-yr period, 2004–2008). Computed tomography reports were compared with operative reports that were defined as the gold standard for the diagnosis of BTDR, and the CT scan sensitivity and specificity were calculated. **Results:** In total, 2706 patients were admitted over the study period. Most (69%) were male; their mean age was 45 (SD 20) years and mean ISS was 25 (SD 13). Most BTDRs were owing to motor vehicle collisions and were on the left side (61%); 10% were bilateral. Thirty-one patients had BTDR diagnosed during surgery (gold standard). Of these, 24 had a positive CT scan, whereas for 3 patients the CT scan diagnosis of BTDR was not confirmed by surgery. Overall, the 64-slice CT scan had a sensitivity of 77%, a specificity of 99% and a positive predict value of 89%. **Conclusion:** Computed tomography scanning is a useful tool in the diagnosis of BTDR, with excellent specificity and positive predicted value.

Predictors of solid abdominal organ injury — role of concurrent rib and pelvic fractures. *A. Al-Hasani,* I. Afifi,* K. Maull.†* From the *Hamad Medical Corporation and the †Hamad General Hospital, Doha, Qatar

Background: In a previous report on multiple rib fracture patients from this institution, only lower rib fractures were associated with an increased incidence of solid organ injury (SOI). In this study, patients with rib and pelvic fractures were studied to determine whether pelvic fractures increased the likelihood of SOI and whether the previous patterns of rib fractures held up in the presence of pelvic fractures. **Methods:** During the 30-month period ending May 2010, data were collected prospectively on all patients admitted with multiple rib fractures. Rib fractures were characterized as upper ribs (1–4), mid (5–8) and lower (9–12). Patients with coexisting pelvic fractures were identified, and SOIs were compared in rib fracture patients with and without pelvic fractures. Patients with isolated pelvic fractures served as controls. **Results:** There were 426 men and 24 women ($n = 460$). Vehicular collisions and falls from height were the most common causes of injury. There were 131 patients with 174 SOIs: liver (60), kidney (40) and spleen (74). Pelvic fractures were present in 69 patients. Patients with multiple rib and pelvic fractures had a higher incidence of SOI than patients with rib fractures alone

(42% v. 28%, $p < 0.02$). Pelvic fractures and lower rib fractures were highly predictive of SOI compared with patients with pelvic fractures alone (62% v. 15%). **Conclusion:** When pelvic and multiple rib fractures coexist, the incidence of SOI exceeds either group occurring in isolation. Pelvic fractures and lower rib fractures together cause a 5-fold increase in the likelihood of SOI compared with pelvic fractures alone.

Policy-relevant trauma system performance reporting: What do decision-makers need to know? E. Randall,* N. Bell,[†] B. Sobolev,[†] D. Evans.* From the *Vancouver General Hospital and the [†]Department of Surgery, University of British Columbia, Vancouver, BC

Background: Informed decision-making by trauma system architects is challenged by variable definitions of trauma systems, their objectives and the inconsistent use of performance metrics. Better tools to support decision-makers in design and policy development are needed. This study described decision-makers' perceptions of the scope and objectives of regional trauma systems in Canada, and identified their needs for performance metrics useful for system design and policy development. **Methods:** A 35-question electronic survey was disseminated to 183 health administrators (health ministry, regional health authority, hospital, emergency medical service) influential in the design of injury management systems from health regions across Canada. Responses were collated and descriptive statistics generated. **Results:** The response rate was 44.6%. Strong support (96.3%) was expressed for the broadly inclusive trauma system definition articulated by Trauma Association of Canada and for government oversight using standard performance indicators. Ensuring rapid delivery of appropriate care (41.2%) and minimizing individual and societal burden of injury (31.7%) were identified as the principal drivers of system design. Of 24 performance indicators, measures of timeliness of care, preventable death, severity-adjusted hospital mortality, safety, satisfaction and access to care were preferred. Most (96.3%) considered that system reporting could be made more useful. **Conclusion:** Decision-makers responsible for regional trauma systems in Canada believe that trauma systems should coordinate multiple agencies around clear, evaluable system objectives that encompass both major and minor trauma, prevention and disaster preparedness. Government-endorsed national standards are advocated to ensure efficient and effective processes that reduce the individual and societal burden of injury.

Crowd-generated collapse of the barricades: a response to multiple casualties during LiveCity Yaletown, Vancouver/Whistler Olympics 2010. A. Lund,* N. Amiri,[†] S. Turris,[†] K. Lewis,[†] S. Gutman.[†] From the *Department of Emergency Medicine, University of British Columbia, and the [†]University of British Columbia, Vancouver, BC

Background: Mass gatherings characterized by large crowds are becoming more prevalent. Mass casualty incidents (MCI) have been associated with these events. Currently, minimal regulations exist with regard to requirements for on-site medical care. We report on the provision of a high-level, multidisciplinary response in relation to a barricade collapse leading to significant injuries at the LiveCity Yaletown community celebrations during the Vancouver 2010 Olympic Winter Games. **Methods:** The prehos-

pital medical care provided to over 200 000 attendees over the 19-day period was prospectively captured using an event and patient registry. Among others, the multidisciplinary medical team included physicians, nurses and first responders. Patient encounters specific to this collapse were isolated from the registry for analysis. **Results:** Twenty injuries were identified related to the collapse. Patients presented over a 48-minute period. The majority ($n = 19$) were seen and treated at the main medical tent. Treatment provided included wound care, immobilization, splinting and analgesic provision. Twelve patients were treated on scene, thereby requiring only 8 ambulance transfers. This MCI occurred against a background of 958 patient encounters over 19 days, with total of 15 ambulance transports. **Conclusion:** Our team worked effectively to treat and triage patients to surrounding hospitals. Furthermore, liaison and effective communication with the local ambulance service and hospitals minimized the impact on the local emergency system. Appropriate planning of medical care at mass gathering events is an important part of emergency response planning in the prehospital environment and should be a requirement for event permits.

Pedestrians — a population at risk for serious injury. H. Al-Razzaq,* M. Alani,* R. Alajaj,* J. Riebe,[†] K. Maull.* From the *Hamad General Hospital, Doha, Qatar, and the [†]University of Pittsburgh Medical Center—International Division, Pittsburgh, Pa.

Background: It is widely recognized that pedestrians are the most vulnerable group of road users. Since the inception of the trauma service, pedestrian injuries have consistently ranked among the more severely injured according to Injury Severity Score (ISS). This is a heavy burden on hospital resources, the emotional state of families and on long-term societal costs. Effective injury prevention begins with sound data to define the problem. This report represents phase 1 of an ongoing 3-phase injury-prevention initiative to improve pedestrian safety. **Methods:** All injured pedestrians admitted from Nov. 1, 2007, through Mar. 1, 2010, were identified and underwent retrospective review of their hospital medical records and emergency medical service run sheets. A spreadsheet was used to compile demographics, prehospital transport, service admission, injuries by system, need for operation and/or care in the intensive care unit, complications and disposition. **Results:** There were 420 pedestrians injured seriously enough to warrant admission. The majority were male ($n = 386$). Pedestrians were most often transported by ambulance (91%), followed by private vehicle (6%) and helicopter (3%). Floor admissions were 42%, followed by intensive care unit 38%, and 17% went to the operating room. By ISS definitions, 40% were either seriously or critically injured. Approximately 60% of patients were admitted to the trauma service. There was a total of 804 injuries, including extremities ($n = 242$), head ($n = 185$), chest ($n = 144$), abdomen ($n = 98$), face ($n = 75$) and spine ($n = 60$). Most patients were discharged home (78%). There were 35 deaths (8%). **Conclusion:** Efforts to reduce pedestrian injuries and/or mitigate their consequences appear warranted. These data lend emphasis to the urgency of finding solutions.

The use of trauma transfusion pathways for blood component transfusion in the civilian population: a systematic review and meta-analysis. K. Vogt,* J. Ann VanKoughnett,*

L. Dubois,* D. Gray,† N. Parry.† From the *University of Western Ontario and the †London Health Sciences Centre, London, Ont.

Background: This study was undertaken to determine if, among civilian trauma patients requiring massive transfusion, the use of a formal trauma transfusion pathway (TTP), in comparison with transfusion without a TTP, is associated with a reduction in mortality or changes in indices of coagulation, blood product utilization and complications. **Methods:** A systematic review of 3 bibliographic databases, reference lists and conference proceedings was conducted. Studies were included if comparisons were made between patients receiving transfusion with and without a TTP. Data were extracted by 2 independent reviewers on population characteristics, transfusion strategies, blood product utilization, indices of coagulation, clinical outcomes and complications. Data were pooled using a random effects model, and heterogeneity was explored. **Results:** Seven observational studies met all eligibility criteria. Among 1801 patients requiring massive transfusion, TTPs were associated with a significant reduction in mortality (RR 0.69, 95% CI 0.55–0.87). No significant increase in the mean number of packed red blood cells transfused between TTP and control patients was seen (mean difference –1.17, 95% CI –2.70 to 0.36). When studies assessing only trauma patients were considered, TTPs were associated with a reduction in the mean number of units of plasma transfused (mean difference –2.63, 95% CI –4.24 to –1.01). **Conclusion:** The use of TTPs appears to be associated with a reduction in mortality among trauma patients requiring massive transfusion without a clinically significant increase in the number of packed red blood cells transfused and a potential reduction in plasma transfusion. The effects of TTPs on platelet transfusion, indices of coagulation and complications remain unclear. A randomized controlled trial is warranted.

Admitting base deficit and lactate levels in blunt trauma patients: Are they useful markers? J.-F. Ouellet,* D. Roberts,† V. Trottier,‡ M. Mercado,§ A. Kirkpatrick,§ D. Feliciano,† C. Ball.† From the *Division of Trauma Surgery and the †Department of Surgery, University of Calgary, Calgary, Alta., the ‡CHA—Hopital de l'Enfant-Jesus, Québec City, Que., and the §Foothills Medical Centre, Calgary, Alta.

Background: High admission base deficit and lactate levels in patients injured by predominantly penetrating mechanisms have been shown to be associated with increased mortality. This relation is unclear in the Canadian experience, where most patients sustain blunt trauma. The goal of this study was to define the relation between admission arterial blood gas values and mortality in a blunt-injured Canadian population. **Methods:** A retrospective review of 3000 consecutive adult admissions with major injury (ISS \geq 12) to the Foothills Medical Centre was conducted. Arterial blood gas values at the time of arrival were analyzed with respect to associated mortality. **Results:** Among 3000 trauma patients, 96% were injured by a blunt mechanism. Arterial blood gas values were available at arrival in 25% of patients. Presenting systolic blood pressure and eventual mortality were linearly associated with admitting pH (acidosis), base deficit and lactate ($p < 0.05$). Patients who died had a lower mean pH (7.21 v. 7.29), higher mean lactate (5.1 v. 2.6 mmol/L) and worse mean base deficit (–10 v. –6) at arrival compared with survivors ($p < 0.05$), despite similar

initial mean systolic blood pressures (123 v. 123 mm Hg, $p > 0.05$). Acidosis and hyperlactemia at admission were also associated with a longer length of stay ($p < 0.05$). **Conclusion:** Admission arterial blood gas values in Canadian blunt trauma patients reflect mortality in a similar manner to patients injured via penetrating mechanisms. Survival curves for presenting pH, lactate and base deficit reflect initial patient physiology, exsanguinating hemorrhage and eventual outcome. These data should be available to all clinicians within their individual trauma centres.

Evaluation of a youth unsafe driving video: a comparison of 2 communities. T. Charyk Stewart,* J. Harrington,* D. Tanner,† D. Polgar,* M. Girotti.* From the *London Health Sciences Centre and the †Trauma Program, London Health Sciences Centre, London, Ont.

Background: To evaluate and compare the effectiveness of an injury prevention video (iDrive2) designed to raise awareness among youth about the risks and consequences of aggressive, unsafe driving in 2 Canadian communities with different injury experiences. **Methods:** The video with accompanying presentation was delivered to 2 high schools in different communities. A survey was designed and distributed to students to evaluate program effectiveness. Program components were scored on Likert scales, with open-ended questions included. The χ^2 and t tests were used to compare group results. **Results:** There was a total of 651 completed surveys (462 [71%] from Brantford, 189 [29%] from London). Whereas less than one-third of each school responded that this was new information, the majority of students (91% Brantford, 83% London; $p < 0.001$) found the program effective in raising awareness of unsafe driving, rating it 5 (London) and 6 (Brantford) out of 7 ($p < 0.001$). The Brantford students were more likely to find the video effective to educate on driving distraction, speeding, drugs and buckling up ($p < 0.001$). More Brantford students reported they had a better understanding of risks and had learned strategies (87% v. 69%, 87% v. 70%; $p < 0.001$), and nearly all (97% v. 88%) would recommend the video. **Conclusion:** Whereas the majority of students found this program effective in raising awareness of unsafe driving (distractions, drugs, speeding, no seatbelt use), the results from the Brantford group were more favourable. This high school had a fatal crash involving students in the months preceding the program. The context of this experience created a learning opportunity when students were more receptive, thereby maximizing program effectiveness.

Nontherapeutic trauma laparotomies: recent experiences in a Canadian level 1 trauma centre. D. Paskar,* K. Al-Ali,† V. Speers,‡ A. Madani,* S. Rizoli.‡ From the *University of Western Ontario, London, the †Department of General Surgery, University of Toronto, and the ‡Sunnybrook Health Science Centre, Toronto, Ont.

Background: Nonoperative management of abdominal trauma is increasingly commonplace. However, nontherapeutic trauma laparotomies (NTL) still occur, with considerable morbidity and cost. We analyzed our institution's NTL cases, aiming to identify factors that may prevent NTL. **Methods:** We conducted a retrospective database and chart review of all trauma laparotomies performed at a major Canadian trauma centre from 2002 to 2009.

Patient demographics, injury mechanism, initial assessment and operative findings were recorded. Nontherapeutic trauma laparotomy was defined as a trauma laparotomy with serosal/mesenteric/superficial or no injuries identified and/or treated. All other laparotomies were considered therapeutic (TTL). **Results:** Of 873 trauma laparotomies, 33 (3.8%) were nontherapeutic. There was no significant age or sex difference between patients undergoing NTL and TTL. Twenty-one (63.6%) NTL patients sustained stab wounds; 6 (18%) were self-inflicted. In TTL, these proportions were significantly lower, at 28.3% and 5.8%. Unconsciousness and overall injury severity were less important: the mean NTL Glasgow Coma Scale score was 14 (SD 2.1) compared with 12 (SD 5.1) for all trauma laparotomies; and the mean NTL ISS was 11.5 (SD 11.4) versus 29 (SD 16.4) for all laparotomies. More than half of NTLs (51.5%), compared with 44% of TTLs, were performed without preceding abdominal CT scans, despite approximately 75% being hemodynamically stable. Peritonitis was an indication for surgery in approximately one-third of NTLs. **Conclusion:** Nontherapeutic trauma laparotomies are uncommon, constituting less than 4% of our institution's trauma laparotomies. They are commonly done in patients with less severe injuries, stab wounds and without preoperative abdominal CT scans, even when hemodynamically stable. Further studies should investigate whether preoperative CT scans and diagnostic adjuncts such as laparoscopy reduce NTL in stable penetrating trauma patients.

