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Trauma 2013

**Trauma Association of Canada (TAC)
Annual Scientific Meeting**

The Westin Whistler Resort & Spa, Whistler, BC

Thursday, Apr. 11 to Saturday, Apr. 13, 2013

Abstracts

Trauma Association of Canada Annual Scientific Meeting abstracts

Testing the reliability of tools for pediatric trauma teamwork evaluation in a North American high-resource simulation setting. *G. Hoit, K. Bailey, J. Pemberton.* From McMaster University, Hamilton, Ont.

Background: Literature suggests that teamwork and team performance greatly impact medical trauma outcomes. While trauma simulations have been shown to improve teamwork and clinical outcomes, there is a need to establish reliable teamwork evaluation tools. This study aims to test the reliability of the Teamwork Emergency Assessment Measure (TEAM), the Trauma Teamwork Assessment Tool (TTAT) and, specifically, the teamwork domain of the TTAT (TTATtw). **Methods:** An expert and non-expert panel evaluated 3 prerecorded pediatric trauma in situ simulations using TEAM and TTAT. Inter-rater reliability was determined using intraclass coefficient (ICC; 95% CI) and Cohen's kappa for TEAM, TTAT and TTATtw. **Results:** Average measures ICC data for TEAM (expert 0.954, nonexpert 0.941), TTAT (expert 0.851, nonexpert 0.828) and TTATtw (expert 0.964, nonexpert 0.889) proved to be "extremely" reliable for both expert and nonexpert panels. Single measures ICC data for TEAM (expert 0.591, nonexpert 0.676), TTAT (expert 0.326, nonexpert 0.342) and TTATtw (expert 0.445, nonexpert 0.711) demonstrated "fair to good," "poor" and "fair to good" reliability for both panels, respectively. Kappa indicated "moderate" agreement between expert and nonexpert panels for TEAM (0.467) and TTATtw (0.497) and indicated "fair" agreement for TTAT (0.329). **Conclusion:** The TEAM, TTAT and TTATtw were found to be reliable instruments when used by both a panel of experts and nonexperts. Further validation studies would be beneficial to warrant the tools appropriate for teamwork evaluation in pediatric trauma simulations.

The association of etomidate with mortality in trauma patients. *C. Hinkewich, R. Green, J. Tallon.* From Dalhousie University, Halifax, NS

Background: Etomidate is a commonly used medication to facilitate emergent endotracheal intubations in trauma patients, despite concerns regarding its safety. This study examined the association of etomidate use with patient mortality in trauma patients. **Methods:** This study is a retrospective review of adult trauma patients who required intubation at the Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia, since 2000. Patients who received etomidate were compared with those who did not, with a primary outcome of 28-day mortality. Secondary outcomes included length of stay in the hospital and intensive care unit (ICU), and mechanical ventilation days. Multivariate logistic models were created adjusting for age, Injury Severity Score (ISS), sex, comorbidities and injury type. **Results:** We included 315 patients for analysis. Patients who received etomidate had a more recent median arrival date (November 2006 v.

February 2005, $p = 0.0003$) and a higher ISS (23.4 v. 26.8, $p = 0.03$); 28-day mortality was higher in the etomidate group (20.0% v. 10.8%, $p = 0.04$). There was no difference in ICU length of stay, hospital length of stay or number of days requiring mechanical ventilation. Etomidate was associated with an increased mortality, with a crude odds ratio of 2.06 (95% CI 1.08–3.91, $p = 0.03$). After adjustment for age, female sex, ISS and comorbidity, the odds ratio was 2.00 (95% CI 0.91–4.40, $p = 0.08$). **Conclusion:** Etomidate administration for emergent endotracheal intubation in trauma patients may be associated with increased mortality. Further investigation is warranted.

Definition of isolated hip fractures as an exclusion criterion in trauma centre performance evaluations: a systematic review. *J. Tiao,* L. Moore,* A. Turgeon,† A. Boutin.** From the *Université Laval, Laval, and the †Centre de recherche FRSQ du CHA, Québec, Que.

Background: Patients presenting with isolated hip fractures are commonly excluded from trauma centre performance evaluations. We aimed to evaluate whether there is consensus on the definition of isolated hip fractures used as an exclusion criterion in studies evaluating the performance of trauma centres in terms of mortality. **Methods:** We searched MEDLINE, EMBASE, BIOSIS, The Cochrane Library, CINAHL, the Trip database and ProQuest for cohort studies that assessed trauma hospital performance in terms of mortality and excluded isolated hip fractures. A standardized, piloted data abstraction form was used to extract data on study settings, hip fracture definitions and methodological quality. Consensus was considered to be reached if 50% or more of studies (GRADE criteria) used the same definition. **Results:** We identified 8506 studies, of which 11 were eligible for inclusion. Only 2 studies (18%) used the same definition of isolated hip fractures; 3 (27%) used a definition based on Abbreviated Injury Scale codes and 5 (45%) on International Classification of Diseases codes; 4 (36%) studies also used criteria based on age, 5 (45%) on secondary injuries and 4 (36%) on injury mechanism; 8 studies (72%) respected at least 4 out of 6 methodological quality criteria and were therefore considered at low risk of bias. **Conclusion:** We observed important heterogeneity in the definition of isolated hip fractures used as exclusion criteria in studies evaluating the performance of trauma centres using mortality. Further research is needed to evaluate if variations in definitions influence benchmarking results. If so, consensus on a standardized definition will be needed.

Estimation of acute care hospitalization costs for trauma hospital performance evaluation: a systematic review. *V. Porgo,* L. Moore,* D. Reinartz,* G. Lapointe,† A. Turgeon.** From the *Université Laval, Laval, and the †Institut national d'excellence en santé et en services sociaux and the ‡Centre de recherche FRSQ du CHA, Québec, Que.

Background: In 2004, the total direct and indirect costs of injuries in Canada were estimated to be \$19.8 billion, yet information on trauma centre performance in terms of costs is scarce. The objective of this systematic review was to describe how data on costs have been estimated in order to evaluate the performance of acute care trauma hospitals. **Methods:** A systematic review of cohort studies evaluating the performance of trauma hospitals in terms of costs was performed. We searched MEDLINE, EMBASE, Web of Science, The Cochrane Library, CINAHL, the Trip database and ProQuest. Two authors conducted the data abstraction independently using a piloted electronic data abstraction form. Methodological quality was evaluated using the STROBE statement and the Downs and Black tool. **Results:** The search retrieved 6669 studies of which 8 were eligible for inclusion; 7 studies were conducted in the United States and 1 in Europe. Four studies used patient charges as a proxy for costs, 1 used average unit costs, and 3 used real costs obtained from a hospital accounting system. Average cost per patient in 2012 USD varied between \$2524 and \$74 144. Two studies were considered to be of good methodological quality. **Conclusion:** Studies evaluating the performance of trauma hospitals in terms of costs are scarce and most have low methodological quality. Further research is needed to develop methodology to estimate the costs of trauma care, particularly in public health systems. These data could then be used to develop a valid and reliable quality indicator to benchmark trauma centres in terms of resource use.

Hospital length of stay following admission for traumatic injury in Canada: a multicentre cohort study. L. Moore,* H.T. Stelfox,[†] A. Turgeon,[‡] A. Nathens,[§] X. Neveu.[¶] From the *Université Laval, Laval, Que., the †University of Calgary, Calgary, Alta., the ‡Centre de recherche FRSQ du CHA, Québec, Que., §St. Michael's Hospital, Toronto, Ont., and the ¶Axe de recherche en traumatologie-urgence-soins intensifs du CHU, Laval, Que.

Background: Prolonged hospital length of stay (LOS) has important consequences in terms of costs and patient outcome, yet detailed information on LOS following trauma is lacking. This study aimed to, first, describe acute care LOS following trauma over all consecutive hospitalizations related to the injury, second, describe LOS according to level of care provided (intensive care unit, intermediate, general ward), and third, compare LOS for trauma system admissions to LOS for all provincial admissions. **Methods:** This multicentre retrospective cohort study was based on adults discharged alive from a Canadian provincial trauma system (1999–2010, $n = 104\,447$). Trauma registry data were linked to hospital discharge data to obtain information on consecutive acute care hospitalizations. Comparable LOS for general admissions was obtained by matching mean LOS for all provincial hospital discharges by year, age and sex to trauma registry data. Length of stay was log-transformed and is presented with geometric means. **Results:** Mean LOS was 8.6 days for the index hospitalization and 9.3 days for all consecutive hospitalizations for the same injury. Intensive care unit, intermediate and general ward care constituted 9.1%, 2.4% and 88.5% of total hospital days. Observed mean LOS in our trauma patients was 2.9 days longer than for general admissions (8.6 v. 5.7 d, $p < 0.0001$). **Conclusion:** Including information on addi-

tional hospitalizations for the same injury increased mean LOS by 8%. Intensive care unit or intermediate care, associated with higher resource use than general ward care, constitute an important part of LOS. This study provides detailed information on LOS following trauma that can be used to inform the development of a quality indicator.

Predictors of hospital length of stay following traumatic injury: a multicentre cohort study. L. Moore,* H.T. Stelfox,[†] A. Turgeon,[‡] A. Nathens,[§] X. Neveu.[¶] From the *Université Laval, Laval, Que., the †University of Calgary, Calgary, Alta., the ‡Centre de recherche FRSQ du CHA, Québec, Que., §St. Michael's Hospital, Toronto, Ont., and the ¶Axe de recherche en traumatologie-urgence-soins intensifs du CHU, Laval, Que.