Noninvasive hemoglobin monitoring in trauma patients. P. Engels,* A. Romanovsky,† S. Bagshaw.† From the *Sunnybrook Health Science Centre, Toronto, Ont., and the †University of Alberta, Edmonton, Alta.

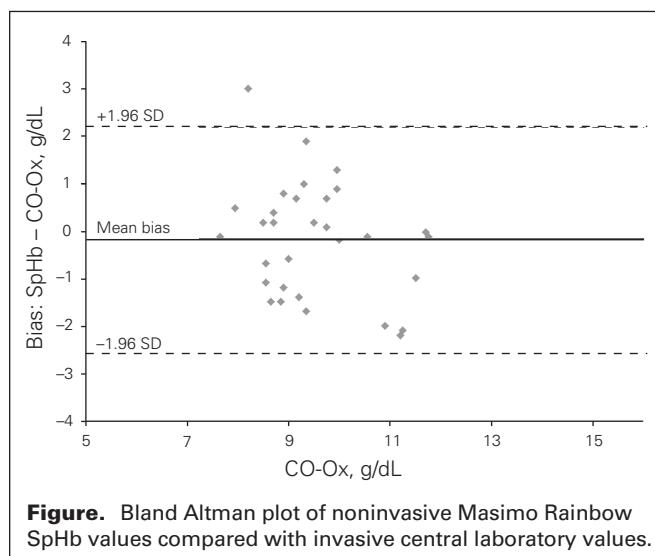
Background: Detection of bleeding is critical in the management of trauma patients. Use of a noninvasive hemoglobin monitor may detect drops in patient hemoglobin and alert clinicians of immediate risk. In this observational study, we evaluated the accuracy of noninvasive hemoglobin monitoring in resuscitation of critically ill major trauma patients. **Methods:** We performed a prospective, observational, pilot study of 10 critically ill trauma patients admitted to the intensive care unit at the University of

Alberta Hospital. All patients were continuously monitored with the Masimo Rainbow SET Pulse CO-Oximetry device for hemoglobin (SpHb) when admitted. Blood samples were measured in the central laboratory by CO-Oximetry. SpHb measurements were recorded at the time of the blood draw and compared with CO-Oximeter values. **Results:** The mean (SD) age of these patients was 32 (10.1) years, and 70% were men. Blunt injury was the mechanism in 90% (78% owing to motor vehicle collision). The mean (SD) injury severity score was 38 (17.7). All patients were mechanically ventilated, and 50% required emergency operative interventions. Patients were monitored with the Masimo ReSposable Sensors for an average of 43.9 (SD 23.5) hours. Figure 1 shows the Bland Altman plot of the SpHb versus laboratory CO-Oximeter values. **Conclusion:** The measurement of SpHb in major trauma shows reasonable accuracy across several days of care in trauma patients. A larger prospective investigation of this novel bedside tool is warranted.

Quality improvement practices of trauma centres in the United States, Canada and Australasia. M. Jose Santana,* S. Strauss,† A. Nathens,‡ R. Gruen,§ A. Kirkpatrick,¶ H.T. Stelfox,¶ From the *University of Calgary, Calgary, Alta., the Departments of †Medicine and ‡Surgery, Saint Michael's Hospital, University of Toronto, Toronto, Ont., the §University of Melbourne, Melbourne, Australia, and the ¶Foothills Medical Centre, University of Calgary, Calgary, Alta.

Background: Injury is a leading cause of morbidity and mortality in countries around the world, but patient outcomes vary among countries with similar systems of trauma care. We performed an environmental scan to compare the "real world" quality improvement practices of trauma centres in 4 high-income countries. **Methods:** We surveyed medical directors and program managers from 330 trauma centres verified by professional trauma organizations in the United States ($n = 263$), Canada ($n = 46$) and Australasia (Australia $n = 18$, New Zealand $n = 3$) regarding their quality improvement practices. Quality indicators were requested from all centres that indicated they measured their quality of care. Follow-up interviews were performed, with 75 centres purposively sampled across 6 baseline criteria. **Results:** We received survey responses from 251 centres (76%) with a similar distribution across countries. Trauma centres in the United States were more likely than those in Canada and Australasia to report measuring quality indicators (100% v. 94% v. 93%, $p = 0.008$), using report cards (53% v. 33% v. 31%, $p = 0.033$) and benchmarking (81% v. 61% v. 69%, $p = 0.019$). Centres in all 3 regions primarily used hospital process and outcome measures designed to establish whether care was safe (95% v. 100% v. 92%, $p = 0.252$), effective (94% v. 86% v. 83% $p = 0.042$), timely (87% v. 100% v. 100%, $p = 0.027$) and efficient (78% v. 91% v. 42%). Few centres included quality indicators to measure whether care was patient-centred (5% v. 9% v. 8%, $p = 0.411$) or equitable (2% v. 0% v. 8%, $p = 0.293$). **Conclusion:** Significant regional variation exists in how trauma centres perform quality improvement activities. Opportunities exist for improving and standardizing quality improvement processes.

Concurrency in data collection improves patient outcomes. T. Taulu,* L. Quinn,† N. Lakha.‡ From *Trauma



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Background: The definition of data concurrency differs throughout the country, and the value of concurrent data collection and analysis has never been formally realized within the health care setting. Trauma registry (TR) data collection is historically primarily collected on patient discharge and is therefore retrospective in nature when looking at quality. This time frame can differ from weeks to months, depending on the institution. The purpose of this study is to identify strategies for concurrent data collection that integrate data within the TR and assess whether real-time data collection improves quality. **Methods:** This was a prospective study that included all trauma consults and trauma team activations directly admitted to Vancouver General Hospital between July 2010 and October 2010. A preregistry database was created that enabled the trauma coordinator to gather data elements and monitor performance in real time. This database is linked directly to the TR, therefore decreasing redundant data collection. A matching data dictionary was also created to standardize definitions. This allowed the coordinator to follow-up on issues daily while events were still clear in the provider's memories. The matching linked data were then dumped into the trauma registry. **Results:** During the study period, the trauma population had better patient outcomes. Performance indicators such as compliance with trauma team activation and trauma centre criteria increased to between 90% and 95%. Timely temperatures and arterial blood gas values in trauma activations also increased from 50% to over 75% during that time frame. The trauma patients also had significantly lower incidence rates of infection, deep vein thrombosis and length of time in high acuity beds and overall decreased length of stay in hospital. **Conclusion:** This study identified that the implementation of a concurrent preregistry database improved quality and overall trauma patient outcomes. The preregistry also allowed the team to monitor trends and issues concurrently and develop mitigation strategies in timely manner.

Blunt aortic injury: a population-based analysis with the national trauma registry. C. de Mestral,* B. Haas,† A. Dueck,‡ D. Gomez,* S. Sharma,§ A. Nathens,¶ From *St. Michael's Hospital, the †University of Toronto, the ‡Division of Cardiac and Vascular Surgery, Sunnybrook Health Sciences Centre, the §Division of Neurosurgery, University of Toronto, and the ¶Department of Surgery, St. Michael's Hospital and University of Toronto, Toronto, Ont.

Background: Blunt aortic injury (BAI) represents 0.3% of trauma admissions to designated trauma centres; however, the proportion of patients with BAI treated at nontrauma centres (NTC) is unknown. Our objective was to evaluate the epidemiology of BAI across Canada and describe the clinical course of patients managed at NTCs. **Methods:** This is a population-based retrospective cohort study of patients with BAI using the Canadian National Trauma Registry (NTR). All adult patients admitted from 2002 to 2008 following blunt injury with a diagnosis code for traumatic thoracic BAI were included. **Results:** We identified 539 patients with BAI. The incidence of hospitalization was 3.10 per million Canadians per year, and has remained stable from 2002 to 2008.

Over the study period, the proportion of open repairs declined (from 34.8% to 12.0%, $p < 0.0001$) and that of endovascular repairs increased (from 4.0% to 23.5%, $p < 0.0001$). Mortality (17.3%) remained unchanged over this time. Forty-six patients (8.5%) were first admitted to an NTC. Of these patients, 31 (67%) were transferred to another institution (90% within 48 hr), and 6 patients (13%) died within 24 hours of arrival to the NTC. Of the 9 patients who received their definitive care at the NTC, only 5 underwent repair (4 open, 1 endovascular). **Conclusion:** Most patients with BAI are cared for in trauma centres, and among those first admitted to a NTC, transfer is relatively prompt. In contrast to other reports, the increasing use of endovascular repair was not associated with lower mortality.

The song remains the same although the instruments are changing. Complications following selective nonoperative management of blunt spleen trauma: a retrospective review of patients at a level I trauma centre from 1996 to 2008. A. Clancy,* L. Kmet,† D. Ashman,† C. Tiruta,‡ C. Ball,§ A. Kirkpatrick,§ From *Queen's University, Kingston, Ont., the †Regional Trauma Services, the ‡Department of Surgery, University of Calgary, and the §Foothills Medical Centre, Calgary, Alta.

Background: Despite a widespread shift to selective nonoperative management (SNOM) for blunt splenic trauma, there remains uncertainty regarding the role of adjuncts such as interventional radiological techniques, the need for follow-up imaging and the incidence of long-term complications. We evaluated the success of SNOM (including splenic artery embolization) for the management of blunt splenic injuries in severely injured patients. **Methods:** We conducted a retrospective review (1996–2008) of the Alberta Trauma Registry and health records for blunt splenic trauma patients, aged 18 and older, with injury severity scores of 12 or greater, admitted to the Foothills Medical Centre. **Results:** Among 538 eligible patients, 28% underwent early operative intervention, although the proportion of patients who underwent SNOM rose over the study period. The overall success rate of SNOM was 86%, whereas injury acuity remained unchanged over time. Among the patients for whom SNOM failed, 70% underwent surgery within 24 hours of admission. Splenic artery embolization was used in only 7% of patients managed nonoperatively, with a low rate of complications. Among Calgary residents undergoing SNOM, the hospital readmission rate for splenic indications in the 6-month postdischarge period was 2%, and the rate of follow-up CT imaging was 20%. None of the CT images identified occult hemorrhage or pseudoaneurysm. **Conclusion:** Selective nonoperative management was the initial treatment strategy for most patients with blunt splenic trauma, with 14% requiring subsequent operative intervention. The low use of both follow-up imaging and splenic artery embolization make assessment of the utility of these adjuncts difficult, and adherence to formalized protocols will be required to fully assess the benefit of multimodality management strategies.

Implementing a provincial burn registry to support quality assurance. M. Vivas,* A. Papp,* R. Simons,† N. Lakha,‡ From the *Vancouver General Hospital, †Trauma Services, Vancouver Coastal Health, and the ‡University of British Columbia, Vancouver, BC

Background: British Columbia has 2 provincial burn centres, one for adult and one for pediatric care. It is important to understand the coordination of burn care from prehospital to discharge and follow-up. Databases existed at each facility without standard data definitions, criteria or personnel to collect data. It became evident that obtaining data from the existing databases was troublesome. The lack of a standard tool was a limitation to determining the incidence of burn injuries, referral processes, care, outcomes and resources required. **Methods:** A provincial burn registry was implemented at the 2 burn centres between October 2009 and September 2010. Software from the American Burn Association (ABA) was obtained to collect data. Criteria were formalized to determine patient population for the burn registry. Standardized data collection forms were developed to be consistent with ABA data requirements. **Results:** Data for burn patients were collected concurrently. Through this process, a complications data collection form was designed to support peer reviews. The burn diagram form was enhanced to accurately determine the extent, severity and location of burn injuries. Monthly reports were generated identifying trends, etiology, outcome, total body surface area, length of stay, complications and resources used. These trends were reported in quality assurance meetings influencing change in policies and care. **Conclusion:** Concurrent data collection for the burn registry is a vital tool in the continuous monitoring of care and patient outcomes. It has the potential to improve the quality of care through quality assurance and research.

Simple, almost anywhere, with almost anyone: remote low-cost telementored resuscitative lung sonography conducted wherever there is Internet access. *P. McBeth,* T. Hamilton,† K. Musselwhite,† N. Panebianco,† L. Melnick,† R. Chun,† C. Ball,† L. Gargani,‡ C. Gherdovich,‡ A. Kirkpatrick,§* From the *University of Calgary, the †Department of Surgery, University of Calgary, ‡WINFOCUS and the §Foothills Medical Centre, Calgary, Alta.

Background: Apnea (APN) and pneumothorax (PTX) are life-threatening conditions common in many emergencies. Ultrasound (US) is a portable tool that captures physiology as digital information, allowing ready communication. Both APN and PTX are simply ruled out by noting respiratory motion at the visceral-parietal pleural interface, termed sliding (SLD), corroborated by either M-mode or colour-power Doppler depiction of SLD. We thus assessed how economically and practically this information could be obtained from remote sites. **Methods:** Ultrasound images were obtained on a first-generation machine streamed to a free Internet service (Skype) tethered by an iPhone to a local 3-G network. Expert sonographers directed remote providers (with variable to no US experience, including a 7-year-old child) to obtain images by viewing the transmitted US signal as well as the remote examiners' actions over a head-mounted webcam. Examinations were conducted between a series of remote sites and a base station. Remote sites were on-mountain (2) and in a Calgary household, with base sites located in Pisa, Rome and Calgary. **Results:** In all lung fields (8/8) on all occasions, lung sliding could easily and quickly be seen, including when a 7-year-old in Calgary was mentored by a physician in Pisa. Sliding was easily corroborated and documented through capture of colour-power Doppler and M-mode images. **Conclusion:** The emergent exclusion of

APN and PTX can be achieved using a remote expert economically linked to almost any responder. Further work should explore the range of other physiologic functions that could be remotely assessed through simple, mentored ultrasound algorithms.

Microarray analysis of gene expression profiles in traumatic brain injury patients: impact of prehospital fluid resuscitation. *M. Shiu,* J. Cushieri,† S. Rizoli,* S. Rhind,† C. Virtanen,† W. Junger,§ A. Baker,¶ E. Bulger,¶* From the *Sunnybrook Health Sciences Centre, †Defence Research & Development Canada, the ‡UHN Microarray Centre, Toronto, Ont., the §Department of Surgery, Beth Israel Deaconess Medical Center & Harvard Medical School, Boston, Mass., and ¶St. Michael's Hospital, Toronto, Ont.

Background: Traumatic brain injury (TBI) elicits a cascade of biomolecular events leading to neuroinflammation, cerebral edema and delayed cellular damage. Prehospital resuscitation restores cerebral perfusion and modulates inflammatory responses. Evidence suggests that different resuscitation fluids induce distinctive patterns of cellular activation and gene expression. The aim of this trial was to characterize global gene expression profiles in severe TBI patients (mean Glasgow Coma Scale score 4.8 [SD 2.1]; mean ISS 31.8 [SD 14.6]; mean Abbreviated Injury Scale, head score 3.9 [SD 1.1]) resuscitated with 250 mL of 7.5% saline (HS), 7.5% saline/6% detran 70 (HSD) or 0.9% saline (NS). **Methods:** Peripheral blood samples were collected directly into PaxGene RNA stabilization tubes from patients ($n = 70$) within 3 hours of resuscitation and from healthy controls ($n = 10$). Purified leukocyte mRNA was hybridized using 2-colour Agilent oligonucleotide arrays. Data were analyzed using GeneSpring Software by t test and analysis of variance with false discovery rate correction of $p < 0.05$ using the Benjamini and Hochberg methodology. **Results:** This study provides the first genome-wide interrogation of the peripheral blood transcriptome in TBI patients. Of 41 000 genes profiled, statistically significant alterations in the pattern expression of 12 856 genes were found in patients versus controls. At the 2-fold level, 3006 genes were differentially regulated between the groups. Further analysis indicated that 2333 genes were differentially expressed between the fluid treatment groups, which were most commonly associated with immune activation, inflammation, proliferation and cellular signaling. **Conclusion:** These findings identify complex patterns of gene expression in TBI that provide insight into altered cellular functions underlying secondary brain injury and may suggest a rationale for specific resuscitation strategies. (NIH R01-2007-000-20819-0; Defence R&D Canada)

Sports concussion — an Olympic boxing model (biomechanics, cognitive function, second impact syndrome). *M. Boitano.* From Hamilton Health Sciences / McMaster University, Hamilton, Ont.

Background: Previous studies have evaluated the biomechanics of a punch; however, real time data during a bout have never been collected. The objective was to measure the location, frequency and severity of impacts during a competitive bout, along with evaluation of cognitive function and sequelae. **Methods:** Using instrumented boxing headgear (12 single-axis linear accelerometers, battery pack and radio placed in the back panel of the headgear of

Olympic-style boxers), translational and rotational accelerations, Head Injury Criterion (HIC) and Gadd Severity Index were determined for each impact. The Standardized Assessment of Concussion (SAC) test was used to evaluate cognitive function. Data were collected on 45 male boxers. **Results:** The data from the Instrumented Boxing Headgear (IBH) included 1930 impacts. The HIC had a mean of 44 (SD 100), maximum 981; a translational mean of 29 (SD 21) g, maximum 178 g; and a rotational mean of 2240 (SD 1592) rad/s², maximum 10163 rad/s². The SAC test noted a decrease in delayed memory. Three boxers sustained a concussion, and 2 of these also sustained a second impact syndrome. **Conclusion:** Rotational acceleration plays a more substantial role in boxing than in football. Our goal is to develop training that will decrease rotational acceleration. Regarding cognitive function, the average drop was 2.1 for the SAC test (this was not statistically significant).

Recalling preinjury disability following orthopedic trauma. *O. Williamson,* A. Sutherland,* M. Hart,† B. Gabbe.** From *Monash University, Victoria, and the †Royal Melbourne Hospital, Melbourne, Australia

Background: Preinjury disability must be accounted for when assessing the effects of injuries or treatment on injury recovery. The need to collect this information close to the time of injury has been suggested to minimize recall bias, but evidence to support this is lacking. This study investigated factors that influence the recollection of preinjury disability following orthopedic trauma. **Methods:** Self-reported preinjury disability was recorded at baseline, 6 and 12 months postinjury in patients admitted with orthopedic injuries to two level 1 adult trauma centres. Multinomial logistic regression was used to identify factors associated with changes in reported preinjury disability with time. **Results:** In all, 801 patients participated (62% male, median age 44 [range 15–92] yr). Patients presented with isolated (34%) or multiple orthopedic injuries (24%), or orthopedic and other injuries (42%). At baseline, patients reported no (80%), mild (12%), moderate (5%) or severe (3%) preinjury disability. Seventy-four percent of patients reported the same preinjury disability at subsequent time points, with 89% of patients reporting the same level of preinjury disability at 6 and 12 months. Although 14% of patients reported less preinjury disability at 12 months, 7% reported more disability compared with baseline. There was no association between sex, age, compensation status, injury severity or head injury status and the reporting of less or more preinjury disability at 6 and 12 months. **Conclusion:** This study did not find systematic changes in the reporting of preinjury disability with time and suggests that valid preinjury disability ratings can be obtained when assessing outcomes 6 or 12 months after orthopedic injury.

Comparing the responsiveness of functional outcome assessment measures for trauma registries. *O. Williamson, B. Gabbe, A. Forbes, R. Wolfe, A. Sutherland, P. Cameron.* From the Monash University, Victoria, Australia

Background: Measuring long-term disability and functional outcomes following major trauma is not standardized across trauma registries. An ideal measure would be responsive to change but not have significant ceiling effects. The aim of this study was to com-

pare the responsiveness of the Glasgow Outcome Scale (GOS), Glasgow Outcome Scale–Extended (GOSE), Functional Independence Measure (FIM) and modified FIM in major trauma patients both with and without significant head injuries. **Methods:** Patients admitted to 2 adult level 1 trauma centres in Victoria, Australia, who survived to discharge from hospital, were aged 15–80 years, with a blunt mechanism of injury, and had an estimated Injury Severity Score (ISS) greater than 15 on admission, were recruited for this prospective study. The instruments were administered at baseline (hospital discharge) and by telephone interview 6 months following injury. Measures of responsiveness, including effect sizes, were calculated. Bootstrapping techniques and floor and ceiling effects were used to compare the measures. **Results:** In all, 243 patients participated, of whom 234 (96%) completed the study. The GOSE and GOS were the most responsive instruments in this major trauma population, with effect sizes of 5.3 and 4.4, respectively. The GOSE had the lowest ceiling effect (17%). **Conclusion:** The GOSE was the instrument most responsive to change in major trauma patients with and without significant head injury and is recommended for use by trauma registries for monitoring functional outcomes and benchmarking care in trauma patients. The results of this study do not support the use of the modified FIM for this purpose.

Evolution of a trauma flight program in a rural Canadian province. *C. Smith, D. Boone.* From the Memorial University of Newfoundland, St. John's, NL

Background: Evaluation of a newly developed trauma flight program demonstrated prolonged transport times. There was a trend toward improvement in quality of care. Our goal was to reassess the program 2 years after its inception. **Methods:** We conducted an observational study comparing outcomes of trauma patients transported before and after the institution of an air transport program. We compared patients transported in the year before the development of the flight program from July 2006 to August 2007 (Before Flight) to those transported from August 2009 to September 2010 (After Flight). The primary outcome measure was total transport time (Total). Secondary outcome measures were dispatch time (Dispatch) and actual transport time (Transport). All times are reported in minutes. **Results:** Interim analysis showed significantly prolonged Total time in the After Flight group (400 v. 285, $p = 0.001$) owing to increased Dispatch time (253 v. 100, $p < 0.001$). There was a trend toward improvement in Transport time (147 v. 187, $p = \text{NS}$). In our current analysis, Total time was similar in both groups (345 v. 285, $p = \text{NS}$). Dispatch time has improved but still remains significantly prolonged (207 v. 100, $p < 0.001$), whereas Transport time has decreased (139 v. 187, $p = 0.046$). **Conclusion:** Improvements have been made in flight team mobilization and the transport of severely injured trauma patients. Dispatch time remains a limiting factor. Further studies will be required to explore the clinical impact of the trauma flight team.

The New Brunswick trauma program: a model of system inclusivity. *I. Watson, M. Martin.* From the New Brunswick Trauma Program, St. John, NB

Background: Beginning in February 2010, directors of the New Brunswick Trauma Program began formalizing an inclusive

model of trauma system design for the new, provincial trauma program. The resulting model provides for an integrated, provincial approach to trauma services delivery that is unique to Canada. **Methods:** Following a related literature review, directors of the newly-created New Brunswick Trauma Program began active discussions with the government of New Brunswick, the provincial emergency medical services provider and Regional Health Authorities with a view to creating an inclusive model of system design — one that recognizes key partners to the program, individual trauma centres, and a provincial scope that includes trauma care, education, research and prevention. **Results:** The resulting system design for the NB Trauma Program, approved in July 2010, recognizes the government of New Brunswick, Ambulance NB and Regional Health Authorities as co-owners of the program. Together with the inclusion of 19 acute care hospitals and structures to support trauma care, education, research and prevention, the NB Trauma Program is structured in a way that is unique to Canadian jurisdictions. **Conclusion:** The NB Trauma Program has formalized an inclusive system design that not only recognizes strategic partners, but also acute care hospitals and a comprehensive program scope. Ongoing process review and performance management measures will demonstrate the effect this design has had on trauma mortality and morbidity.

Implementing a provincial field trauma triage system: process and outcomes. *R.-D. Boulay,* E. Goulette,* M. Martin,† I. Watson,† J.-P. Savoie,* A. Touchburn.‡* From **Ambulance New Brunswick, Moncton, the †New Brunswick Trauma Program, St. John, and the ‡NB Health Emergency Management Services, Fredericton, NB*

Background: A program of Field Trauma Triage (FTT) by all New Brunswick paramedics was developed in the summer of 2010. The development phase identified several key success factors to ensure acceptance of the program by New Brunswick paramedics and acute care hospitals. **Methods:** Beginning in April 2010, the NB Trauma Program conducted a comprehensive, international literature review of available FTT guidelines. The review identified a set of evidence-based guidelines that were suitable for adaptation and adoption in New Brunswick. Definitive destination guidance was added to the guidelines, and supporting processes within the provincial emergency medical services communications centre were developed. Following the development and delivery of an associated, 1-day paramedic education program, provincial FTT guidelines were implemented across New Brunswick on Nov. 1, 2010. **Results:** Several factors have influenced the acceptance of the program with New Brunswick acute care hospitals and with NB paramedics. Specifically, definitive destination guidance within the FTT guidelines, coupled with a system of real-time verification of paramedic decisions, demonstrable knowledge transfer for paramedics, the value of a provincial registry of bed and specialist availability and the need for a comprehensive data set to review all FTT decisions were identified as system strengths. **Conclusion:** Developing and implementing a provincial system of Field Trauma Triage requires an integrated, comprehensive approach that ensures both paramedic and acute hospital acceptance before implementation. Ongoing process review and performance measurement remain critical success factors.

Continuous improvement in a new, provincial toll free trauma referral system. *A. Hogan,* R.-D. Boulay,† J.-P. Savoie,† M. Martin,* I. Watson.** From the **New Brunswick Trauma Program, St. John, and †Ambulance New Brunswick, Moncton, NB*

Background: Beginning in June 2010, the New Brunswick Trauma Program began processing all trauma transfers through a single, toll-free trauma referral system. This system used a single trauma control physician for the first 6 months of operation. During this period, methods of data capture and analysis identified areas for process improvement. **Methods:** The toll-free trauma referral system records all physician calls related to potential trauma transfers in New Brunswick. Following system development and associated education for standardized call processing, including use of physician checklists, 100% of these calls were reviewed by an experienced trauma coordinator who annotated each call and assigned a numeric score to each transaction occurring within each call. These notes and scores were shared with the trauma control physician and other call participants to improve process performance. **Results:** Scoring and analysis of toll-free trauma referral calls identified the specific call transactions requiring the most improvement, allowing targeted improvement efforts. Improved compliance with established guidelines and checklists further improved performance. **Conclusion:** Although common in the aviation industry and in surgical suites, application of checklists to the management of toll-free trauma referral systems is useful in improving system performance. Scoring each transaction within a series of toll-free trauma referral calls is an effective way to identify areas of strength and opportunities for improvement.

Emergency department procedural sedation and analgesia: use of a standardized nursing documentation template to improve documentation of care. *A. Hogan, S. Benjamin.* From the *New Brunswick Trauma Program, St. John, NB*

Background: Our aim was to determine if the use of a standardized nursing documentation record improves documentation and delivery of care for procedural sedation and analgesia (PSA) in a Canadian tertiary emergency department (ED). **Methods:** We performed a consecutive review of emergency department records (all ages) between February 2007 to March 2010 of patients who required procedural sedation and analgesia due to an injury. A PSA nursing documentation template was designed and introduced in October 2007. A comparison was done pre- and post-template implementation that examined the recorded weight, consent, intravenous (IV) solution, post-treatment limb neurovascular assessment, written discharge instructions and length of stay after last sedation medication. **Results:** The baseline group included 119 cases, whereas the postdocumentation group included 777 cases. Prior to implementation, compliance was low for weight (28%), post-limb assessment (56%), appropriate IV solution (61%) and discharge instructions (24%). For the 6 months following implementation of the template, the rates improved weight (64%), post-limb assessment (83%), appropriate IV solution (82%) and discharge instruction (31%). There was an 80% usage rate of the notes. In the 2.5 years following implementation, the compliance rate for weight (73%), post-limb assessment (75%),

appropriate IV solution (84%) and discharge instructions (34%). In 2009–2010, the PSA nursing documentation template use remained high at 95% or more. **Conclusion:** The introduction of a standardized documentation template for PSA improved compliance with documentation. Use of a standardized documentation template for PSA remained high after 3 years.

Exploring opportunities for improving triage in an urban trauma system. *A. Doumouras,* B. Haas,* D. Gomez,† D. Boyes,‡ A. Craig,‡ L. Morrison,§ A. Nathens.‡* From the *University of Toronto, †St. Michael's Hospital, ‡Toronto Emergency Medical Services, and §St. Michael's Hospital and the Department of Surgery, University of Toronto, Toronto, Ont.