Background: Despite the important consequences of prolonged hospital length of stay (LOS) in terms of resource utilization and morbidity, the determinants of LOS and its components following trauma are not well known. This study aimed to, first, identify predictors of LOS, second, verify whether predictors vary if we consider LOS in the definitive treatment hospital only (index LOS) or LOS for all consecutive admissions related to the same event (total LOS), and third, identify predictors of LOS according to level of care (intensive care unit [ICU], intermediate, general ward). **Methods:** This multicentre retrospective cohort study was based on adults discharged alive from a Canadian provincial trauma system (1999–2010, $n = 104\,447$). Registry data were linked to hospital discharge data to obtain information on consecutive hospitalizations. Potential predictors were identified through literature review and expert opinion and evaluated using multiple linear regression with adjustment for hospital clusters. **Results:** The strongest determinants of index LOS were discharge destination, age, transfer status and injury severity. The association between predictors and LOS remained unchanged when total instead of index LOS was considered. The strongest determinants of ICU LOS were mechanical ventilation, injury severity and body region injured. The strongest determinants of LOS in intermediate care were trauma centre designation level, age and body region injured. **Conclusion:** Predictors of hospital LOS did not vary when total rather than index LOS was considered but did differ according to the level of care provided. This study provides detailed information on the influence of physiologic reserve, injury characteristics and processes of care on LOS and its components.

Influence of the heterogeneity in definitions of an isolated hip fracture used as an exclusion criterion in trauma centre performance evaluations: a multicentre cohort study. J. Tiao,* L. Moore,* A. Turgeon.[†] From the *Université Laval, Laval, and the †Centre de recherche FRSQ du CHA, Québec, Que.

Background: The evaluation of risk-adjusted mortality plays an important role in trauma quality improvement activities. Patients with isolated hip fractures (IHF) are often excluded from such evaluations, but we recently observed important heterogeneity in definitions of the latter. Our objective was to evaluate the influence of heterogeneity IHF definitions on the results of trauma centre performance evaluations. **Methods:** We conducted

a multicentre retrospective cohort study based on a provincial trauma system using registry data (1999–2010, 59 centres). Trauma centre performance was evaluated with the Trauma Risk Adjustment Model. Seven definitions of IHF based on diagnostic codes, age, mechanism of injury and secondary injuries were used according to the results of a systematic review. Agreement in risk-adjusted mortality across definitions was evaluated with Pearson correlation coefficients weighted by patient volume. A coefficient of 0.95 or greater was considered to reflect high agreement. Analyses were stratified by age. **Results:** The study population comprised 201 216 patients before exclusion and between 128 094 and 139 588 patients after exclusion of IHF. Low agreement was observed for hospital risk-adjusted mortality when patients with IHF were included/excluded from analyses ($r = 0.88$, 95% CI 0.78–0.94). However, in the whole sample and in patients younger than 65 years, correlation coefficients across IHF definitions were all 0.95 or greater. **Conclusion:** While the exclusion of patients with IHF does impact the results of performance evaluations based on mortality, the definition of an isolated hip fracture in terms of diagnostic codes, age, mechanism of injury and secondary injuries has no significant impact on results.

Pediatric trauma, advocacy skills and medical students. C. Wang,* I. Bratu,* C. Gladwin,* D. Voaklander,† M. Lewis.* From the *Stollery Children's Hospital and the †Alberta Centre for Injury Control and Research, Edmonton, Alta.

Background: As one of the CanMEDS roles, advocacy is unique because it challenges medical schools' abilities to define, apply and evaluate this role. To address this gap, our project utilizes pediatric injury prevention as a stepping stone for assessing the impact of undergraduate medical curriculum on health advocacy competencies among medical students. **Methods:** First-year (167) and fourth-year (189) medical students at our local medical school are administered an anonymous, cross-sectional questionnaire. The survey explores the students' awareness, attitudes, training and experience in health advocacy and its significance in pediatric trauma prevention. Responses from the 2 cohorts are compared. **Results:** First-year ($n = 73$, 44%) and fourth-year ($n = 50$, 26%) students have responded and are aware that advocacy is a CanMEDS role and of its importance. By their fourth year, students are aware of the major causes of mortality in the pediatric population, of risk factors for injury in the pediatric population, and express confidence in engaging in advocacy at the clinical and community levels. Despite this, students believe that the top 3 most important pediatric public health issues in the province are immunization, smoking prevention and child poverty. Both groups express a lack of confidence in their knowledge of the policy-making process and their ability to lobby on behalf of their patients. Both groups prefer community-based experiences as the most effective mode of learning advocacy. **Conclusion:** Medical school curricula need more emphasis on pediatric injury prevention as a major public health issue that can be used as a learning tool for advocacy.

Compliance with the prescribed packed red blood cell, fresh frozen plasma and platelet ratio for the trauma transfusion pathway at a level 1 trauma centre. B. Moffatt,* K. Vogt,† K. Eckert,† J. Williamson,† T. Charyk Stewart,†

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

Background: The London Health Sciences Centre Trauma Transfusion Pathway (TTP) was created for use in patients requiring massive transfusion (MT) after trauma. The pathway is designed to provide blood products in a ratio of 1 unit packed red blood cells (pRBC): 1 unit frozen plasma: 1 pool platelet dose. This study was undertaken to determine compliance with the TTP and factors associated with clinically unwarranted activations. **Methods:** All adult trauma patients who required MT and/or who had the TTP activated from 2007 to 2011 were identified from our prospectively collected blood bank and trauma databases. A control group of consecutive patients requiring MT in the 2 years before creation of the TTP was selected. Data were analyzed using multivariable logistic regression. **Results:** Of patients who required MT with TTP activation, 49% met the blood product ratio outlined. Failure to meet this ratio was associated with higher Injury Severity Score ($p < 0.01$). Of all TTP activations, 34 (39%) did not require MT. The need for operative intervention was associated with appropriate TTP activation (OR 4.6, 95% CI 1.2–18.2). Patients requiring MT after implementation of the TTP received fewer units of pRBC and frozen plasma ($p < 0.01$ and 0.01, respectively) and were less likely to manifest coagulopathy with peak international normalized ratio ($p < 0.01$), peak partial thromboplastin time ($p = 0.02$) and lowest platelet count ($p = 0.01$). **Conclusion:** The creation of our TTP is associated with a reduction in blood product transfusion and improvements in early coagulopathy. Only about half of patients requiring MT are meeting the predefined blood product ratio. More severely injured patients are at higher risk for not meeting this ratio. Many TTP activations occur in patients who do not require MT.

Early fixed-wing aircraft activation for major trauma in remote areas. S. Wheeler,* R. L'Heureux.† From the *British Columbia Ambulance Service and †BC Air Ambulance, Victoria, BC

Background: The majority of Canada is rural and remote. For trauma victims in these locations, transport time may run from many hours to days. Rotary Autolaunch programs for the early activation and transport of trauma patients have been functioning in British Columbia since 2004 and have helped to reduce time to definitive care for some trauma patients. But these programs only service areas close to major trauma centres. For trauma victims in more remote locations beyond the range of rotor machines, Autolaunch programs have no benefit. **Methods:** BC Air Ambulance looked at applying the principals of rotor Autolaunch to fixed-wing aircraft. The skills learned by dispatch centres in managing Autolaunch can be transferred to identify major trauma in remote areas. However, Autolaunch criteria cannot be simply applied to fixed-wing aircraft, and the unique issues of early fixed-wing aircraft activation (EFWA) will be presented. **Results:** BC Air Ambulance decided to trial a pilot program on northern Vancouver Island in 2009 but had limited numbers. The program was then expanded to the Northern Health Authority in 2011. Time to definitive care has been markedly reduced for these patients. A case series of these patients will be presented. Time intervals to primary and tertiary centres will be presented and discussed in

comparison to pre-EFWA, where possible patient outcomes will be examined. **Conclusion:** The EFWA program can reduce time to definitive care for trauma patients in remote areas.

Development of a national, multi-disciplinary trauma crisis resource management curriculum: results from the pilot course. L. Gillman,* M. Ziesmann,* J. Kortbeek,[†] P. Brindley,* C. Hicks,[§] P. Fata,[¶] P. Engels,** C. Ball,^{††} D. Paton-Gay,** S. Widder.** From the *University of Manitoba, Winnipeg, Man., the [†]University of Calgary, Calgary, [‡]Alberta Health Services, Edmonton, Alta., [§]St. Michael's Hospital, Toronto, Ont., [¶]McGill University, Montréal, Que., the **University of Alberta, Edmonton, and the ^{††}Foothills Medical Centre and University of Calgary, Calgary, Alta.

Background: Most medical errors are nontechnical and include failures in team communication, situational awareness, resource usage and leadership. Other high-risk industries have adopted team-based crisis resource management (CRM) training strategies to address “nontechnical” skills and to improve human error and safety. Here we describe the development and evaluation of a national multidisciplinary trauma CRM curriculum. **Methods:** A needs analysis survey was distributed to general surgery program directors across Canada. Using this feedback, a course called STARTT (Standardized Trauma and Resuscitation Team Training) was developed and held in conjunction with the Canadian Surgery Forum. Participants completed a pre- and postcourse evaluation exploring changes in attitudes toward simulation and CRM principles using previously validated survey tools. **Results:** In all, 20 surgical residents, 6 nurses, 4 respiratory therapists and 11 instructors (trauma surgeons, emergency physicians, nurses and intensivists) participated; 100% of participants completed the survey. Satisfaction was very high, with 97.5% of participants rating the course as “good” or “excellent” and 97.5% recommending it to others. The pre- and postcourse surveys showed statistically significant improvement in attitudes toward simulation and overall CRM principles (136.3 v. 140.3, $p = 0.004$) following the course, primarily in the domain of teamwork (69.1 v. 72.0, $p = 0.002$). **Conclusion:** Creation of a national multidisciplinary trauma CRM curriculum is feasible, has high satisfaction among participants and can improve attitudes toward the importance of simulation and CRM principles. The goal is to create a national curriculum to train all trauma team members with the ultimate goal of improving patient safety and care.