Background: Urban trauma systems are characterized by high population density, availability of trauma centres and transport times less than 30 minutes. Small changes in triage practices might significantly impact lives saved. In such systems, patients meeting field trauma triage criteria should be transported directly to a trauma centre (TC), bypassing closer nontrauma centres (NTCs). We evaluated triage practices in Toronto to identify opportunities for improving care delivery. **Methods:** This is a retrospective cohort study of adults meeting field trauma triage criteria in Toronto (2005–2010). Road travel distances between the site of injury, the closest NTC and the closest TC were estimated using geographic information systems. For patients who were transported to an NTC, we estimated “differential distance” (DD): the additional travel distance required to transport directly to a TC. Logistic regression was used to analyze the effect of DD on triage decisions, adjusting for other patient characteristics. **Results:** Inclusion criteria identified 898 patients; 53% were transported directly to a TC. Falls, female sex and age greater than 65 were associated with transport to an NTC. Differential distances of 2.5–5 km (OR –0.48, 95% CI 0.29–0.77), 5–10 km (OR –0.26, 95% CI 0.16–0.42) and more than 10 km (OR –0.18, 95% CI 0.11–0.30) were associated with a decreased likelihood of triage to a TC, compared with a DD of less than 2.5 km. **Conclusion:** Differential distance between the closest NTC and closest TC was associated with lower compliance with triage protocols, even in an urban setting where TCs can be accessed in an acceptable length of time. These findings will lead to further exploration of knowledge and perceptions of providers to better tailor resources to patients' needs.

Effective crisis team training for postgraduate trainees: an update, literature review and best-practice guideline. *A. Doumouras,* I. Keshet,* A. Nathens,†‡ N. Ahmed,* C. Hicks.** From *St. Michael's Hospital and the †Department of Surgery, University of Toronto, Toronto, Ont.

Background: Team-based training and crisis resource management (CRM) has gained popularity as a strategy to minimize the impact of medical error during critical events. The purpose of this review was to appraise and summarize the design, implementation and efficacy of peer-reviewed simulation-based CRM training programs for postgraduate trainees (residents). **Methods:** Two independent reviewers conducted a structured literature review, querying multiple medical and allied health databases (MEDLINE, EMBASE, CINAHL, EBM and

PsycINFO). Studies to be included must have involved residents, evaluation in a team setting, crisis situations and simulation training. Peer-reviewed articles describing the implementation of CRM instruction were critically appraised using the Kirkpatrick framework for evaluating training programs. **Results:** Fifteen studies involving a total of 404 residents met inclusion criteria; the majority reported high resident satisfaction for CRM training. Themes relating to pedagogical techniques and evaluation including the importance of pairing scenarios with timely, targeted feedback, potential synergy between didactic teaching and simulation, validity of behaviour rating scales to evaluate non-technical skill uptake, and efficacy of a single day of simulation-based instruction to provoke positive changes in team-based knowledge, skills and behaviours. No studies demonstrated a link between simulation-based CRM training and performance during real-life critical events. **Conclusion:** The findings support the utility of CRM programs for postgraduate trainees. A high degree of satisfaction and perceived value reflect robust resident engagement. The iteration of themes from our review provides the basis for the development of best practices in curricula design.

Access to trauma centre care following severe TBI. *S. Sharma,* D. Gomez,† C. de Mestral,† J. Rutka,* A. Nathens.†‡* From the *Division of Neurosurgery, University of Toronto, †St. Michael's Hospital, and the ‡Department of Surgery, University of Toronto, Toronto, Ont.

Background: Traumatic brain injury (TBI) is one of the most common causes of injury-related morbidity and mortality. Access to neurosurgical services is critical to optimal outcomes through reduction of secondary injury. We sought to evaluate variations in access to neurosurgical care across a regional trauma system. **Methods:** This analysis is based on a retrospective cohort design. The cohort included patients with isolated severe TBI across Ontario from 2005 to 2009. Population-based data sets were linked to identify the cohort and follow their course of care. Initial care was characterized as at a nontrauma centre (NTC) or trauma centre (TC). Determinants of TC care were evaluated. **Results:** We identified 9660 patients with severe TBI. Thirty-day mortality was 21% ($n = 1984$). Almost two-thirds (60%, $n = 5496$) received initial care at an NTC. Less than one third (18%, $n = 1737$) of these patients were subsequently transferred to a TC. Mortality at a TC versus an NTC was 20% and 22% ($p < 0.05$), respectively. Sixty-seven percent of patients younger than 65 had access, whereas 41% of patients older than 65 had access ($p < 0.01$). Access differed at the county level, from a low of 16% of patients with severe TBI having access to TC care to a high of 97% of all TBI patients accessing TC care. **Conclusion:** Considerable variation in delivery of initial care to TBI patients was identified. Factors such as age and geography played a role in whether patients were initially treated at a TC. The role of timely care in TBI necessitates improvements in access for TBI patients to TC care.

The use of focused assessment with sonography for trauma in North American pediatric trauma centres. *K. Vogt,* L. Dubois,* N. Merritt.†* From the *University of Western Ontario and the †Children's Hospital at London Health Sciences Centre, London, Ont.

Background: Despite the potential benefits of focused assessment

with sonography (FAST), incorporation in pediatric trauma has been slow. This study was undertaken to identify pediatric trauma centres in North America currently using FAST. Further, we aimed to describe the logistics of FAST in these centres, the use of alternate modalities for abdominal assessment and attitudes toward FAST utilization and training. **Methods:** A cross-sectional survey was administered to trauma program directors at 12 Canadian and 34 American pediatric trauma centres using an electronic survey collection tool and a modified Dillman approach. **Results:** Responses were received from 36 (78%) institutions. Twenty-one centres (58%) reported using FAST. There was no difference between the proportion of Canadian and American centres using FAST ($p = 0.27$). Emergency physicians perform FAST exams in the majority of centres (14 of 36, 39%). The rate of CT utilization was felt to have declined in only 3 centres (14%) with the use of FAST. The majority of respondents (61%) felt that FAST should become a formal component of pediatric trauma training. Among respondents who reported FAST was not used in their centre, the most frequently cited barriers were the perception that FAST does not change management, and a lack of training. **Conclusion:** This is the first study to assess the utilization for FAST specifically in pediatric trauma centres, and demonstrates that FAST may be underutilized in the pediatric population. Barriers to the implementation need to be addressed, and the incorporation of FAST as a formal component of pediatric trauma training may be beneficial.

Epidemiology of major trauma: a Canadian perspective. *A. Hill,* R. Fowler,* R. Pinto,* A. Nathens.†* From the *Sunnybrook Health Sciences Centre and †St. Michael's Hospital and the Department of Surgery, University of Toronto, Toronto, Ont.

Background: Major injury (Injury Severity Score [ISS] > 15) epidemiology is poorly described within Canada. We sought to provide demographics, injury characteristics and outcomes for injured patients treated in Canada. **Methods:** Analysis of the data collected as part of the National Trauma Registry Minimum Data set was for fiscal years 2002–2008, for all provinces except Quebec. The study cohort included patients older than 16 years, and where cause of injury was not due to burns, suffocation or drowning. A validated ICD-10 to Abbreviated Injury Scale cross-walk was used to generate an ISS for patients. **Results:** A total of 95 783 major trauma hospitalizations were identified. The age- and sex-standardized major injury hospitalization rate increased 11.7%, from 63.1 per 100 000 in 2002 to 70.5 per 100 000 in 2008. During the same period, age- and sex-standardized hospitalization rates for older patients (age ≥ 65) increased 19%. Hospital mortality was 9.9%, with the age- and sex-adjusted mortality rate remaining stable (6.1 per 100 000 in 2002 to 6.2 per 100 000 in 2008). Male patients, older patients (age ≥ 65) and young adults (age 17–34) represented 67.7%, 36.7% and 26% of the patient population, respectively. Falls (45%) and motor vehicle collisions (39%) were the leading mechanisms of injury. **Conclusion:** The hospital mortality rate has remained stable over time. However, the major injury hospitalization rate increased over the 7-year study period, in particular among older patients. These findings suggest that the burden related to major injury will continue to increase, owing in part to the aging population. Attention to these trends must be considered in injury prevention strategies.

Hospital factors impact the time to definitive care for patients undergoing interfacility transfer. *D. Gomez,* B. Haas,† C. de Mestral,* S. Sharma,‡ B. Zagorski,§ J. Ray,*¶ G. Rubenfeld,*¶ A. Nathens.*††* From *St. Michael's Hospital, the †University of Toronto, the ‡Division of Neurosurgery, University of Toronto, the §Institute for Clinical Evaluative Sciences, the ¶Department of Medicine, University of Toronto, the **Sunnybrook Health Sciences Centre and the ††Department of Surgery, University of Toronto, Toronto, Ont.

Background: Severely injured patients who receive initial care at nontrauma centres (NTC) commonly experience prolonged emergency department lengths of stay (ED-LOS) before transfer to trauma centres (TC). Furthermore, significant variation in ED-LOS across NTCs has been described. Our objective was to evaluate whether hospital characteristics are associated with prolonged ED-LOS. **Methods:** This is a population-based retrospective cohort study of severely injured (ISS > 15) adults who were transferred from an NTC to a TC in Ontario (2002–2009). Emergency department LOS was evaluated using data sources that capture all ED visits and hospital admissions in the province; an ED-LOS above the 75th percentile was considered prolonged. Predictors of prolonged ED-LOS at the patient and hospital level were evaluated. **Results:** We identified 4544 severely injured patients across 134 NTCs. The mean ISS was 26 (SD 9), and 30-day mortality was 11% ($n = 522$). The median ED-LOS was 2.9 hours (IQR 1.7–4.5 hr). The proportion of patients with prolonged ED-LOS varied significantly across NTCs, with a range of 0%–100% (median 19%, IQR 8%–36%). Penetrating mechanisms of injury and higher ISS scores were associated with decreased odds of prolonged ED-LOS. The presence of a CT scanner at the NTC (OR 2.9, 1.8–4.9) and the presence of a TC in the same county (OR 1.6, 1.0–2.6) were independently associated with prolonged ED-LOS. **Conclusion:** Severely injured patients experience significant delays before transfer. We have identified that NTC characteristics were independent predictors of ED-LOS, even after adjusting for patient and injury characteristics.

Close to home: an analysis of the relation between location of residence and location of injury. *B. Haas,* A. Doumouras,† D. Gomez,† A. Craig,‡ L. Morrison,†§ A. Nathens.†§* From the *University of Toronto, †St. Michael's Hospital, the ‡Toronto Emergency Medical Services and the §Department of Surgery, University of Toronto, Toronto, Ont.

Background: Injury surveillance is critical in identifying the need for targeted prevention initiatives. Understanding the geographic distribution of injuries facilitates matching prevention programs with the population most likely to benefit. At the population level, however, the geographic site of injury is rarely known, leading to the use of location of residence as a surrogate. To determine the accuracy of this approach, we evaluated the relation between site of injury and of residence over a large geographic area. **Methods:** Data were derived from a population-based, prehospital registry of persons meeting triage criteria for major trauma. Patients dying at the scene or transported to hospital were included. Distance between locations of residence and of injury was calculated using geographic information system

network analysis. **Results:** Among 3280 patients (2005–2010), 80% were injured less than 10 km from home (median 1.6 km). There were significant differences ($p < 0.01$) in distance between residence and location of injury based on mechanism of injury, age and hospital disposition. The large majority of injuries involving children (84%), the elderly (93%), pedestrians (81%), cyclists (84%), falls (90%) and assaults (77%) occurred less than 10 km from the patient's residence. Only 64% of motor vehicle collisions occurred less than 10 km from the patient's residence. **Conclusion:** Though the majority of patients are injured less than 10 km from their residence, the probability of injury occurring "close to home" depends on patient and injury characteristics. These findings will significantly improve the utility and interpretability of geospatial analyses in the context of injury prevention and trauma system planning.

Combat versus civilian open upper extremity fractures — effects of blast mechanism on limb salvage. *J. Doucet,* M. Galarneau,† D. Kim,* D. Fortlage,* J. Dye,† L. Kobayashi,* J. Lee,* P. Girard,* R. Coimbra.** From *UC San Diego and the †Naval Health Research Center, San Diego, Calif.

Background: This study compares open upper extremity fractures (UEF) in USMC/USN casualties from Iraq and Afghanistan with those from an academic level 1 trauma centre. We hypothesize that 60-day limb salvage success will be greater in a civilian setting than for combat injuries. **Methods:** We compared 28 646 records from the civilian Trauma Registry from 1985–2006 with 2282 records from the military Combat Trauma Registry for 2004–2007. Upper extremity fractures were graded using the Gustilo–Anderson (G–A) scale. Independent variables included mechanism of injury, shock, transfusions, associated injuries, ISS and mangled extremity severity score. Dependent variables included amputation and mortality. **Results:** Improved explosive devices were the most common mechanism of injury in the military group, seen in 52%, versus motor vehicle collisions in the civilian group, seen in 50.5%. Blast mechanisms were seen in 139 of 255 (55%) in the military group but were rare in the civilian group at 4 of 591 (0.7%, $p < 0.001$). The military group had 6 amputations in 255 UEF patients, and the civilian group had 591 UEFs with 9 amputations (1.5% v. 2%, NS). Military group patients had a higher mean ISS than civilian patients (21.3 [SD 14.2] v. 13.4 [SD 10.1], $p < 0.001$). Nerve injuries were more common in military than civilian UEFs (54 of 255, 21% v. 56 of 591, 9.5%; $p < 0.001$). Limb salvage of UEFs graded G–A IIIC at 60 days was successful in 20 of 22 military cases and 43 of 46 of civilian cases (91% v. 93%, NS). Mangled Extremity Severity Scores were not useful in predicting failure of limb salvage. **Conclusion:** Despite severe mechanisms and associated injuries, combat injury damage control techniques were successful in salvaging limbs and achieved results comparable to an academic trauma centre.

A web-based trauma registry system: assessing the reliability of severity scoring. *A. Abdoh, B.J.Hancock, R. Saadia, R. Nason.* From the University of Manitoba, Winnipeg, Man.

Background: Having a centralized clinical database system that could be used by multiple locations over a wide geographic area has been always a big challenge. The goal was to construct a

secure web-based trauma registry (TR) system for data acquisition, analysis and dynamic reporting. The purpose of this study is to assess the reliability of the new system in terms of calculating severity scores based on an online coding mechanism as compared with the currently used localized system. **Methods:** A structured query language (SQL) database server has been used to allow for centralized access, with proper authentication, for the purpose of data entry, analysis and up-to-the-minute reporting. The newly developed system had to allow for importing the TR data for the past 10 years to allow for the assessment of agreement between the new and current systems in calculating the Glasgow Coma Score (GCS), the Revised Trauma Score (RTS) and the Injury Severity Score (ISS), using the intraclass correlation coefficient (ICC) as a measure of absolute agreement. **Results:** A total of 2745 injured persons, 72% men, with a mean age of 40.3 (SD 22.6) years, between December 1999 and March 2009, have been imported into the new system. The agreement of the current and the new systems, as measured by ICC, was 0.9999, 0.9914 and 0.9994 for the GCS, RTS and ISS, respectively (all $p < 0.0000$). **Conclusion:** The perfect agreement with the currently used system allows for using the new centralized web-based system in a wider geographic area.

Chest trauma mortality remains unchanged over a 10-year period in Southwestern Ontario. *S. Patel,* K. Vogt,† R. Malthaner.** From the *London Health Sciences Centre and the †University of Western Ontario, London, Ont.

Background: This study was undertaken to describe the epidemiology of and assess trends in chest trauma at a single institution over a 10-year period. **Methods:** We retrospectively reviewed all patients admitted to the trauma service at the London Health Sciences Centre (LHSC) between 1999 and 2008 with a chest injury, an Injury Severity Score (ISS) greater than 12 and aged 18 or older. Demographics, injury data, interventions, length of stay and disposition were obtained from a prospectively collected trauma database. **Results:** Of the 5188 patients admitted to LHSC after trauma between 1999 and 2008, 2077 patients (40%) had chest injuries. Their mean ISS was 29, with a mean acute injury score (chest) of 3.4. The mean age was 46 years, and male patients accounted for 71% of admissions ($n = 1468$). The majority of patients incurred blunt trauma ($n = 2010$, 97%), with unintentional injuries accounting for 94% of admissions ($n = 1943$). Chest tubes were placed in 651 patients (31%), whereas 87 patients (4%) required operative intervention. Fourteen patients underwent an emergency department thoracotomy. Overall mortality was 14% (yearly range 7%–21%), the overall proportion of intentional injuries was 6% (yearly range 4%–9%) and overall incidence of penetrating trauma was 3% (yearly range 1%–6%). None of these changed significantly over the 10-year study period. **Conclusion:** There has been no significant change in the yearly mortality rate of patients with chest trauma at our centre. The proportion of intentional trauma and the proportion of penetrating trauma also were unchanged during the study period.

Outcomes of underage versus legal-age trauma alert patients under the influence of alcohol. *F. Muakkassa,* R. Marley,* F. Muakkassa,† E. Horattas,‡ A. Salvator.** From the *Akron General Medical Center, Akron, the

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Background: This study is to determine whether alcohol intoxication in legally underage trauma patients results in different outcomes compared with those who are at a legal age of alcohol consumption. **Methods:** Data were retrospectively collected from Jan. 1, 2003, to Dec. 31, 2009, at a level 1 trauma centre. There were 1299 patients admitted after trauma team activation with a positive blood alcohol level (BAC). The patients were grouped into 4 age categories: less than/equal to 18 years (high school), 19–20 years (college), 21–29 years (young adult) and 30 years and over (adult). Data were analyzed using χ^2 and analysis of variance. **Results:** Of the 1299 patients, 80% were male, and accident types were predominately motor vehicle and motorcycle collisions (MVC; 51%), falls (16%) and assaults (23%). Patients in the high school group with an MVC had a significantly lesser rate of being discharged home versus going to extended care facilities (77%) than patients in the college (87%), young adult (89%) and adult groups (84%; $p = 0.03$). Patients in the high school group had a statistically significantly higher percentage of Injury Severity Score (ISS) greater than 9 compared with the 3 other groups (50% high school v. 27% college v. 36% young adult v. 41% adult, $p = 0.04$). **Conclusion:** High school patients with a traumatic brain injury and positive BAC had higher ISS scores and lower rate of discharge to home than patients in the college group. The results of this investigation demonstrate the need for education and prevention of underage drinking and driving.

Hyperfibrinolysis is associated with increased mortality and transfusion requirements in trauma. D. Paton-Gay,* S. Scarpelini,† H. Tien,‡ P. Engels,§ A. Beckett,§ S. Rizoli.† From the *University of Alberta Hospital, Edmonton, Alta., the †University de São Paulo, São Paulo, Brazil, the ‡Sunnybrook Health Science Centre, Toronto, and the §Canadian Forces Health Services, Ottawa, Ont.

Background: The prevalence of hyperfibrinolysis following severe trauma and its clinical consequences remain unknown. Recent work suggests that antifibrinolytic drugs reduce mortality in trauma. We sought to identify the frequency of early hyperfibrinolysis in severely injured patients using thromboelastography (TEG), the only single laboratory test capable of identifying pathological fibrinolysis, and to determine its significance with respect to mortality and transfusion requirements. **Methods:** We used data from a recent observational study of consecutive adult trauma patients with an ISS of 16 or greater who were admitted to a Canadian level 1 trauma centre. Thromboelastography was performed on arrival to the trauma bay. Hyperfibrinolysis was defined as clot lysis at 30 minutes (LY30) of greater than 5.77%. Patient demographic information, ISS, clotting profile, mortality and transfusion requirements were recorded. **Results:** Overall, 377 patients were included. Hyperfibrinolysis was identified in 14 (3.7%) and was associated with an 11-fold increase in mortality (71% v. 6%). Transfusion requirements over the first 24 hours were significantly higher in the hyperfibrinolysis group (20 units v. 7 units of red blood cells). The groups differed in ISS, initial international normalized ratio and activated partial thromboplastin time. Mortality in the hyperfibrinolysis group was higher than that predicted by ISS (40%). **Conclusion:** Approximately 4% of

severely traumatized patients arrive to hospital with laboratory evidence of hyperfibrinolysis. This is associated with a major increase in mortality and transfusion requirements. Thromboelastography identifies the group of patients that may benefit from antifibrinolytic agents. Thromboelastography also identifies patients at risk of massive transfusion.

Comparing angiographic embolization with preperitoneal pelvic packing in shock due to pelvic fracture: a systematic review. B. Weatherhead,* D. Malish,† M. Menon.† From the *University of British Columbia, Vancouver, BC, the †Canadian Forces, Ottawa, Ont., and the ‡University of Alberta, Edmonton, Alta.

Background: Shock following pelvis fracture may be treated by angiographic embolization, external fixation and preperitoneal pelvic packing. Published results of these techniques have not been clearly compared with guideline treatment. We conducted a systematic review of the literature to compare the effects of embolization versus packing for the treatment of exsanguinating pelvis trauma. **Methods:** A search of the MEDLINE and EMBASE databases using predefined search terms was performed. A hand search of major journals was also performed. Titles were screened to identify relevant clinical series, comparative studies and trials. Abstracts were reviewed by 2 reviewers, and papers were selected based on strict criteria. Final papers were examined for data concerning participants, results and mortality. **Results:** Of 351 articles, 72 primary studies were identified: 16 studies had useful data and were included in the review. Ten case series reported on embolization. Arterial bleeding was demonstrated in 43%–100%. Mortality was from 16% to 47%. Four case series reported on pelvic packing: 18–28 participants were included in these series. Mortality was 25%–70%. One study compared angiography with external fixation: 65% had arterial bleeding. One study compared packing with embolization: 64% found arterial bleeding. Mortality between groups was equal. **Conclusion:** This systematic review confirms angiography as effective in controlling life-threatening hemorrhage in pelvis fracture patients. Contrary to previously thought, arterial bleeding is the common cause of hemorrhage in a majority of these patients.

Pediatric vascular trauma: implications for resource utilization. A. Beres,* B. Vartian,† P. Wales,* A. Shawyer,* M. Brindle.† From *The Hospital for Sick Children, Toronto, Ont., and the †Alberta Children's Hospital, Edmonton, Alta.

Background: Most pediatric trauma centres do not have subspecialist pediatric vascular surgeons. The role of the vascular surgeon is not formalized in the management of pediatric trauma. We sought to document the involvement of the adult vascular surgeon in managing pediatric vascular trauma at a high-volume level 1 pediatric trauma centre. **Methods:** We collected and analyzed information on all patients with vascular trauma at the Toronto Hospital for Sick Children from January 2000 to December 2007. **Results:** In all, 58 children were treated for vascular trauma with a mean age of 8 and ISS of 11. Most injuries were accidental, frequently involving broken glass (22 of 58, 38%). Forty-three of 58 (73%) patients underwent vascular repair, 7 of which involved vascular grafting, and 14 of 58 (24%) patients had a vascular

surgery consultation. Although the frequency of vascular repair remained constant, the rate of vascular surgery consultation increased from 1 of 18 in the first 2 years (5.6%) to 13 of 40 (32.5%) in the last 6 years. Certain injuries consistently had vascular surgery involvement, and 4 of 5 popliteal injuries and 3 of 3 brachial artery injuries had a vascular surgical consultation. Also, femoral artery and vein injuries involved vascular surgeons, whereas ulnar, radial and digital arterial injuries were typically repaired by plastic surgeons. **Conclusion:** The involvement of vascular surgeons in the management of pediatric trauma is increasing in many pediatric trauma centres. Given the emergent nature of vascular trauma, a formal arrangement for adult vascular surgical involvement is likely of benefit at pediatric trauma centres without institutional vascular surgical support.

Quantification of CT radiation dose during initial trauma patient assessment. L. Beatty,* B. Furey,† C. Daniels,† A. Berman,† J. Tallon.† From the *Department of Emergency Medicine, Dalhousie University, and †Dalhousie University, Halifax, NS

Background: Radiographic imaging, in the form of CT scans, has become a standard component of trauma patient assessment in Canadian facilities. There is increasing concern regarding the possible adverse effects of the associated radiation on a predominantly young patient population. The objective of this study was to determine the dose of radiation received during the initial trauma team evaluation of adult trauma patients seen at a tertiary care Canadian trauma centre. **Methods:** This study was a retrospective chart review of all adult patients who underwent a trauma team activation between Mar. 1, 2008, and Mar. 1, 2009, including patients initially managed at regional centres who were transferred to the trauma team. Radiation dosages for each scan were calculated using dosimetry calculation software, based on parameters collected from the CT scanner. The mean effective dose of radiation was calculated for all scans done during the initial trauma work-up. **Results:** Complete data were available for 162 patients who underwent trauma team activation during the study period. The average patient age was 37 (interquartile range [IQR] 22–51) years with a mean Injury Severity Score of 18 (IQR 9–26). The median effective radiation dose was 24.4 mSv (IQR 19.9–31.4 mSv). **Conclusion:** Trauma patients are exposed to a substantial dose of radiation during their initial trauma assessment. Consideration should be given to limit the number of CT scans done, and centres should consider adjusting CT parameters to minimize radiation exposure.

Rural trauma development course — Can we reduce time to transfer for rural trauma patients? A. Porte, M. Hogan, J. Hapgood, D. Boone. From the Memorial University of Newfoundland, St. John's, NL

Background: The Rural Trauma Team Development Course (RTTDC) was developed by the American College of Surgeons Committee on Trauma to improve trauma care in the rural setting. We have previously shown it has high participant satisfaction scores, improves trauma knowledge and rural practitioner teamwork. This study assesses the effect of RTTDC on transfer to definitive care times of rural patients. **Methods:** The provincial trauma registry was used to identify patients transferred to a

level 1 trauma centre from regional rural hospitals taking part in the RTTDC. We compared transfer times from a 12-month period preceding RTTDC (before) to transfer times after RTTDC delivery (after), assessing the impact of the RTTDC on trauma care. **Results:** The before group comprised 23 patients, and the after group contained 18 patients. Before group patients were slightly older (43 v. 32 yr) and had similar mean ISS (11.9 and 11) and GCS (15 and 14) scores to the after group patients. In this preliminary trauma patient group, there was a trend to decreased time to transfer in rural primary care facilities following exposure to the RTTDC (before 197 v. after 255 min, $p > 0.05$). **Conclusion:** Initial results suggest that the Rural Trauma Team Development Course is effective at hastening the decision to transfer and shortening the time spent in rural hospitals before transfer to definitive management.

Surgical trainees' failure to recognize trauma patients in shock. T. Zakrisson,* M. Quiodettis Ponce,† C. Schulman,† G. Garcia,† F. Habib,† M. McKenney,† N. Namias.† From *St. Michael's Hospital, Toronto, Ont., and the †Miller School of Medicine, University of Miami, Miami, Fla.

Background: The early recognition of shock in the trauma patient is important for expeditious patient care and management. In level 1 trauma centres, both surgical and nonsurgical trainees comprise an important group of early caregivers. Despite standard definitions, it is unclear if these trainees consistently recognize trauma patients in shock. Our objective was to evaluate the ability of trauma trainees to correctly identify patients in shock. **Methods:** A prospective, pilot study was performed to evaluate trainees' ability to recognize those patients who arrive in shock to a level 1 trauma centre. Trainees on call were asked which trauma patients during the previous 24 hours presented in shock. Agreement on the presence of shock was compared between the various team members for each patient. Final determination of those in shock was made by trauma surgery attendings after reviewing all available information. **Results:** In all, 114 trauma patients were included in this study. Of these patients, 53 (46%) were determined to be in shock. Trainees correctly identified only 30 of 53 patients (57%) as being in shock. There was no 24-hour call period in which all trainees caring for patients had 100% concordance in the recognition of patients in shock. Most commonly, trainees misdiagnosed class 1 and 2 shock by missing the physiologic parameters of acidosis and tachycardia. **Conclusion:** The presence of shock in trauma patients is a poorly recognized phenomenon by trainees at all levels in a level 1 trauma centre. Further work is needed to improve both the recognition of shock and intragroup communication in order to correctly identify patients in shock.

Surgery or medical management in fulminant *Clostridium difficile* colitis. M. Arjang,* A. Madani,† A. Simor,† A. Smith,† S. Rizoli.† From *Trauma Research, Sunnybrook Health Science Centre Toronto, and the †Sunnybrook Health Science Centre, Toronto, Ont.

Background: Fulminant *Clostridium difficile* colitis (FCDC) incidence and severity is growing in acute care settings, with more patients undergoing urgent surgery. Surgical indications for FCDC include failure of medical management, which is poorly

defined. We investigated objective parameters leading to surgery in FCDC and its effect on mortality. **Methods:** We conducted a retrospective analysis of all *C. difficile* colitis (CDC) was in a large university hospital between 2007 and 2009. Fulminant *C. difficile* colitis was defined as either admission to the intensive care unit (ICU) or urgent surgery primarily for CDC. Demographic, laboratory, imaging, endoscopic and pathologic characteristics and mortality rates were compared between patients undergoing only medical management versus surgery. **Results:** Of 371 CDC patients, 21 had FCDC: 11 were treated medically and 10 surgically. There was no difference in age, sex and comorbidities between groups. There was no difference in FCDC severity (extent of colitis, megacolon, leukocyte count, ICU length of stay) or multiorgan failure parameters (vasopressor use, creatinine, lactate, base deficit, APACHE II, international normalized ratio) between the groups, except for decreased albumin in surgical patients ($p = 0.02$). Three patients in the medical group refused aggressive treatment and died. The median duration of FCDC until surgery was 1.5 (0–5) days. All mortalities were related to FCDC, with a 12.7% higher mortality in the medical group (95% CI –31.9% to 52.2%). **Conclusion:** Despite the small sample size and the inability to evaluate bedside clinical judgment, we found no unique measurable factor defining failure of medical management and no mortality benefit to surgery. Further studies are needed before defining objective surgical indicators for FCDC.