The management of blunt hepatic trauma in the age of angioembolization: a single centre experience. K. Bartens,* K. Vogt,[†] R. Hernandez-Alejandra,[†] D. Gray.[†] From the *University of Western Ontario and the [†]London Health Sciences Centre, London, Ont.

Background: Nonoperative management of blunt hepatic injury (BHI) is increasingly common. Although literature demonstrates decreasing mortality, liver-related morbidity remains high. This study was undertaken to explore morbidity and mortality of BHI during the era of angioembolization (AE) and to evaluate the role of routine postinjury imaging. **Methods:** A retrospective cohort of patients with BHI treated at our lead trauma hospital between 1999 and 2011 was identified. Logistic regression was undertaken

to identify factors associated with need for operative management (OM) and mortality. **Results:** A total of 396 patients was identified. Mean Injury Severity Score (ISS) was 33 ± 14 . Sixty-two (18%) patients had severe liver injuries (AAST grade 4 or higher). Operative management occurred in 109 (27%) patients. Logistic regression revealed high ISS (OR 1.07, 95% CI 1.05–1.10) and lower systolic blood pressure on arrival (OR 0.98, 95% CI 0.97–0.99) as associations with need for OM. Eight hepatic AEs occurred, 4 to treat pseudoaneurysms identified on routine, repeat CT imaging. The overall mortality was 17%, with increasing age (OR 1.05, 95% CI 1.03–1.07), increasing ISS (OR 1.11, 95% CI 1.08–1.14) and requirement of OM (OR 2.89, 95% CI 1.47–5.69) associated with death. Liver-related morbidities occurred with similar frequency in the OM (23%) and AE (29%) groups ($p = 0.32$). Only 3% of those treated nonoperatively experienced morbidity. **Conclusion:** Blunt hepatic injury can be successfully managed nonoperatively with low morbidity. Although patients with BHI are routinely assessed for pseudoaneurysms at some centres, our data suggest that this may not be justified in patients with less severe BHI.

Early predictors of in-hospital mortality in adult trauma patients. P. Lysecki, L. Vanderbeek, F. Forrokhhyar, R. Anatharajah, N. Howatt, S. Lamb, N. Sne, K. Kahn moui. From McMaster University, Hamilton, Ont.

Background: Trauma scoring systems assist in prognostication, triage, research, resource allocation and quality assurance for trauma patients. Numerous scores have been developed for clinical use, though an ideal, simple yet comprehensive score has remained elusive. We sought to identify factors predictive of in-hospital mortality in adult trauma patients for the purposes of creating such a score. **Methods:** We conducted a retrospective review of data from 2426 consecutive adult patients with Injury Severity Scores greater than 12, seen at a level 1 trauma centre from 2002 through 2006. Those without vital signs upon arrival were excluded. The primary outcome of interest was in-hospital mortality. In all, 27 clinical variables, each obtainable within 24 hours of presentation, were chosen for univariate analysis, and those reaching statistical significance were entered into a stepwise multivariate logistic regression model. **Results:** Four variables were retained in the final model, including age greater than 50 years (OR 3.4, 95% CI 2.2–5.2, $p < 0.001$), presence of endotracheal tube on arrival (OR 4.3, 95% CI 2.8–6.5, $p < 0.001$), abnormal serum troponin on arrival (OR 1.7, 95% CI 1.1–2.6, $p = 0.014$) and blood product transfusion (packed red cells, fresh frozen plasma, platelets or cryoprecipitate) within 24 hours (OR 2.0, 95% CI 1.3–3.0, $p = 0.01$). **Conclusion:** Advanced age, presence of an endotracheal tube on arrival, abnormal serum troponin and need for blood product transfusion were predictive of inpatient mortality in adult trauma patients. These predictors will be used toward the development of a mortality prediction score for trauma patients.

The impact of open tibial fracture on health service utilization in the year preceding and following injury. I. Pallister,* R. Lyons,* A. Walters,* C. Brooks,* L. Pinder,* S. Rahman,* A. Walters.[†] From *Swansea University and the [†]DECIPHER UKCRC Public Health Research Centre of Excellence, Swansea, United Kingdom

Background: Understanding of open tibial fractures is focused on emergency surgery, with definitive care being delivered in an orthoplastic unit. The aim of this study was to determine the impact of these injuries more broadly upon health care service utilization in patients managed in accordance with treatment guidelines or at variance with them. **Methods:** Open tibial fractures managed in accordance with guidelines were divided into directly admitted patients (DAP) and transferred patients (TP). Those referred outside the terms of existing guidelines with complications were also studied (limb salvage patients [LSP]). The Secure Anonymised Information Linkage system was used to gather relevant data in relation to pre- and postinjury health care service utilization. **Results:** The average length of hospital stay was similar for the DAP, TP and LSP groups (34, 30 and 32 d, respectively). However, the average number of outpatient clinic visits differed appreciably between the groups (DAP 12, TP 22 and LSP 18). Following injury, general practice visits increased from an average of 16 to 25/patient/year in the DAP group, 10 to 34 in the TP group and 3 to 20 in the LSP group. **Conclusion:** Although open tibial fractures are well recognized as surgical emergencies, the impact of these injuries beyond the initial hospital treatment remains poorly defined. Greater demands upon hospital outpatient clinics and primary care are suggested in patients managed outside of standard guidelines, and also those who required interhospital transfer to the Orthoplastic unit. These data will help inform trauma service network development.

A systematic review and meta-analysis of the efficacy of red blood cell transfusion in the trauma population. *S. Patel,* B. Kidane,† N. Parry.** From the *London Health Sciences Centre and the †University of Western Ontario, London, Ont.

Background: Numerous previous studies have assessed the association between transfusion and mortality and morbidity in the trauma population. The objective of this study is to perform a systematic review and meta-analysis of these studies. **Methods:** A literature search was completed. The primary outcome was mortality, with multiple organ failure (MOF) and acute respiratory distress syndrome (ARDS) as secondary outcomes. The results were pooled using the random effects model. **Results:** In all, 35 observation studies ($n = 68\,675$) met the inclusion criteria. No randomized controlled trials were identified. Mortality was assessed in 22 studies, MOF in 8 studies and ARDS in 9 studies. From these studies, 6 ($n = 16\,028$) we assessed red blood cells (RBCs) as a continuous variable, adjusting for injury severity and other confounders. There was evidence of an association between increased mortality and number of units transfused (OR 1.08/unit, 95% CI 1.02–1.15, $p < 0.02$). Six other studies ($n = 36\,515$) assessed transfusion as a binary variable and adjusted for confounders. There was strong evidence of association between RBC transfusion and mortality (OR 3.33, 95% CI 1.96–5.65, $p < 0.001$). Due to the heterogeneity of design, the results from the studies assessing MOF and ARDS could not be pooled. **Conclusion:** The studies included were heterogeneous in the quality, design, categorization of RBC transfusion and reporting of results. We found an association between transfusion and mortality when the results were pooled. The difficulty in adjusting for confounding from injury severity limits the strength of conclusions that can be made based on observation studies.

Sources of support for paramedics managing work-related stress in a Canadian EMS service responding to multisystem trauma patients. *P. Bradford,* E. Donnelly,† M. Lewell,‡ R. Mellow,§ C. Hedges,§ P. Morassutti.** From the *Hotel Dieu Grace Hospital and the †University of Windsor, Windsor, Ont., the ‡Southwest Ontario Regional Base Hospital Program, London, and the §EWEMS Corporation of the County of Essex, Essex, Ont.

Background: Paramedics are routinely exposed to work-related stress from treating trauma patients. Greater clarity is needed to understand how paramedics would seek help in anticipation of providing and funding needed resources to treat work-related stress. **Methods:** Paramedics were invited to complete an online questionnaire. Participants were asked to report likelihood of seeking help from a supervisor, a partner or other coworker, a union representative, a base hospital educator, family or a therapist. Repeated-measures analysis of variance and strategies were used to analyze the data. **Results:** In all, 145 paramedics (a 54% response rate) completed the questionnaire. Respondents were more likely ($p < 0.001$) to seek support from family or a paramedic work partner than from any other source. Respondents were less likely to seek support from (sequentially) a coworker, a therapist, a union representative, a supervisor or a base hospital educator. Analysis revealed higher levels of organizational ($p < 0.001$) and operational ($p < 0.05$) workplace stress in those individuals who were unlikely to seek support from their supervisor. **Conclusion:** These findings indicate that investments in awareness and education on accessing help for paramedics with work-related stress, including care of multisystem trauma patients, should be spent on peer programs and open houses with family and friends rather than sending supervisors for extra training in stress identification. Further work with paramedics needs to be done to remove the cultural stigma involved in coming forward to seek assistance.

Analysis of prehospital treatment of pain in the multisystem trauma patient at a community level 2 trauma centre. *P. Bradford,* R. Bulatovic,† P. Morassutti,‡ E. Galbraith,* S. McKenzie,* D. Bradford,* M. Lewell,‡ M. Peddle,‡ A. Dukelow,‡ D. Eby,‡ S. McLeod.‡* From the *Hotel Dieu Grace Hospital, Windsor, the †University of Toronto, Toronto, the ‡Southwest Ontario Regional Base Hospital Program and the §University of Western Ontario, London, Ont.

Background: The primary objective of this study was to determine how often analgesia is provided to trauma patients as defined by an Injury Severity Score (ISS) greater than 12 by either the prehospital medical directive or through online medical control. **Methods:** A retrospective chart review of trauma patients transported to a level 2 trauma centre from Apr. 1, 2010, to Mar. 31, 2011, was performed. Cases were reviewed by a trained advanced care paramedic (ACP) auditor, medical student and emergency medical services trauma team leader physician. **Results:** In all, 228 patients with an ISS greater than 12 were reviewed; 78 were excluded (53 interfacility transports, 23 walk-ins and 2 in-hospital falls). Of the remaining 150 cases, 62 cases (41%) had an ACP response where the potential to provide analgesia existed. Of these 62 cases, only 5 (8.1%) received

prehospital analgesia. The time to prehospital analgesia was 29 (IQR 19–29) minutes. Of the 57 ACP patients who did not receive prehospital analgesia, 37 (64.9%) were given analgesia in the emergency department (median 68, IQR 48–165 min).

Conclusion: Despite demonstrated rapid delivery, the frequency of prehospital analgesia use for multisystem trauma patients is extremely low. Promoting more frequent use of online medical control by ACP may allow patients to receive analgesia much sooner. Consideration should be given to expanding prehospital directives for all paramedics to include pain control for multisystem trauma patients.

Increased mortality associated with placement of central lines during trauma resuscitation. B. Kidane,* P. Bradford,† T. Charyk Stewart,* N. Parry.* From the *University of Western Ontario, London, and the †Hotel Dieu Grace Hospital, Windsor, Ont.

Background: Complications associated with central and arterial lines are well documented. Our objective was to determine if insertion of central or arterial lines in adult trauma patients during trauma resuscitation is associated with higher in-hospital mortality, after controlling for injury severity, hemodynamic instability as well as other prognostic and process-of-care factors.

Methods: A retrospective cohort study at a level 1 trauma centre in Ontario. All adult patients presenting with Injury Severity Scores (ISS) greater than 12 were consecutively sampled between 1999 and 2011. Multivariable hierarchical logistic regression was performed to evaluate the adjusted predictors of mortality.

Results: There were 5002 trauma admissions. Arterial/central lines were placed in the trauma bay in 445 (9%) patients. These patients had higher ISS ($p < 0.001$), lower presenting systolic blood pressure ($p < 0.001$) and were more likely to have had penetrating trauma ($p = 0.001$). After adjusting for age, sex, trauma bay vitals, ISS, comorbidities, year of presentation (to control for effect of secular trends in improvement of general medical care), trauma team activation and direct arrival to a level 1 trauma centre, trauma bay placement of central lines was associated with a significantly higher risk of in-hospital mortality ($p = 0.004$), with an odds ratio of 3.36 (95% CI 1.46–7.71). However, placement of arterial lines was not associated with higher risk of in-hospital mortality ($p = 0.83$, OR 0.91, 95% CI 0.38–2.20). **Conclusion:** Insertion of central lines during trauma resuscitation was associated with a significant increase in risk of in-hospital mortality. Future studies are needed to elucidate the mechanisms by which this increased risk of mortality occurs.

Chronic pain after serious injury — identifying high risk patients. A. Holmes,* O. Williamson.† From the *University of Melbourne and the †JPOSC Pain Clinic, Melbourne, Australia

Background: Persistent pain is common after serious injury. A range of factors, such as early pain severity, sociodemographic background and psychological distress are known to increase the chances of persistent pain, but it has not been established whether they can be used to identify high-risk patients in order to triage them early to specialized services. **Methods:** Patients admitted to 2 level 1 adult trauma centres underwent a comprehensive physical and psychological assessment of known and potential risk fac-

tors for chronic pain during their index admission. Three years after injury, these patients were assessed for the presence of chronic pain (score was 5 or more on an 11-point numerical rating scale during the last episode of pain, and present in the last month and several times in the past week). Logistic regression was used to identify independent risk factors for the presence of chronic pain. **Results:** In all, 220 patients (76% of original cohort of 290) were assessed at 3 years. Of these, 146 (67%) reported some pain, and 52 (24%) reported chronic pain. Factors (present at the time of injury) that predicted chronic pain were lower socio-economic status, pain severity and injury severity. These factors combined were able to predict chronic pain at 3 years with a sensitivity of 70%, but the specificity was only 50%. **Conclusion:** Chronic pain is present in almost a quarter of patients 3 years after serious injury. High-risk patients cannot be identified by using information collected in the acute hospital alone. A stepped screening model over the first 3 months may be more effective.

Epidemiology of in-hospital trauma deaths in a Brazilian university teaching hospital. A. Trajano, G. Fraga, B. Pereira. From the University of Campinas, São Paulo, Brazil

Background: Trauma is the leading cause of death and disability of people between the ages of 1 and 44 years in Brazil. About 70% of deaths in young people and 60% in childhood are due to trauma. The analysis of the causes, the time and the location of in-hospital deaths from trauma can identify critical areas of the hospital and improve assessment of the trauma system.

Methods: A retrospective study of deaths recorded by the department of trauma surgery of the University of Campinas was conducted in order to profile in-hospital deaths due to trauma. The patients studied all died secondary to violent causes (ICD-10 V01 ranked among the Y98 in chapter XX, excluding deaths from drownings, poisonings, long bone fractures from falls and medical complications) met during the years 1995, 2000, 2005 and 2010.

Results: During the analyzed periods, 22 858 patients with traumatic injuries were admitted, an average of 5714 patients per year. Of the total admissions, there were 549 deaths (2.4% of total). We selected 467 cases (85% of total), and of these, 325 (69.6%) were admitted with signs of life. The mean age was 36.55 ± 18.69 years, and 85.4% were male. Blunt trauma occurred in 73.0% of patients and penetrating trauma in 27.0%. The mean Injury Severity Score (ISS) of patients with signs of life was 26.12 ± 9.23 , and 71.3% had an ISS greater than 24 and the average Revised Trauma Score was 5.18 ± 2.09 . In 2000, the most common mechanism of injury leading to death was firearms (37.7%); in 2010, firearms were responsible for 9.6% of injuries leading to death. In contrast, motorcycle collisions were responsible for 7.3% of deaths in 1995; this rose to 31.5% in 2010. The main cause of death remains injuries to the central nervous system (56.3% of total), followed by hemorrhagic shock (18.1%). The trimodal distribution of deaths, with the third peak after more than 7 days, is still noted in our series (17.1% of total). **Conclusion:** During the last 15 years, there has been a shift of deaths from trauma in our hospital, with a large decrease of penetrating injuries, from 40.8% in 2000 to about 17.8% in 2010. In contrast, there was a higher incidence of motorcycle collision deaths, from 7.3% of deaths to about 31.5% of the total.

Increased suicidality following major trauma: a population-based study. J. March, J. Sareen, M. Doupe, J. Gawaziuk, D. Chateau, S. Logsetty. From the University of Manitoba, Winnipeg, Man.

Background: Nonfatal injuries are a leading cause of morbidity and mortality. In 2008, 14 065 patients were hospitalized across Canada with major trauma. With individuals surviving trauma, the psychosocial sequelae of severe physical injury have become an important area of research. No previous studies have used a population-based sample to estimate the incidence of suicidality (suicide or suicide attempt) following physical injury. We assess the odds ratio (OR) of suicidality among adults with major trauma compared with a matched cohort. **Methods:** Persons over 18 years of age who experienced an unintentional major traumatic injury (Injury Severity Score > 12) at a regional academic trauma centre between Apr. 1, 2001, and Mar. 31, 2011, who had no suicide attempts in the previous 5 years were identified from the trauma registry. These individuals were matched with data from provincial administrative databases. An age-, sex- and date of indexed injury-matched cohort was created from the general population, with 5 controls for each trauma case, and the rate of suicidality was compared between groups. **Results:** In all, 2198 adults with major trauma were matched to 10 990 controls. Suicidality was increased in the trauma cohort (OR 4.31). This increase persisted even if adjusted for anxiety/mood disorders and substance abuse (adjusted OR 1 = 3.65) and residence, physical comorbidities, income quintile as well as those factors in adjusted OR 1 (adjusted OR 2 = 3.30). All odds ratios were significant ($p < 0.05$). **Conclusion:** Individuals who experience major traumatic injuries are at a greater risk of postinjury suicidality than those in a matched cohort.

Development of a population-wide record linkage system to support trauma research. R. Lyons,* I. Pallister,[†] J. Lewis,[‡] D. O'Doherty,[‡] S. Hopkins,[‡] S. Griffiths,[§] S. Palmer,[¶] B.J. Gabbe.** From the *DECIPHer UKCRC Public Health Research Centre of Excellence and [†]Swansea University, Swansea, the [‡]Cardiff and Vale University Health Board, the [§]Public Health Wales NHS Trust and [¶]Cardiff University, Cardiff, United Kingdom, and **Monash University, Melbourne, Australia

Background: Serious injury often results in a number of short- and long-term social and medical consequences. Measurement of the frequency and duration of these consequences is necessary for accurate cost effectiveness analyses to support developments in prevention, treatment and rehabilitation, but is challenging. Record linkage provides a potential solution. We describe the development of such a system in Wales, United Kingdom. **Methods:** The Secure Anonymised Information Linkage (SAIL) system supports deidentified record linkage between health and nonhealth data sets for the 3 million people of Wales. The system is being further developed to measure the impact of trauma on health and social outcomes, including educational attainment, employment and independent living. In the proof of concept phase, we used the Wales Electronic Cohort for Children (WECC) to measure the impact of early childhood head injuries on educational attainment. **Results:** The WECC contains records of 90 661 deidentified children born between 1996 and

2000, with linked health and educational attainment data at age 7. Some 355 children were discharged with head injuries. After adjustment for birth weight, gestation, sex, Apgar score, age at assessment, within-school clustering and area deprivation score, hospitalization with a head injury was associated with an elevated risk of underachievement (OR 1.46, 95% CI 1.11–1.93).