A simplified CT-angiography grading system for blunt aortic injury. Y. Lamarche,* F. Berger,* S. Nicolaou,* M. Janusz,* J. Rodrigues Inacio,† L. Louis,† A. Bilawich,† D. Evans.† From the *Department of Radiology, University of British Columbia, and the †Vancouver General Hospital Vancouver, BC

Background: The delineation of blunt aortic injury (BAI) by computed tomography with angiography (CTA) guides management of this potentially fatal injury. Existing grading systems are problematic to apply and have not been linked to outcome. We sought to develop a simplified CTA-based BAI grading system linked to clinical outcomes and to evaluate feasibility and reliability of the new radiologic grading system. **Methods:** A retrospective review of all BAI cases presenting to a single provincial quaternary referral centre designated for BAI management between 2001 and 2009 was completed. Management, associated injuries, hospital survival and cause of death were determined. Initial CTA imaging was reviewed, and injuries were graded according to the new BAI grading system developed by 2 of the study authors. Three additional trauma radiologists then graded the aortic injuries using 2 existing systems and the new one. Inter-rater reliability was determined. **Results:** Forty-eight patients were identified. Two had a minimal aortic injury (grade I), 7 had an intimal flap greater than 1 cm (grade II), 32 had traumatic pseudoaneurysm (grade III) and 6 had active contrast extravasation (grade IV). Survival was 100%, 90% and 33% for grades I/II, III and IV, respectively. Of grade III injuries, 14% had medical management, 68% underwent endovascular repair and 18% had open repair. Inter-radiologist correlation was best using the simplified score, which also correlated most consistently to clinical outcomes compared with the 2 existing systems. **Conclusion:** The simplified BAI grading system is easy to use and correlates with clinical outcomes of patients. Prospective external validation is required.

Motorcycle collisions with fatal casualties: a serious public health problem. C. Eduardo Carrasco, T.M. Zago, R.B. Carvalho, G.P. Fraga. From the State University of Campinas (UNICAMP), Campinas, São Paulo, Brazil

Background: Motorcyclists are among the most vulnerable groups in traffic collisions, and the increasing incidence of fatal events has become an important concern. The objective of this study was to identify the injuries responsible for these deaths. **Methods:** All fatal motorcycle collisions ($n = 405$) that occurred from January 2001 to December 2008 in Campinas, Brazil, were considered. Official data have been collected from police incident reports, hospital charts and autopsies. The proportion of victims intoxicated with alcohol who underwent surgical procedures was analyzed. The time and causes of death were reviewed and trauma scores calculated. **Results:** Fatal accidents increased by 124% between 2001 and 2008. Main accident causes were collisions with cars (22%), trucks or buses (21%) and falls (13%). As for the victims, 90% were male, their mean age was 27 (range 1–73) years, and 85% were drivers. Blood alcohol results were positive in 43% of the victims. Forty-two percent died at the scene or during transport to a hospital. The mean Abbreviated Injury Scale score for the head/neck was 3/39; for the thorax it was 2/3; and for the abdomen it was 1/75. The mean ISS was 38.5 (range 9–75). Head trauma (69%), hypovolemic shock (40%) and thoracic trauma (39%) were the most relevant injuries resulting in death. Surgical procedures were done in 85 patients, with thoracic drainage (29, 4%), laparotomy (28, 2%) and craniotomy (27%) being the most common procedures. **Conclusion:** Collisions with other vehicles and alcohol were responsible for most injuries involving motorcycles. Head trauma was the most common cause of death following motorcycle collisions.

How important are routine laboratory and image tests in the late management of trauma patients? J. Rezende-Neto,* H. Vieira Jr.,† S. Freitas,† S. Rizoli.‡ From the *Universidade Federal de Minas Gerais, Minas Gerais, the †Risoleta T. Neves Trauma Centre, Belo Horizonte, Brazil, and the ‡Sunnybrook Health Science Centre, Toronto, Ont.

Background: In the age of health care cost containment, a selective approach toward laboratory and image tests is important to avoid unnecessary costs. However, the standard of care should not be put in jeopardy. **Methods:** Forty-nine ($n = 49$) injured patients admitted to an academic trauma centre were prospectively studied. We set forth to investigate the number and the types of tests ordered for the patients, as well as the impact of the results of the tests on change in patient management, including hospital discharge plans, surgical intervention and prescription. **Results:** A total of 303 tests were analyzed (average 6.2 tests/patient). Image tests were the most frequently ordered (86%). Approximately half of the exams showed normal results (49.8%). In general, 78% of the tests did not lead to a change in patient management. Furthermore, change in management occurred despite normal tests in 14.3% of the patients. Prescription changes were the most common (33.3%), followed by requirement of a surgical procedure (29.2%); 13.9% of the patients had a change on the discharge plan. **Conclusion:** Change in patient management is more common with image tests than with laboratory tests. Changes in patient management were more commonly related to individual patients than to test results.

Kiting injuries: 211 cases provoked by abrasive coated threads used for kite fighting. *J. Rezende-Neto,* R. Ladeira,† P. Carreiro,†‡ S. Rizoli.‡* From the *Universidade Federal de Minas Gerais, Minas Gerais, the †Hospital Joao XXIII Trauma Centre, ‡Unifenas, Belo Horizonte, Brazil, and the §Sunnybrook Health Science Centre, Toronto, Ont.

Background: Kite fighting is a traditional sport in many countries. Contestants engage in a competition to cut their opponents' kite lines coated with a mixture of ground glass and glue. Unfortunately, those lines can produce serious injuries to passersby, particularly cyclists and motorcyclists. **Methods:** We conducted a retrospective review of injuries caused by abrasive, coated kite lines from January 2005 to December 2009 at the Joao XXIII Trauma Centre, Belo Horizonte, Brazil. Medical charts were analyzed for various demographic and injury-related data. **Results:** A total of 211 patients sustained kite-line related injuries, 0.4% of all trauma patients admitted (509 547 patients) during the study: 94% were male, and the median age was 15 years. Most injuries occurred in June (37%) and July (41%). The most commonly injured body areas were the upper limbs (57.3%), followed by the neck and head (28.4%). Motorcyclists constituted 18.5% of the patients, including 2 patients who were "clotheslined" and died as a result of severe airway and vascular injuries to the neck. To reduce clothesline injuries, a safety device similar to an antenna with hooked ends has been recently adapted for the handlebars of most motorcycles. **Conclusion:** Abrasive, coated lines used in fighter kites can cause severe injuries, particularly when the head and the neck are involved by a clothesline mechanism. Most cases occur during the winter, the windiest season in southeastern Brazil. The effectiveness of the safety device remains to be confirmed by clinical research.

"Mandatory" alcohol testing in a Canadian level 1 trauma centre: a missed opportunity for intervention. *S. Karim, J. Tallon, M. Asbridge.* From Dalhousie University, Halifax, NS

Background: Alcohol misuse in the emergency department and trauma centres have been described in the literature. This evidence has supported development of clinical practice guidelines, intended to promote routine testing of trauma patients for drug and alcohol intoxication. Despite the prevalence of alcohol among injured patients, and the success of screening and brief interventions to identify and treat alcohol misuse, routine screening is not standard practice in most emergency departments and trauma centres. The purpose of this study is to determine the prevalence of blood alcohol testing, the proportion of patients that was missed and the characteristics of major trauma patients that predict the probability of not testing blood alcohol in the tertiary trauma care centre major trauma patient cohort. **Methods:** This study is a 9-year retrospective review of all major trauma patients who have presented or been transferred to a tertiary care centre from 2000 to 2008. Statistical analysis was conducted to describe the demographics and injury characteristics of the patient population. **Results:** The study population consisted of 1861 patients. Despite mandatory blood alcohol screening, 46% of the sample was not screened for blood alcohol. There is a significant difference in patient demographics and injury characteristics in patients who are and are not screened for blood alcohol.

Conclusion: The results of this study indicate that blood alcohol screening varies according to patient demographics and injury characteristics. Strategies to increase compliance of blood alcohol screening are required in both emergency departments and trauma centres.

Trauma formula-driven versus laboratory-guided transfusion study (TRFL study) — an update. *B. Nascimento,* J. Callum,* H. Tien,* V. Speers,* Y. Lin,* G. Rubinfeld,*† S. Rizoli.** From the *Sunnybrook Health Science Centre and the †Department of Medicine, University of Toronto, Toronto, Ont.

Background: The transfusion of a near 1:1:1 ratio of red blood cells (RBC) to plasma (FP) and platelets (PLT) has recently been suggested in trauma. However, no prospective study has evaluated this strategy. This pilot randomized controlled trial aims to assess the feasibility of formula-driven (1 RBC:1 FP:1 PLT) and laboratory-guided transfusion protocols in trauma. **Methods:** Trauma patients with hypotension and bleeding who are predicted to require massive transfusions are randomized (under delayed informed consent) to either formula-driven or laboratory-guided resuscitation. The main outcome is feasibility. **Results:** Thirty-five patients (18 formula-driven v. 14 laboratory-guided) have been randomized over 16 months. Three were excluded postrandomization and 1 refused to participate. The ratios 1.2 RBC: 1FP: 1PLT and 2RBC: 1FP: 0.6 PLT were reached for the formula-driven and laboratory-guided groups for the duration of protocols, respectively. In the formula-driven group, 75% received 1:1:1, 40% received massive transfusion and 28% died. In the laboratory-guided group, 100% had hemoglobin, platelets and international normalized ratio measured every 2 hours, 75% had fibrinogen measured, 83% received massive transfusion and 14% died. The return and wastage of thawed plasma were 39% and 32% (formula-driven) and 17% and 14% (laboratory-guided), respectively. **Conclusion:** The feasibility of conducting such a massive transfusion study relies mostly on prompt activation of research personnel, simple inclusion criteria, a data monitoring board for postrandomization exclusions, fast delivery of plasma and platelets, delayed consent and fast turnaround times for laboratory tests.

A systematic review of rounding practices in intensive care. *D. Lane,* M. Ferri,† H.T. Stelfox.†* From the *University of Calgary and the †Foothills Medical Centre, University of Calgary, Calgary, Alta.

Background: Effective rounding in the intensive care unit (ICU) is associated with reduced mortality and improved patient and provider satisfaction. We describe a systematic search of the literature to identify current interprofessional ICU rounding practices, facilitators and barriers to information exchange. **Methods:** We searched MEDLINE, CINAHL and the Cochrane Library to identify articles pertaining to the rounding process in the ICU. Both quantitative and qualitative articles were eligible for inclusion. Two reviewers independently appraised study quality and extracted relevant data. **Results:** Our search strategy identified 2744 articles. A review of citations resulted in the selection of 88 articles for full-text review. From these citations, 34 (39%) were identified as observational, 24 (27%) as interventional and

30 (34%) as review articles. Of the observational articles, 13 (38%) were concerned with the composition of the rounding team, 5 (15%) considered provider satisfaction, 6 (18%) suggested tools to improve rounds and 10 (29%) discussed current rounding practices. Of the interventional studies, 11 articles (46%) discussed the rounding team, whereas 13 (54%) discussed improvement tools. The main focus for review articles was current practice (16 articles or 53%) and tools for improvement (10 articles or 33%); however, 2 articles (7%) were also determined to consider the rounding team, and 2 articles (7%) considered provider satisfaction. **Conclusion:** A substantial body of literature exists describing current rounding practices in the ICU.

Stab wounds to the posterior chest wall: Does CT scanning change management? *T. Nouh,* T. Razek,† M. Dakermadjji,† L. Ferri,† D. Mulder,† D. Deckelbaum,† K. Khwaja,† P. Fata.†* From *King Saud University, Kingdom of Saudi Arabia, and the †McGill University Health Centre, Montréal, Que.

Background: In the literature, management strategies for abdominal penetrating trauma are divided by location (anterior and flank). Currently, in penetrating chest trauma, recommendations do not differentiate anterior from posterior locations. The role of chest CT in the management of penetrating injuries to the posterior chest remains unclear. **Methods:** We conducted a retrospective chart review of patients with penetrating wounds to the posterior chest, identified using our trauma registry, seen at the Montreal General Hospital between 1998 and 2008. **Results:** Over 10 years, a total of 409 patients with stab wounds to the chest were admitted to hospital. Stab wounds to the posterior chest compromised 25% (101 patients) of all stab wounds. The mean presenting ISS was 13.6. Seventy-two percent of patients with posterior stab wounds underwent both a CT scan of the chest and a chest radiograph. In 16% of patients, CT scan of the chest demonstrated abnormalities not reported on the initial chest radiograph. Of these, over a third (39%) of patients required the insertion of a chest tube. In addition, CT identified pneumomediastinum in 10% of patients requiring further studies. Computed tomography also diagnosed diaphragmatic injury in 8% of patients, all of whom required surgery. **Conclusion:** The diagnosis of all clinically significant injuries in posterior penetrating chest trauma may not be evident by chest radiograph alone. In our study, there was a large proportion of patients who had their management altered as a result of CT findings. The exact role of CT scanning for penetrating chest trauma warrants further investigation.

Thromboelastography in trauma: What is the evidence? *L. Teodoro Da Luz,* S. Rizoli,† B. Nascimento,† S. Scarpelini,† J. Callum.†* From the *University de São Paulo, São Paulo, Brazil, and the †Sunnybrook Health Science Centre, Toronto, Ont.