Conclusion: The SAIL system demonstrated the feasibility of measuring longer term social outcomes following trauma. The system is being further developed to incorporate trauma-registry and patient-reported outcome data and will be used to support the evaluation of new interventions and developments.

Induction of hmgb1 by increased gut permeability mediates acute lung injury in a hemorrhagic shock and resuscitation mouse model. R. Kao,* X. Xu,[†] C. Martin,[†] A. Xenocostas,[†] N. Parry,[†] T. Mele,[†] T. Rui.* From the *University of Western Ontario and the [†]London Health Sciences Centre, London, Ont.

Background: Hemorrhagic shock and resuscitation (HS/R) can promote the development of multiple organ failure, which is associated with high mortality in patients with HS/R. It is believed that an exaggerated inflammation response is the mechanism involved in the development of acute lung injury (ALI). We tested the hypothesis whether HS/R can result in increased in gut permeability and induction of high mobility group box 1 protein (HMGB1), which may play a role in the development of acute lung inflammation. **Methods:** A mouse model of HS/R was employed in this study. Gut permeability was assessed by measuring circulating fluorescein isothiocyanate dextran (FD4) and lipopolysaccharide (LPS). Circulating HMGB1 was determined with a HMGB1 enzyme-linked immunosorbent assay kit. Acute lung injury was determined by measuring lung myeloperoxidase activity and pulmonary protein leak. **Results:** Hemorrhagic shock and resuscitation induces intestinal barrier dysfunction as evidenced by increase in circulating FD4 and LPS at 1 hour and 2 hours after resuscitation, respectively. The circulating HMGB1 levels are increased in mice with HS/R as compared with sham animals ($p < 0.05$). Hemorrhagic shock and resuscitation resulted in mouse ALI (increase in lung myeloperoxidase activity and pulmonary protein leak in mice with HS/R compared with sham mice, $p < 0.05$). Inhibition of HMGB1 (A-box and TLR4^{-/-}) attenuated the ALI in mice with HS/R. **Conclusion:** Our results suggest that induction of HMGB1 by intestinal barrier dysfunction is pivotal in the development of ALI in mice with HS/R.

Patients who sustain gunshot pelvic fractures are at increased risk for deep abscess formation: aggravated by rectal injury. J. Rezende-Neto,* E. Abreu,[†] M. Andrade,* F. Cruz,* R. Pires,* P. Carreiro,* T. Andrade.* From the *University of Minas Gerais and the [†]Risoleta T. Neves Trauma Center, Belo Horizonte, Brazil

Background: The connection between infection and gunshot fractures of the hip joint is well reported. However, the risk of deep abscess formation in patients who sustain gunshot pelvic fractures (GSPF) is ill defined. The purpose of this study was to determine the likelihood of deep infection in GSPF, and the role of gastrointestinal injury. **Methods:** We conducted a prospective

observational study from Oct. 1, 2011, to Oct. 1, 2012. Patient who sustained a GSPF (Injury Severity Score [ISS] < 25) were divided into 3 groups: group 1 (GSPF + gastrointestinal [GI] injury), group 2 (GSPF without GI injury) and group 3 (abdominal gunshot wound and GI injury only). Deep abscess formation was the main outcome (30 d patient follow-up). **Results:** In all, 52 ($n = 52$) patients met the study criteria: group 1 ($n = 17$), group 2 ($n = 9$) and group 3 ($n = 26$). All were male, with a mean age of 28.1 (standard deviation [SD] 12.1) years, mean ISS 12 (SD 6) and mean length of stay 8.8 (SD 8) days. Length of stay was significantly longer in group 1 (mean 13.7, SD 11.2 d, $p = 0.003$). Seven patients developed abscesses (6 in group 1 and 1 in group 2); GSPF correlated significantly with abscess formation (OR 19.3, 95% CI 1.2–359.8, $p = 0.01$), and a rectal injury associated with GSPF increased the chances of abscess formation by 55 times (OR 55, 95% CI 1.5–67.5, $p = 0.0039$). **Conclusion:** Patients who sustain GSPF are at greater risk for deep abscess formation. These findings warrant a more comprehensive approach that includes wound cleansing and debridement.

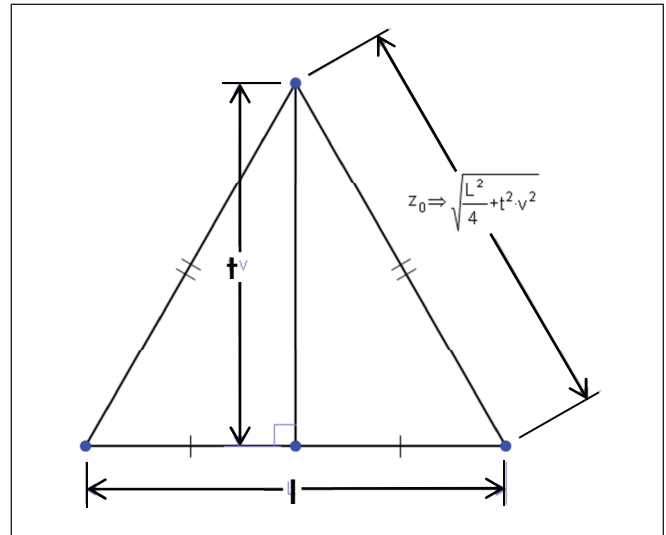
Are we transfusing more with conservative management of isolated blunt splenic injury? A retrospective study. Y. Leblanc,* J. Lampron,† F. Balaa.† From the *University of Ottawa and †The Ottawa Hospital, Ottawa, Ont.

Background: The management of patients with isolated blunt splenic (IBS) injury remains an area of controversy, mostly because of the challenging inability to predict each patient's evolution, despite diagnostic imaging grading systems that attempt to do so. The decision to operate or not often relies more on clinical evolution than initial severity seen on imaging system. New trauma hemostatic methods have been developed over the last decades, namely tranexamic acid and splenic artery embolization. The primary objective of this study is to evaluate the need for transfusions between nonoperative management to an operative management group. The secondary objective is to evaluate clinical outcomes, which are length of stay and mortality at 30 days. **Methods:** This study is a retrospective case study of all patients with IBS injury who presented to a Canadian university hospital over a 10-year period (April 2002 to April 2012). Data reviewed include patient characteristics, type of intervention, number of packed red blood cells (pRBC) transfused and outcomes. Two groups will then be compared looking at the number of pRBCs required in each group and outcomes. **Results:** Results will be coming shortly. **Conclusion:** No conclusion is available yet, but our hypothesis is that the number of pRBCs transfused is higher in the nonoperative group than in the operative group.

Motorcycle clothesline injury prevention: Experimental test of a protective device. J. Rezende-Neto, R. Fortuna, H. Issa, P. Dias, M. Marques, T. Fernandes, T. Sousa. From the University of Minas Gerais, Belo Horizonte, Brazil

Background: A clothesline injury mechanism has been reported in unprotected vehicles (motorcycles, bicycles, all-terrain vehicles [ATVs]) and also in serious neck injuries provoked by abrasive coated threads used in kite fighting. To prevent those injuries, motorcycles in Brazil are equipped with a protection device consisting of 2 steel rods vertically attached to each end of the handlebar. However, the effectiveness of that device has never

been tested. We set forth to experimentally test the protection against clothesline injury provided by the device. **Methods:** A collision against an object (L) at a speed (V) was represented mathematically:



According to the equation, the thread unwinds at twice the speed of the motorcycle and generates a tension of 10 kgf at 90 km/h. Experimentally, a Styrofoam cylinder (simulating the neck of a rider) was mounted on a motorcycle fixed to the bed of a pickup truck. An abrasive coated thread was placed across the path of the Styrofoam cylinder (horizontally and 60°), and the truck was accelerated to 40 and 70 km/h. Three situations were created with the protective device (steel rods): no device, 1 device and 2 devices on the handlebar (the experiment was done in triplicate). **Results:** The Styrofoam cylinder was consistently transected completely when no device was used; 1 device provided partial protection; 2 devices provided total protection regardless of the angle. **Conclusion:** Two protective devices can effectively prevent a motorcycle clothesline injury. A similar concept can help design clothesline injury protection devices for ATVs and bicycles.

A prospective analysis of compliance with a massive transfusion protocol - activation alone is not enough. K. Vogt,* K. Inaba,† J. Smith,* O. Okoye,† E. Joos,* I. Shulman,* J. Nelson,* N. Parry,‡ P. Rhee,§ D. Demetriades.† From the *LA-USC Healthcare Network and the †University of Southern California, Los Angeles, Calif., the ‡London Health Sciences Centre, London, Ont., and §The University of Arizona, Tucson, Ariz.

Background: The impact of compliance with massive transfusion protocols (MTPs) remains unclear. This study was undertaken to assess compliance with an institutional MTP and the effect on outcome in patients requiring massive transfusion (MT). **Methods:** This prospective cohort study assessed all patients at a level 1 trauma centre requiring MT over a 30-month period. Patients who died within 1 hour of arrival were excluded. Ratio compliance was defined as a red blood cell: fresh frozen plasma: platelet ratio of 1:1:1 or 2:1:1. Patients were compared based on MTP activation status and ratio compliance. **Results:**

In all, 643 trauma patients required transfusion, of whom 204 (32%) required MT. The MTP was activated in 139 (68%) patients. Overall mortality was 38%, with no difference based on MTP activation ($p = 0.73$). Ratio compliance was achieved in 78% of patients who had the MTP activated and 62% of patients who did not. Patients with ratio compliance had a lower mortality rate (32% v. 46%, $p < 0.01$). After adjusting for age, mechanism of injury, hemodynamics and emergent operative intervention, only higher Injury Severity Score was associated with increased odds of MTP activation (OR 1.03, 95% CI 1.01–1.07). **Conclusion:** Massive transfusion protocol activation occurred in only 68% of patients requiring MT, and factors associated with failure to activate this protocol remain elusive. Activation of the MTP does not ensure ratio compliance, and many patients without MTP activation achieved ratio compliance. Independent of MTP activation, compliance is associated with improved survival. Efforts to identify barriers to and increase compliance with MTPs will be required to ensure maximal benefit.

An evaluation of diagnostic modalities in penetrating injuries to the cardiac box: Is there a role for routine echocardiography in the setting of negative pericardial FAST? *S. Alzaid, R. Ostrofsky, G. Butler-Laporte, T. Chughtai, K. Khwaja, P. Fata, D. Mulder, T. Razek, D. Deckelbaum.* From McGill University, Montréal, Que.

Background: In the setting of penetrating trauma to the cardiac box, the performance of an echocardiogram after negative focused assessment with sonography for trauma (FAST) remains common practice. Our objective is to ascertain the yield of an echocardiogram in the context of a negative FAST. **Methods:** A retrospective analysis of the trauma registry at a level 1 trauma centre (2000–2010) was performed. All patients with a penetrating injury to the cardiac box with a FAST examination of the pericardial space were included. Basic demographic data, as well as diagnostic imaging and any operative intervention, were collected. Patients were evaluated for discrepancies between FAST and echocardiography, pericardial window or other interventions based on intention to treat analysis. **Results:** During the study period, 127 patients with penetrating injury to the cardiac box had pericardial FAST performed. Their mean age was 33.67 years, and 90.4% of the population was male. The overall mortality was 2.4%, and the mean Injury Severity Score was 17.97. In addition to the FAST, of the 127 patients, 77 had an echocardiogram and 52 had a pericardial window. The sensitivity, specificity, negative and positive predictive values for FAST were 100%, 86%, 100% and 58.8%, respectively. Adding an echocardiogram to a negative pericardial FAST did not significantly improve the sensitivity, specificity, negative or positive predictive value for detecting hemopericardium. **Conclusion:** The above study suggests that routine performance of echocardiography following a negative pericardial FAST in penetrating trauma to the cardiac box may be an unnecessary practice.

Achievement of pediatric national quality indicators — an institutional report card. *G. Jansz, K. Bailey, J. Pemberton.* From McMaster University, Hamilton, Ont.

Background: In 2010, the Trauma Association of Canada (TAC) generated consensus-based pediatric quality indicators (QIs).

Using these indicators, we generated an institutional “report card” for trauma care at the McMaster Children’s Hospital (MCH). The goal was to identify deficiencies in our program that could be immediately improved. **Methods:** This was a retrospective chart review of all pediatric patients presenting to MCH in 2010 with an Injury Severity Score (ISS) greater than 11 ($n = 43$). We assessed whether each TAC QI was achieved, not achieved, not applicable or not documented. Percent achievement, comparative statistics and outcome variables of death, unplanned return to the operating room or intensive care unit, and missed injuries were analyzed. **Results:** In 70%–100% of patients 10 of 16 (62.5%) indicators were achieved. The most notable deficiencies included hourly measurement of all vital signs (46%) and operative management of subdural or epidural hematoma within 4 hours (21%). Mortality was 14%, missed injuries rare (2%), and unplanned operation or readmission to the pediatric intensive care unit uncommon (10%). No statistical significance was noted between the QIs and outcome variables. **Conclusion:** We successfully created an institutional report card to understand how our institution fares with regards to achieving the management targets outlined in the TAC consensus-based QIs. Ongoing efforts are underway to address areas of deficiency identified in the report card. Our site has since joined the Canadian multicentred national pediatric trauma quality indicator study in efforts to determine benchmarks, guidelines and best practices for pediatric trauma care across Canada.

Process mapping trauma care in 2 regional health authorities in British Columbia: a tool to assist trauma system design and evaluation. *D. Andrusiek,* D. Evans,[†] H. Anton,[‡] J. Wei,* E. Randall,[†] B. Sobolev.[§]* From the *Emergency and Health Services Commission, Victoria, the [†]Vancouver General Hospital, the [‡]GF Strong Rehabilitation Centre and the [§]University of British Columbia, Vancouver, BC

Background: The continued absence of validated process indicators linked to meaningful outcomes obfuscates policy-relevant performance evaluation and redesign of trauma systems. Process mapping is a business systems quality improvement methodology that may help to identify key care processes that optimally drive trauma system performance toward desired outcomes. We want to map trauma care processes and describe the information flow in 2 BC health authorities for use by senior decision-makers engaged in system-level performance evaluation, strategic planning and design change. **Methods:** We used the following steps: (1) establish scope, (2) conduct interviews, (3) draw the process map, (4) validate the map and (5) develop an English-language narrative of the patient and information flow. We used swim lane diagrams to plot trauma care workflow. An independent business analyst verified procedures and technical rendering of the map. **Results:** Seventeen interviews with 8 key informants were conducted. Patient management activities across the continuum of care were captured in 4 overlapping domains: injury prevention, prehospital care, acute hospital care and rehabilitation. The final map placed 35 agents (multiple entities in injury prevention) in 27 swim lanes and identified 125 care processes and/or decision points in the following categories: injury prevention (6), prehospital care (24), acute hospital care (83) and rehabilitation (10). Seventy-two (72) general performance metrics from the literature were plotted. **Conclusion:** We have developed a communication

tool that relates key processes to preferred outcomes to assist policy-relevant performance evaluation of our trauma system by decision-makers.

Patient safety checklist for emergency intubation: a systematic review. *D. Andrusiek,* B. Ballantyne Scott,† R. van Heest.** From the *Emergency and Health Services Commission, Victoria, the †Fraser Health Authority, Surrey, and the ‡Royal Columbian Hospital, New Westminster, BC

Background: Emergency endotracheal intubation is an intervention with known complications that result in patient injury and death. Patient safety checklists are becoming more commonly used in complex procedures; however, they are uncommon for emergency intubation. The purpose of this systematic review is to determine if the use of a patient safety checklist for intubation results in improved intubation success and reduces patient morbidity or mortality. **Methods:** This systematic review was conducted in MEDLINE, EMBASE, CINAHL and the Cochrane Database of Systematic Reviews. These databases were systematically searched for English-language interventional and observational studies testing the effect of checklists during intubation to a comparison group, including standard practice, for literature published from 1960 to Nov. 1, 2011. A second consulting librarian peer reviewed the search strategies, before executing the search. Deduping was performed before title and abstract screening. Title and abstract screening was performed by 2 researchers, blinded to each other's decisions, using a screening tool. Full title search was conducted by 2 researchers, blinded to each other's decision. Disagreement at all stages of review was resolved through consensus. **Results:** The search returned a total of 231 citations, which was reduced to 156 after deduping. There was disagreement on inclusion based on title and abstract review for 7 articles ($\kappa = 0.5$), which was resolved through consensus review. Of these, 9 articles were selected for full text review (no disagreements). A total of 0 articles met all inclusion criteria. **Conclusion:** The World Health Organization surgical checklist first appeared in 2008 and led to uptake in the use of checklists for performance of complex medical tasks that may result in human error and patient harm. Emergency endotracheal intubation is a complex procedure, performed under considerable time constraints and often in an austere environment, making it an appropriate candidate for the use of a safety checklist. Despite this, no checklists have been evaluated to establish their effectiveness in emergency intubation.

A standardized flow sheet improves pediatric trauma documentation. *K. Bailey,* C. Frankfurter,† J. Pemberton,† S. McKerracher.** From the *McMaster Children's Hospital and †McMaster University, Hamilton, Ont

Background: To compare the utilization and documentation rates for pediatric trauma patients before and after implementing a revised pediatric trauma flow sheet within the emergency department (ED) at McMaster Children's Hospital. **Methods:** A retrospective cohort study of 51 pediatric trauma patients admitted between March 2009 and March 2010 was performed. Patients bypassing the ED were excluded ($n = 8$). Patients were divided by flow sheet used: pediatric trauma flow sheet (PTF1;

$n = 18$) and the ED flow sheet (EDF; $n = 18$). The 2 cohorts were further categorized by age, sex, trauma type and Injury Severity Score (ISS). Variables were analyzed and compared between the PTF1 and EDF cohorts. A new pediatric trauma flow sheet (PTF2) was designed and implemented using key stakeholder input. A prospective review of documentation on 21 consecutive pediatric trauma patients admitted between Sept. 1, 2011, and Mar. 25, 2012, using PTF2 was conducted; patients bypassing the ED were excluded ($n = 4$). **Results:** Patients assessed using PTF1 had a higher documentation of key variables compared with the EDF cohort ($p < 0.0001$). PTF1 documentation overall was significantly higher in both sexes ($p < 0.0001$), multiple ($p < 0.0001$) and single ($p < 0.001$) trauma victims, children aged 2–12 ($p < 0.0001$) and children with an ISS between 11 and 25 ($p < 0.0001$). Upon implementation of the newly revised PTF2, the overall documentation rate increased from 34.6% to 82.4% ($p = 0.006$). **Conclusion:** Using a revised PTF2 in the ED resulted in greater completion of trauma documentation. We recommend that standardized pediatric trauma flow sheets should be used and audited in the ED setting.