Background: Conventional laboratory coagulation tests are of limited value for trauma resuscitation owing to the long wait for results, poor correlation with bleeding and inability to guide transfusion. There is renewed interest in thromboelastography (TEG), which is a test of blood viscoelastic properties that quickly assesses the whole coagulation process. We reviewed the recent literature on this TEG in search of its clinical usefulness in

trauma. **Methods:** "Thromboelastography" was used for the search on PubMed and BIREME (including LILACS, IBECs, MEDLINE, Cochrane, SciELO). Two independent investigators identified relevant studies involving TEG in trauma, both in military and civilian settings. Important case reports, retrospective studies and prospective observational studies were considered. A critical appraisal was conducted. **Results:** Our search identified 267 studies. Of these, 19 studies were on trauma and were included in the analysis (7 prospective observational studies, 7 retrospective and 5 case reports). The studies addressed the diagnosis of hypercoagulability and hypocoagulability, the accuracy of detecting clotting abnormalities in comparison to conventional laboratory tests, the use of TEG as a point of care test during resuscitation of bleeding patients and the possibility of guiding blood transfusion in trauma. The overall quality of the studies varied from poor to good. As there were strong variations, a meta-analysis was not undertaken. **Conclusion:** Despite suggestions of its usefulness during resuscitation of severely bleeding trauma patients, which support its routine use, the literature does not support its use to guide blood transfusion in trauma. Better quality studies are needed.

Radiation dose from computed tomography in pediatric trauma: effective dose during resuscitation, hospital stay and 6 months post-trauma. *A. Igric,* K. Vogt,* M. Livingston,* C. Vinden,† N. Parry,‡ M. Girotti,‡ N. Merritt.‡* From the *University Of Western Ontario, the †Department of General Surgery, University of Western Ontario, the ‡London Health Sciences Centre and the §Children's Hospital at London Health Sciences Centre, London, Ont.

Background: Computed tomography is a valuable diagnostic tool in pediatric trauma management. Serious concerns persist regarding the harmful effects of ionizing radiation associated with CT in children. We attempted to quantify the cumulative radiation dose in a group of pediatric trauma patients. **Methods:** Our hospital trauma database identified children aged 18 and younger, with an ISS greater than 12 or a trauma team activation over a 2-year period. All CT scans of the head, neck, chest, abdomen and pelvis performed during the initial trauma resuscitation, hospital stay and 6 months after trauma were noted. Scan parameters were used in combination with published conversion factors to calculate the effective radiation dose. Data were collected on the indications for the CT scans. **Results:** In total, 158 patients were included, with 130 (82%) of patients receiving at least 1 CT scan. The mean age was 9 (SD 6) years, and the mean ISS was 23 (SD 9). Patients received a mean of 3 (SD 2.6) scans. Excluding the resuscitative CTs, indications for the CT scan were follow-up imaging (70.62%) and a change in clinical condition (29.38%). **Conclusion:** Computed tomography is a major source of radiation in pediatric trauma up to 6 months postinjury. Clinicians should be aware of the radiation received by pediatric patients during their clinical course and possibly use alternative imaging modalities.

Building trauma systems: identification of regional resources for managing injured patients. *B. Lawless, A. Bilton, V. Blount, J. Trpkovski.* From the Ontario Ministry of Health and Long-term Care, Ottawa, Ont.

Background: Time delays in the transfer of injured patients to a

tertiary care centre from rural areas can result in increased morbidity and mortality. This study determines the resources available to manage injured patients at all acute care hospitals in the province of Ontario, a region comprised of large rural areas. **Methods:** A survey tool was developed based upon criteria used by the Trauma Association of Canada (TAC) for accreditation and assignment of levels (1–5) for trauma services. An electronic link to the survey was sent to a designated contact at 147 hospital sites. The data were analyzed to determine where appropriate resources for managing an injured patient exist and to designate levels (1–5) for each hospital. **Results:** In total, 138 hospital sites (94%) replied with a completed survey; 87.2% had never completed an external review regarding resources for managing injured patients. Application of TAC criteria against survey results yielded the following: level 1, 5 sites; level 2, 3 sites; level 3, 52 sites; level 4, 32 sites; level 5, 52 sites; pediatrics level 1, 2 sites, pediatrics level 2, 2 sites. **Conclusion:** To create a successful regionalized model for the delivery of trauma services, it is important to understand the capabilities of both the tertiary and nontertiary hospitals that participate in the system to care for injured patients. Identifying these resources is a necessary first step toward improving efficiencies in the delivery of trauma care.

The design and validation of an assessment tool to evaluate intraosseous insertion. *S. Al-Qadhi.* From the Health Sciences Centre, Winnipeg, Man.

Background: The lack of a gold standard for nonsurgically trained physicians' procedural performance represents an obstacle in formally validating evaluation tools and performance for emergency procedures. Our study examined the face, content and constructs validity of the Global Rating Scale of Medical Procedural Performance (GRSMPP), Final Product Checklist (FPC) and Procedure-Specific Checklist (PSC) for the formal procedural evaluation of a bench model-based technique of intraosseous (IO) insertion. **Methods:** The PSC and FPC were developed by the study team, whereas the Modified Global Rating Scale of Operative Performance (MGRSOP) was modified from the Global Rating Scale of Operative Performance (GRSOP). All 3 tools were reviewed by 4 independent experts in IO insertion using Delphi methodology to confirm face and content validity. Construct validity was evaluated by using the technical proficiency evaluation model to compare the anonymously video-recorded procedural performances of 10 experts and 10 novices. Two blinded experts assessed these performances, and a statistical analysis was performed to examine inter- and intrarater reliability. **Results:** Face and content validity were confirmed for all 3 tools in the second iteration of the Delphi process, and the construct validity for the MGRSOP was also approved using the technical proficiency evaluation, with good inter- and intrarater reliability. **Conclusion:** The PSC, FPC and MGRSOP were validated as good assessment tools for IO insertion. Further study of validation of these tools with other emergency procedures is required.

The use of uncrossmatched blood for the identification of massively transfused trauma patients. *B. Nascimento, J. Callum, H. Tien, S. Rizoli.* From the Sunnybrook Health Science Centre, Toronto, Ont.

Background: Early identification of patients who will require

massive transfusion is challenging. We assess the ability of uncrossmatched red blood cell (RBC) use to predict massive transfusion. **Methods:** We looked at the cases of trauma patients receiving any RBC transfusion (July 2009 to July 2010). Massive transfusion was defined as 10 or more units of RBCs in 24 hours. Sensitivity, specificity, positive and negative predictive values (PPV and NPV) were calculated. **Results:** In total, 124 patients received RBCs. The use of uncrossmatched RBC had high sensitivity and NPV for the need of massive transfusion (see the Table). **Conclusion:** The use of uncrossmatched RBCs is an early and simple screening tool for the identification of massively transfused trauma patients.

Table. Uncrossmatched red blood cell (URBC) and massive transfusion (MT) in trauma patients

Blood product	MT+	MT–	Total
URBC+	18	51	69
URBC–	1	54	55
Total	19	105	124

Sensitivity = 95%; specificity = 51%; positive predictive value = 26%; negative predictive value = 98%.

Flail chest revisited: A role for operative fixation? *Y. Almarhabi,* M. Hameed,† J. Bond,† R. Simons,† R. Brown,† D. Evans.†* From the *Vancouver Coastal Health and †Trauma Services Vancouver Coastal Health, Vancouver, BC

Background: Multiple rib fractures are associated with profound short- and long-term morbidity and high mortality. Although nonoperative management has often been the standard of care, recent studies have shown promising results in terms of both physiologic and clinical outcomes. This study reports the initial experiences with operative rib fracture fixation at 2 thoracic trauma referral hospitals. **Methods:** This study is a case series. The records of 10 trauma patients with multiple rib fractures were reviewed to survey demographic data, the location of fractures, symptoms, diagnostic modalities, treatment and the number of days in the intensive care unit (ICU) and on ventilation. **Results:** Ten patients who underwent operative fixation for flail chest were identified. The female:male ratio was 3:7, with a mean age of 57 years. The mean number of ventilator days, ICU and hospital length of stay were 3 days, 3 days and 10 days, respectively. The mean duration of intravenous narcotic requirement was 8 days. The hospitalization of 2 patients was complicated by pneumonia. There was no mortality. Patients with severe thoracic crush injuries had unexpectedly low narcotic requirements and complications, and rapid recovery. **Conclusion:** Rib fracture fixation is a potentially viable option for reducing the morbidity and mortality of flail chest. More studies are needed to quantify the cost effectiveness of this approach.

Development of a survival prediction tool for pediatric head injury. *E. Kouznetsov,* M. Brennan,† M. Vassilyadi.†* From *The Ottawa Hospital and the †Children's Hospital of Eastern Ontario, Ottawa, Ont.

Background: The ability to provide an accurate prognosis for children with traumatic brain injury (TBI) would be useful for the

children's families and the caregivers. In this study, we examined whether an appropriate mathematical model can predict survival in this patient population. **Methods:** Data from the Children's Hospital of Eastern Ontario (CHEO) TBI registry were analyzed. First, a series of univariate logistic regressions were performed to ascertain the significance of individual predictors, such as age, maximum Glasgow Coma Scale (GCS) score, maximum head injury Abbreviated Injury Scores (AIS) and Injury Severity Score (ISS). Second, a multinomial logistic regression was fitted using only individually significant predictors, and in-model predictive significance and interactions were tested. Only 2 significant predictors were kept in the final model. This final model was subsequently used to predict survival for each individual patient using the $n - 1$ training set (i.e., Lachenbruch's leave-one-out method). The receiver operating characteristics (ROC) method was used to ascertain specificity-sensitivity tradeoffs at different probability cutoffs in order to predict survival. **Results:** Only the maximum GCS score and the maximum head injury AIS remained significant, both individually and in the polynomial logistic regression. Empiric ROC curve analyses from leave-one-out survival predictions showed statistical significance (area under the curve = 0.87, $Z = 6.8$, $p < 0.001$). Only 12% of cases were misclassified using the "best" cutoff. **Conclusion:** An outcome predictive model for pediatric TBI can be devised using an appropriate mathematical model. It may help more objectively estimate the expected outcome in pediatric TBI.

Traumatic spinal injuries in children. M. Vassilyadi,* C. Kim,† P. Moroz.* From the *Children's Hospital of Eastern Ontario and the †University of Ottawa, Ottawa, Ont.

Background: Spinal injuries in children are less common than in adults, with a reported incidence of up to 10% when compared with all spinal traumas. Although relatively rare, spinal injuries may contribute to significant morbidity and mortality in children. These children can have spine fractures with or without myelopathy, or spinal cord injury without radiological abnormalities. **Methods:** Between 1990 and 2004, 187 children with spinal injuries were retrospectively reviewed using ICD-10 codes, the Children's Hospital of Eastern Ontario (CHEO) trauma registry and an independently maintained fracture database. **Results:** The mean age on admission was 11.8 (SD 4.4) years with a male:female ratio of 1.1:1. The age distribution of spinal injuries was highest in the 12- to 16-year-olds, with most injuries at 15 years of age. The top 3 mechanisms of spinal injury were motor vehicle-related (49%), sports (29%) and falls (14%). Myelopathy occurred in 12% of all injuries. Of the 22 children with myelopathy, 12 presented with transient and 10 with permanent neurologic deficits. There were 2 spinal cord injuries without radiographic abnormalities, 16 spinal cord injuries with fractures and 4 spinal cord injuries with radiological abnormalities other than fractures. The most common spine levels injured were between L2 and the sacrum, followed by noncontiguous levels. Associated injuries, including fracture/dislocations (28%) and head injuries (16%), occurred in 56% of children. The overall mortality rate was 4%. **Conclusion:** This study has combined patients seen in a level 1 pediatric trauma centre by orthopedic and neurosurgery staff. The results at CHEO are consistent with the few studies in the literature indicating that the highest risk of injury is in the more active adolescent males. Efforts should continue

to educate children, especially teenagers, about injury prevention.

Effects of prehospital hypertonic resuscitation on coagulation and fibrinolysis in hypovolemic trauma patients. S. Rizoli,* S. Rhind,† J. Cushieri,† W. Junger,‡ M. Dubick,§ M. Shiu,* P. Shek,† E. Bulger.¶ From the *Sunnybrook Health Sciences Centre, †Defence Research and Development Canada (DRDC) Toronto, Ont., the ‡Department of Surgery, Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Mass., the §US Army Institute of Surgical Research — Fort Sam Houston, Houston, Tex., and the ¶University of Washington, Seattle, Wash.

Background: Hypocoagulability and hyperfibrinolysis are common coagulation derangements in severe trauma. Crystalloids cause dilutional coagulopathy and intrinsic hemostatic defects, but few studies have examined the impact of hypertonic fluids on these systems. This study investigated the effects of prehospital resuscitation with 250 mL of 7.5% saline (HS; $n = 9$), 7.5% saline/6% dextran 70 (HSD; $n = 8$) or 0.9% normal saline (NS; $n = 17$) on coagulation markers in hypovolemic trauma patients (systolic blood pressure ≤ 70 mmHg). **Methods:** Plasma from healthy controls ($n = 20$) and patients sampled on admission, 12 hours and 24 hours postresuscitation, was assayed for tissue factor (pg/mL), tissue factor pathway inhibitor (TFPI; ng/mL), thrombomodulin (ng/mL), thrombin-activatable fibrinolysis inhibitor (TAFI; %). Prothrombin time (seconds), international normalized ratio (INR) and platelets ($10^9/L$) were also measured. **Results:** Sixteen patients (47%) arrived coagulopathic (INR ≥ 1.3), but overall INR and prothrombin time did not differ among fluid groups. Mean platelet counts were lower in HS (195.7 [SD 21.7]) and HSD (179.6 [SD 33.0]) versus NS (248.1 [SD 14.9]), consistent with volume expansion. Compared with controls, NS patients had an elevated mean procoagulant tissue factor (192.6 [SD 29.0]). Tissue factor was lower (range 70.3–81.7) and TFPI higher (23.8–33.0) at all times with HSD versus controls. Anticoagulant thrombomodulin (range 6.5–8.5) was elevated, while antifibrinolytic TAFI (range 76.9–92.8) was reduced at 12 hours and 24 hours in patients versus controls, indicative of an imbalance in the coagulation process. **Conclusion:** Trauma patients display distinct coagulation and fibrinolytic abnormalities compared with controls that may relate to the type of fluid administered. Hypertonic fluids may shift hemostatic balance toward hypocoagulation and hyperfibrinolysis, but the significance is currently unknown. (Supported by NIH R01-2007-000-20819-0; Defence R&D Canada)

Relations between inflammatory cytokine release and outcome after hypertonic resuscitation in hypovolemic patients. S. Rhind,* S. Rizoli,† W. Junger,‡ J. Cushieri,§ D. Hoyt,¶ M. Shiu,† A. Baker,¶ P. Shek,* E. Bulger.** From *Defence Research and Development Canada (DRDC), the †Sunnybrook Health Science Centre, Toronto, Ont., the ‡Department of Surgery, Beth Israel Deaconess Medical Center and Harvard Medical School, Boston, Mass., the §American College of Surgeons, Chicago, Ill., ¶St. Michael's Hospital, Toronto, Ont., and the **University of Washington, Seattle, Wash.