Massive transfusion in pediatric trauma: a 5-year retrospective review. *M. Livingston, T. Charyk Stewart, N. Merritt.* From the London Health Sciences Centre, London, Ont.

Background: Massive transfusion is usually defined as the replacement of half the circulating blood volume (40 mL/kg) within 24 hours. The purpose of this study was to describe massive transfusion in pediatric trauma patients at our centre. **Methods:** We conducted a retrospective review of severely injured (Injury Severity Score > 12), pediatric (age < 18 yr) patients treated at our regional pediatric trauma centre, 2006–2011. All patients showed signs of life on arrival. **Results:** Of the 435 total pediatric trauma patients, 66 (15.2%) received a non-massive transfusion (< 40 mL/kg) within 24 hours of presentation, and 13 others (3.0%) were massively transfused. The massive transfusion group consisted of 9 patients with multisystem trauma due to motor vehicle collision, 3 children younger than 2 years of age with isolated head injury and 1 adolescent with multiple stab wounds. Four patients were hypothermic and 6 were coagulopathic on arrival to hospital. Ten of 13 patients (77%) went on to develop coagulopathy within 72 hours of admission. Only 8 of the 13 (62%) who were massive transfused received both fresh frozen plasma and platelets. Six patients were given cryoprecipitate, and 1 received recombinant factor VIIa. Mortality was 4.2% for non-transfused patients, 19.7% for nonmassive transfusion and 38.4% for massive transfusion ($p < 0.001$). **Conclusion:** Massive transfusion is an uncommon event in pediatric trauma but is associated with significant mortality. At our centre, most massively transfused patients became coagulopathic within 72 hours of admission. Guidelines are needed to ensure resuscitation is coordinated and that patients are given appropriate amounts of fresh frozen plasma and platelets.

Is more better: Does a more intensive physiotherapy program result in accelerated recovery for trauma patients? *S. Calthorpe, L. Barber, L. Kimmel, C. Hodgson, M. Webb, A. Holland, R. Gruen.* From The Alfred, Monash University, Melbourne, Australia

Background: Physiotherapy forms part of routine care for inpatients following traumatic injury. Treatment aims to improve the patient's mobility, strength and endurance, thereby enhancing independence to facilitate a timely return home. Previous studies have shown that early physiotherapy is safe, can increase patient independence and decrease hospital length of stay in certain patient populations; however, the multifaceted trauma patient population is yet to be examined. The aim of this study is to investigate the effect on trauma inpatients of an intensive physiotherapy program. **Methods:** We conducted a prospective, randomized, controlled, single-blinded trial of 90 patients admitted to the Alfred Hospital Trauma Unit between October 2011 and June 2012. Patients were randomized into 1 of 2 groups: usual care (daily physiotherapy treatment) and intensive physiotherapy (usual care plus 2 additional daily treatments). One additional session was performed in a ward-based gym with the other being a functional mobility session with patient-specific mobility goals. Outcomes included (1) the modified Iowa Level of Assistance score at days 3 and 5, (2) physical readiness for discharge, (3) acute care length of stay, (4) discharge destination and (5) patient confidence and satisfaction. **Results:** In all, 45 patients were randomized into each of 2 groups. Preliminary analysis shows no difference between groups in any outcomes, although there is a trend toward a shorter length of stay in the intervention group, with no adverse events. **Conclusion:** Intensive physiotherapy for trauma inpatients is safe, although further research with larger groups is warranted to investigate if any subgroups benefit from this intervention.

Trauma care: not just for surgeons. Initial impact of implementing a dedicated multidisciplinary trauma team on severely injured patients. J. Hsu, K. Harrison. From Westmead Hospital, Sydney, Australia

Background: General surgeons have traditionally been responsible for the care of multiply injured patients. The decreasing trauma operative volume along with increasing subspecialization have led to a gradual decline in trauma interest among general surgeons. There is a shortage of trauma-committed surgeons within Australasia, and therefore alternative models of care must be considered. **Methods:** A review of trauma patient outcomes was performed, comparing a 6-month period in 2011, before model implementation (general surgery) to the same period in 2012, when the new model was implemented (trauma). **Results:** Patient numbers, age, Injury Severity Score (ISS) and mechanism of injury were similar between the 2 groups. In those patients with an ISS greater than 12, there was decreased mortality (6.8% v. 9.2%, $p = 0.08$) and length of stay (15.1 d v. 20 d, $p = 0.008$) in the trauma group compared with the general surgery group. Readmission and complication rates were not significantly different. **Conclusion:** Improved outcomes for the severely injured patient can be achieved with a dedicated team involving nonsurgeons. This model of care may be suitable for the Australasian trauma environment.

The role of postmortem autopsy in modern trauma care: Do we still need them? P. Lubbert, M. Hwang, L. Hsee, I. Civil. From the Auckland City Hospital, Auckland, New Zealand

Background: Data collection on trauma patients is one of the cornerstones of trauma patient management and organization. In

our hospital, data on trauma patients are collected by the trauma service on a daily basis, and the information is compared with available postmortem (PM) reports. We investigated whether the PM reports on deceased trauma patients in our hospital added new information to the already available information, and whether it would have changed management or ultimately prevented death. **Methods:** Retrospective analysis was performed for all trauma patients who died in Auckland City Hospital from July 2007 until December 2011. **Results:** During the study period, a total 126 patients were formally declared dead from trauma in the hospital, of whom 86 underwent a postmortem examination. Main cause of death was cerebral injury (64 patients, 74%), followed by hemorrhage (13 patients, 15%). Clinically assumed cause of death was confirmed by the PM report in 62 patients (72%). However, in 18 patients, additional causes were found, and in another 6 patients, different causes were identified. No major changes in management could be confirmed with PM report knowledge. Injury Severity Score (ISS) should probably be changed in 21 patients (mean ISS before and after the PM report 28.7 v. 30.7, range 1–26, for a mean change in ISS of 2.2). **Conclusion:** Although change in ISS and clinical management is relatively small for the patients in our study, we still think post-mortem studies do add information to clinical knowledge that might change future patient treatment.

Prototype cervical spine traction device for reduction stabilization and transport of nondistractive type cervical spine injuries. M. Boitano,* A. Muizelaar,* F. Baillie. From *McMaster University and †Hamilton General Hospital, Hamilton, Ont**

Background: Awake, closed reduction with traction of facet dislocations is preferred over open reduction, as neurologic status can be monitored. The current method using free weights and pulleys has several drawbacks, notably inability to maintain constant force when the patient is being transported on a stretcher, and incompatibility with CT and MRI. The objective was to design a modular system that is portable, able to apply up to 150 lb of traction to achieve reduction, maintain 10–15 lb of constant traction during patient transport, and is CT and MRI compatible. **Methods:** The main structural components were attached directly to the spine board. Attachments included the force application device and a scale to measure the amount of force. Testing included loading the prototype with the nylon rope to 150 lb, analyzing the relaxation of the nylon rope under high loads at 10 lb increments up to 90 lb, and determining the structural integrity of the prototype and safety factors of the components. **Results:** The nylon rope broke between 140 and 150 lb. Regarding relaxation, there were significant amounts of relaxation in the rope as the load increased (up to 9 cm at 90 lb). To determine the structural integrity, since the main attachment is secured to the spine board with bolts, calculations showed that each bolt on the spine board would be subject to a 21.4 lb load. A resultant safety factor of 328 was noted with the bending test (which ensures that the bolts will not fail). **Conclusion:** The prototype has the potential to replace the current method. Further testing will include (1) cadaver testing using both the traditional free weights method and the prototype traction device to determine achieving and maintaining reduction, and (2) development of a custom-built MRI imaging coil.

Going beyond organ preservation: a 12-year review of the beneficial effects of a nonoperative management algorithm for splenic trauma. *W. Leeper,* T. Leeper,† T. Charyk Stewart,* D. Gray,* N. Parry.** From the *London Health Sciences Centre and the †University of Western Ontario, London, Ont.

Background: Rates of organ preservation in splenic trauma have been improved by the use of nonoperative management. We hypothesized that our current algorithm, including repeat CT evaluation and the use of arterial embolization (AE), has resulted in additional benefits beyond organ preservation. **Methods:** We conducted a retrospective cohort study comparing outcomes of splenic trauma before (1995–1999) and after (2000–2012) the implementation of our current management (repeat CT in 48 hr and aggressive AE) algorithm using our prospectively collected institutional trauma database. **Results:** Patient characteristics in the postalgorithm (PA) era ($n = 644$) were similar in comparison with the prealgorithm era ($n = 159$), with the exception of a significantly lower median Injury Severity Score (29 v. 34, $p < 0.01$) and median grade of splenic injury (3 v. 4, $p < 0.01$) in the PA era. In the PA era, more patients were managed without splenectomy (45% v. 71%, $p < 0.01$), and there was a lower failure rate of nonoperative management (6% v. 0.5%, $p < 0.01$). Additional outcome differences in the PA era included shorter hospital length of stay (7 v. 9 d, $p < 0.01$), a decreased median number of transfusions (0 v. 2, $p = 0.03$) and a decreased likelihood of requiring transfusion (45% v. 61%, $p < 0.01$). No difference in mortality was observed between the eras (14% v. 11%, $p = \text{NS}$). **Conclusion:** In addition to improved rates of overall splenic salvage and successful nonoperative management following the implementation of our current algorithm for splenic trauma management, we also found shorter lengths of hospital stay and decreased transfusion requirements.