Background: Posttraumatic shock causes an imbalance between

pro- and anti-inflammatory cytokines, resulting in multiple-organ dysfunction syndrome (MODS), immunosuppression and death. Previous studies suggest hypertonic saline has immunomodulatory properties that reestablish inflammatory equilibrium and attenuate organ dysfunction. This study evaluated prehospital resuscitation with 250 mL of 7.5% saline (HS; $n = 9$), 7.5% saline/6% dextran 70 (HSD; $n = 8$) versus 0.9% saline (NS; $n = 17$) on cytokine release and outcome measures in hypovolemic patients (systolic blood pressure ≤ 70 mmHg). **Methods:** Blood from healthy controls ($n = 20$) and patients on admission, 12 hours and 24 hours postresuscitation, was analyzed by enzyme-linked immunosorbent assay for concentrations (mean [standard errors], pg/mL) of interleukin (IL)-6, IL-1 receptor antagonist (IL-1ra), IL-10, tumour necrosis factor (TNF)- and TNF receptor (TNFR)- types I and II. **Results:** Of 34 study patients (aged 42.7 [20] yr, ISS 22 [12]), MODS occurred in 11 (33%) and 13 (34%) developed nosocomial infection. Serum IL-6 (range 70.1 [26.7] to 158.9 [58.2]), TNF- α (1.7 [0.3] to 4.2 [1.2]), IL-10 (15.5 [3.5] to 39.3 [6.4]) and both TNFRI (2260.9 [211.1] to 3223.5 [459.9]) and TNFRII (2959.8 [184.3] to 5474.4 [307.8]) levels were significantly ($p < 0.05$) higher in patients at all times versus controls. Multiple-organ dysfunction syndrome and/or infected patients had elevated TNF- α , IL-6, IL-10, IL-1ra and TNFRII compared with non-MODS and uninfected patients. TNF- α was higher in NS patients at 12 hours versus HSD; peak TNF- α occurred in infected patients treated with NS. IL-1ra levels were 6-fold higher in HSD versus either HS or NS. Levels of IL-10 were comparable between resuscitation groups. **Conclusion:** These data suggest HSD resuscitation promotes a more balanced inflammatory response following traumatic shock, which is associated with a reduced risk of MODS and nosocomial infection. (NIH R01-2007-000-20819-0; Defence R&D Canada)

Reducing a pediatric trauma centre's over-action rate. S. Noseworthy,* K. Farion,* R. Zemek,* K. Williams,* M. Brennan,* H. Yoxon,† B. Sweeney.† From the *Children's Hospital of Eastern Ontario, Ottawa, Ont., and †Our Lady's Children's Hospital, Crumlin, Ireland

Background: From 2003 to 2009, one-third of all patients treated by the trauma code team at the Children's Hospital of Eastern Ontario (CHEO) were discharged home from the emergency department. This overactivation rate was greater than 5 of 11 other Canadian pediatric trauma centres. To reduce overactivation, we implemented revised trauma team activation guidelines (TTAGs) in March 2010, omitting mechanism alone as a criterion. We hypothesized that the rate of overactivation using the revised TTAGs would be reduced without lessening their sensitivity. **Methods:** We examined data obtained from the CHEO trauma registry, institutional database of discharge diagnoses and patient charts, collected from November 2003 to October 2010. Our primary outcome was the measurement of trauma team overactivation before and after implementation. Our secondary outcomes included the sensitivity and specificity of the guidelines to detect patients requiring the pediatric intensive care unit, emergency surgery or death in the emergency department. **Results:** In total, 123 patients out of 379 trauma codes (32%) were discharged home pre-TTAG revision, whereas 3 patients out of 25 codes (12%) were discharged postrevision ($p = 0.043$). The sensitivities of the pre- and postrevised guidelines were 76%

and 83%, respectively ($p = 0.771$), whereas the specificities pre- and post- increased from 35% to 56% ($p = 0.015$). The mean ISS of all coded patients meeting TTAGs was 11.1 prerevision versus 21.9 postrevision, with medians of 6 and 17, respectively ($p < 0.001$). **Conclusion:** The trauma team overactivation rate was reduced without compromising the TTAGs sensitivity. A prospective study of these guidelines is needed to allow for a more rigorous evaluation.

Long distance damage control. D. McMahon. From the Shock Trauma Service, The Canberra Hospital, Canberra, Australia

Background: Damage control (DC) laparotomy for exsanguinating patients is beneficial in selected patients. In a rural trauma system, does the location of the DC laparotomy influence the outcome? **Methods:** We conducted a retrospective review of the major trauma database of a level 1 trauma centre receiving patients from 25 regional hospitals with the capacity to perform laparotomy in a predominantly rural setting in the period from January 2003 to July 2010. Of 5606 cases, we found 8 cases of DC laparotomy before transfer and 12 requiring DC laparotomy after transfer from a regional hospital. **Results:** See the Table. **Conclusion:** Performance of DC laparotomy at the receiving hospital in a rural trauma system appears to confer an advantage over transfer and DC laparotomy at the trauma centre hospital. Infrequency, heterogeneity of patients, distances and resources makes precise conclusions difficult but a mature rural trauma system should include the capacity for DC laparotomy at hospitals remote from the trauma centre.

Table. Characteristics of patients who underwent damage control laparotomy in a rural trauma system, $n = 24$

Characteristic	Site of damage control laparotomy; mean (range)*		p value
	Rural	Trauma centre hospital	
Age, yr	39.8 (27-56)	39.1 (17-77)	0.924
Mechanism of injury, no.			
Penetrating	5	1	
Blunt	3	17	
ISS	21.8 (9-38)	25.3 (13-41)	0.497
Time to OT, hr	3.1 (1.25-5.25)	9.6 (5-12.25)	0.00003
INR	1.6 (1.1-2.4)	2.5 (1.0-10)	0.280
Blood products, u	19.8 (0-70)	24.6 (1-75)	0.647
Crystalloid, L	6.9 (3-12.75)	8.1 (4-17)	0.568
ICU LOS, d	4.23 (1.27-8.68)	10.32 (0-60.63)	0.211
Total LOS, d	13.57 (2.77-40.47)	39.40 (8.18-151)	0.033
Mortality, no. (%)	0 (0)	3 (18)	0.082

ICU = intensive care unit; INR = international normalized value; ISS = Injury Severity Score; LOS = length of stay.
*Unless otherwise indicated.

Chest radiography is an excellent screening tool for blunt thoracic trauma in children. B. Sweeney,* M. Brennan,† C. Palmer,‡ M. Ee,‡ J. Cramer,‡ N. Yanchar.‡ From *Our Lady's Children's Hospital, Crumlin, Ireland, the †Children's Hospital of Eastern Ontario, Ottawa, Ont., ‡The

Royal Children's Hospital, Melbourne, Australia, and the \S IWK Health Centre, Halifax, NS

Background: Potentially life-threatening blunt thoracic trauma (BTT) injuries in children must be identified promptly. Computed tomography is highly sensitive for evaluating BTT but exposes patients to high radiation doses. We wished to determine variables associated with risk of significant thoracic injury in pediatric BTT. **Methods:** Cases admitted to 3 level 1 pediatric trauma centres between 1999 and 2008 who sustained BTT with an ISS greater than 12 were reviewed retrospectively. Blunt thoracic trauma injuries were classified as significant (hemothorax, pneumothorax, mediastinal or great vessel injuries) versus non-significant (lung contusions or isolated rib fractures). Multivariate analyses were performed to determine associations between clinical and preliminary work-up variables and injury diagnosis. **Results:** In total, 426 patients averaging 10 years of age were included. The most common mechanisms of injury included motor vehicle and pedestrian collisions. The mean ISS was 28, and 102 patients sustained significant thoracic injuries. Although most had an initial chest radiograph, only 40% of all cases underwent a thoracic CT scan. On multivariate analysis, chest radiograph findings of hydrothorax, pneumothorax or subcutaneous emphysema were the only variables associated with the ultimate diagnosis of significant injury seen on CT (ORs 31.7, 2.2, 24.3, respectively; all 95% CIs not spanning 1.0); the mechanism of injury or presence of other major injury (i.e., femur fracture) had no such association. Seven patients with unremarkable chest radiographs ultimately had diagnoses of pulmonary contusion on CT. Interestingly, identifying abnormalities on chest radiography was not associated with the decision to obtain a thoracic CT scan. **Conclusion:** Chest radiographs can be used to screen for significant thoracic injuries and direct selective use of CT scanning in pediatric BTT.

Painting the province purple: evaluation of a regional shaken baby syndrome prevention outreach forum. *T. Charyk Stewart,* D. Polgar,* D. Tanner,[†] M. Girotti,* D.D. Fraser.[‡]* From the *London Health Sciences Centre, the [†]Trauma Program, London Health Sciences Centre, and the [‡]Children's Hospital, London Health Sciences Centre, London, Ont.

Background: Shaken baby syndrome (SBS) accounts for nearly half of severe infant injuries treated at our children's hospital, with the majority from neighbouring communities. A SBS-prevention program (Period of PURPLE crying [PURPLE]) was implemented locally. A regional SBS prevention outreach forum was held to highlight a family perspective and facilitate implementation. Study objectives were to describe and evaluate the forum. **Methods:** A questionnaire was developed on forum level of satisfaction, level of importance of SBS and its prevention (rated on 7-point Likert scales), program implementation and potential barriers. **Results:** Forum attendees ($n = 272$) included health care providers (HCP; 56%), law enforcement (9%) and the Children's Aid Society (8%). The survey response rate was 58%. Overall, 91%, 94% and 94% of respondents felt the forum was successful in describing PURPLE, informing about SBS and highlighting the family perspective, respectively. Overall, 97% were satisfied with the forum (mean 6.6/7). Most new information learned regarded

crying patterns (64%) and the family perspective (16%). Whereas 95% of respondents felt PURPLE would be effective, only 41% had implemented the program, citing funding (36%) and lack of a champion (24%) as top barriers. Shaken baby syndrome and its prevention were reported as "very important" issues by 92% and 88% of respondents, respectively (means 6.9/7). **Conclusion:** Hosting a regional forum was a successful mechanism to outreach to regional organizations, create awareness and educate HCP and policy makers on the importance of SBS and its prevention, while providing the important perspective of family members of children afflicted by this type of abuse.

Identification of blunt abdominal injuries in children. *N. Yanchar,* N. Nynick,* M. Brennan,[†] P. Schmit,* M. Bettoli,[†] S. Noseworthy.[‡]* From the *IWK Health Centre, Halifax, NS, and the [†]Childrens Hospital of Eastern Ontario, Ottawa, Ont.

Background: Optimal mode(s) of identifying clinically significant injuries from blunt abdominal trauma (BAT) in children, while trying to limit exposure to ionizing computed tomography (CT) radiation, remains unclear. This study aims to identify clinical and non-CT variables associated with these injuries. **Methods:** Cases admitted to 2 level 1 pediatric trauma centres, between 2007 and 2010, with a discharge diagnosis of an abdominal injury or having had a CT scan and/or laparotomy for query abdominal injury were reviewed retrospectively. Univariate and multivariate analyses examined associations between clinical and non-CT variables and clinically significant (solid organ or intestinal) intraabdominal injury diagnoses. **Results:** In total, 296 cases were included. The median age was 12 years; 67% were male. Motor vehicle collisions and direct abdominal blows comprised one-fifth, each, of the cases. In all, 213 patients underwent abdominal CT; 135 were diagnosed with clinically significant intraabdominal injuries; 44% involved isolated splenic injuries, 16% each of liver and renal injuries and 11% with multiorgan injuries. After controlling for covariates, variables significantly associated with injuries were hypotension (blood pressure < 90; OR 4.5, 95% CI 1.5–14), clinical findings on abdominal exam (OR 6.9, 95% CI 3.3–14) and mechanisms of injury including direct falls from non-heights and direct abdominal blows (OR 3.3, 95% CI 1.4–7.9 and OR 3.2, 95% CI 1.6–6.3, respectively). Hematuria, free fluid seen on focused assessment with sonography for trauma or standard ultrasound and presence of a pelvic fracture were also significant predictors. **Conclusion:** Diagnoses of significant intra-abdominal injuries after BAT in children remain dependent on CT scanning, yet results are often negative. Efforts are needed to develop screening guidelines based on clinical and ultrasound parameters to identify patients who would benefit from CT scanning.

Qualitative and quantitative analysis of ski and snowboard helmet use in Nova Scotia. *L. Fenerty,* G. Thibault-Halman,* J. Landry,* B. Bruce,* J. Young,[†] S. Walling,* D.B. Clarke.** From the *Division of Neurosurgery, Department of Surgery, Dalhousie University, and the [†]NS Department of Health Promotion and Protection, Halifax, NS

Background: This research study was conducted to examine helmet use with a mixed methods approach of observations and

interviews. **Methods:** Data were collected from 3336 observations and 300 interviews at 3 ski hills. **Results:** Helmet use was observed among 80% of female and 70% of male skiers and snowboarders. On average, three-quarters of skiers and snowboarders were wearing helmets. Helmet use varied from 69% to 79% at the 3 different ski hills. Qualitative data revealed that helmet users were most influenced by the benefits of using a helmet, policy and social norms, whereas non-helmet users were most influenced by social norms, cost and policy, and less so by the benefits of using a helmet. **Conclusion:** Helmets can reduce the risk of a serious injury or death by as much as 60%. Detailed research results will be presented as well as future implications for strategies to increase helmet use while promoting skiing and snowboarding as a safe, enjoyable winter physical activity.

Improving times to tertiary care through the implementation of a head injury guideline: Is this possible?
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Background: This is a study to determine whether implementation of a provincial head injury guideline in all emergency departments across Nova Scotia would improve times to tertiary care for patients with severe traumatic brain injuries (TBIs). **Methods:** Prospectively collected data from the Nova Scotia trauma registry were analyzed to determine various times en route to tertiary care. The time from arrival at the referring emergency department to making a 1-800 provincial trauma hotline call for arranging transportation was used to measure guideline compliance. **Results:** Results of overall time to tertiary care revealed that the guideline had no influence on the polytrauma group with major TBI ($n = 388$) or those with isolated TBI ($n = 99$). Less than 20% of cases were deemed to be guideline compliant (call to provincial hotline within 1 hour). **Conclusion:** Guideline implementation has not helped to decrease times to tertiary care. These results indicate that system changes beyond the implementation of the guideline are required to provide timely access to tertiary care for patients with major TBI.