Assessing the construct validity of a global disability measure in adult trauma registry patients. *O. Williamson,* A. Sutherland,† M. Hart,† B.J. Gabbe.†* From the *JPOCSC Pain Clinic and †Monash University, Melbourne, Australia

Background: Self-assessed global disability measures offer an efficient way for trauma registries to measure outcomes. This study aimed to examine the construct validity of a global disability measure in a trauma population. **Methods:** Global disability (none, mild, moderate, marked, severe), SF-12 physical (PCS) and mental (MCS) subscale scores, Glasgow Outcome Scale Extended (GOSE) and EQ-5D were recorded at 12 months by telephone interview of patients registered by the Victoria State Trauma Registry. Correlation/agreement between global disability and other measures were assessed using Kendall's tau (τ) and weighted kappa (Kw). **Results:** Outcomes were compared in 3066 patients: 75% were male, median age was 43 (range 18–98) years, 54% had motor vehicle-related injuries and the median Injury Severity Score was 17 (range 1–75). Global disability at 12 months was none (37%), mild (24%), moderate (22%), marked (9%) and severe (8%). The median scores were for the PCS 44 (range 15–64), MCS 53 (range 8–72) and EQ-5D utility score 0.8 (range –0.6 to 1.0). There was significant correlation between global scores and PCS ($\tau = 0.48$, $p < 0.001$), MCS ($\tau = 0.23$, $p < 0.001$), GOSE ($\tau = 0.55$, $p < 0.001$) and EQ-5D utility scores ($\tau = 0.47$, $p < 0.001$). Correlation with physical domains was higher than for mental

health. Agreement between global scores and the PCS and EQ-5D utility score quintiles was moderate (Kw = 0.42 and 0.44, respectively) but only fair between global scores and the MCS quintiles (Kw = 0.24). **Conclusion:** Patients consider similar domains to the SF-12, EQ-5D and GOSE when assessing global disability, and changes in global disability reflect changes in these measures. Global disability should be considered as a valid outcome measure in adult trauma registries.

The mactrauma TTL assessment tool: developing a novel tool for assessing performance of trauma trainees. *S. Reid,* F. Tuma,† A. Coates,† F. Farrokhyar,* S. Faidi.†* From *McMaster University and the †Hamilton Health Sciences Trauma Program, Hamilton, Ont.

Background: Our trauma program plays an important role in training clinical fellows and emergency and surgical residents in trauma care. As part of training, trainees assume the trauma team leader (TTL) role in trauma resuscitation under the supervision of the attending physician. Evaluation of training is an important part of medical education. We are unaware of a validated instrument to assess TTL performance. Our aim is to develop an evaluation form to assess the performance of trainees during trauma resuscitation. **Methods:** We used a step-wise approach to develop our TTL evaluation form. Each item was selected to summarize clinical competence and interpersonal skills deemed necessary to effectively lead a trauma resuscitation. The initial draft was vetted through surgical faculty and TTLs at our level 1 trauma centre for content review. Specifically, the clinical experts scrutinized the form for its clarity, completeness, relevance and representativeness. **Results:** Our form evaluates TTL performance according to 5 domains: critical assessment, communication and leadership, decision-making, clinical performance and teaching. Five items were developed to address each domain. Each item is assessed using a 5-point Likert scale. **Conclusion:** We established face and content validity through expert opinion and consensus. Continued testing of the form will include assessing for inter-rater reliability and examining the feasibility and utility of the TTL evaluation form as it relates to trauma education at our trauma centre.

A quality improvement approach to developing a standardized reporting format of ct findings in blunt splenic injuries. *N. Alonazi,* F. Gastaldo,† D. Paskar,‡ S. Reid,§ S. Faidi,* B. Petrisor,† M. Bhandari.§* From the *Hamilton Health Sciences Trauma Program and †Hamilton Health Sciences Centre, Hamilton, the ‡University of Western Ontario, London, and §McMaster University, Hamilton, Ont.

Background: Computed tomography is to the gold standard for identifying and grading the severity of blunt splenic injuries. Injury grading systems provide a way for radiologists to communicate findings in a consistent manner to surgeons and traumatologists. While evidence supports the association between injury grade and the need for surgical management, grading systems have limited prognostic value in selecting patients who are likely to be successfully treated nonoperatively. The aims of this quality improvement research are to describe current radiologic reporting practices at our level 1 trauma centre and to assess the relationship between grading criteria and clinical management

and patient outcomes. We will use our study findings to engage radiology in the development of a standardized reporting format for splenic injuries. **Methods:** We conducted a retrospective chart review of all patients who presented at our trauma centre with splenic injuries from 2007 to 2012. Computed tomography reports were reviewed to determine if criteria from 3 injury grading systems were included. Patient characteristics, treatment and outcome data were also collected. **Results:** Preliminary results indicate that no one grading scale or standardized reporting format is used at our trauma centre to report CT findings for splenic injuries. Current analysis focuses on assessing the relationship between grading criteria and surgical versus nonoperative management and patient outcomes. **Conclusion:** The results of this study will be used to develop a standardized CT reporting format. Report content will be based on factors holding prognostic value or related to directing clinical management.

Outcomes in geriatric trauma: what really matters. C.M. Lee, W-L Loh, C.D. Ho, C.K. Chong. From the Changi General Hospital, Singapore

Background: Trauma in the elderly is associated with higher morbidity and mortality. This is attributed to the physiologic and anatomic differences in the geriatric population. However, factors that predict for poorer outcomes have not been well studied in the Asian population. We aim to identify these factors in order to recognize patients who are expected to do poorly. This could allow for better allocation of health care resources. **Methods:** We performed a retrospective analysis on patients aged 65 years and above who were admitted to our hospital under the trauma protocol. Data collection and analysis was done on patients' demographics, injury pattern, Injury Severity Score, initial parameters, resuscitation efforts and blood investigations. Outcomes were measured objectively with regards to length of stay, complications and mortality. **Results:** Statistically significant factors that were associated with increased mortality were poor Glasgow Coma Scale score (GCS), intubation in emergency department, a higher Abbreviated Injury Scale score of the head and serum lactate over 5 mmol/L. Among survivors, we found that patients who were intubated, those with poor GCS and Injury Severity Score were likely to have a longer stay and develop complications. **Conclusion:** Elderly patients who sustained severe head injuries are more likely to have higher morbidity and mortality. Clinicians should identify these patients early, institute measures to prevent complications and better manage families' expectations. This can potentially allow for better allocation of health care resources.

Fresh whole blood is not better than component therapy (FFP:RBC) in hemorrhagic shock: a thromboelastometric study in a small animal model. J. Rezende-Neto,* G. Rodrigues,* M. Gissoni,* M. Martins,* M. Andrade,* J. Cunha-Melo,* S. Rizoli.† From the *Federal University of Minas Gerais, Belo Horizonte, Brazil, and the †Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: High fresh frozen plasma (FFP):red blood cell (RBC) ratios are associated with decreased early mortality in traumatic hemorrhage, and fresh whole blood (FWB) has demonstrated potential benefits in combat settings. However, data that

demonstrate advantage of FWB to high FFP:RBC ratios are scarce. The objective of this study was to compare FWB resuscitation to component therapy using thromboelastometry in a small animal model. **Methods:** Both FFP and RBC from Wistar rats were previously stored (blood bank protocol). A total of 30 animals were divided in 6 groups ($n = 5$ each): group 1 = sham, group 2 = lactated Ringer's solution alone, group 3 = FFP:RBC 1:1, group 4 = FFP:RBC 1:2, group 5 = FFP:RBC 1:3 and group 6 = FWB. Animals were hemorrhaged (47% of total blood volume), and fluids started after 15 minutes. Blood samples were obtained at 90 minutes for thromboelastometry. **Results:** Mean thrombo-dynamic potential index (TPI) was significantly lower in groups 2 and 5 (52 and 33.5, respectively) compared with other groups ($p < 0.05$). However, there were no significant differences between groups 3 (1:1) and 4 (1:2), compared with group 6 (FWB; $p > 0.05$). Clotting time and maximum clot firmness showed similar results between groups 3, 4 and 6 ($p > 0.05$). Additionally, there were no significant differences between groups 3 (1:1) and 4 (1:2). **Conclusion:** Coagulation parameters with FWB was not better than 1:1 or 1:2 (FFP:RBC) ratios, but all were better than lactated Ringer's solution alone and the 1:3 ratio. Furthermore, an FFP:RBC ratio of 1:2 was as good as 1:1.

Factors affecting mortality of chest trauma patients: a prospective study. E. Aleassa,* F. Abu-Zidan.† From the *University of Manitoba, Winnipeg, Man., and the †United Arab Emirates University, El Ain, United Arab Emirates

Background: Studies on predictors of mortality of chest trauma are limited. We aim to define factors affecting mortality of hospitalized chest trauma patients in Al-Ain City, United Arab Emirates. **Methods:** The data of the Al-Ain Hospital Trauma Registry were prospectively collected over a period of 3 years (2003–2006). Univariate analysis was used to compare chest trauma patients who died and those who survived. Sex, age, mechanism of injury, systolic blood pressure and Glasgow Coma Scale (GCS) score on arrival, presence of head injury, highest Abbreviated Injury Scale score for both the chest and head injuries, extrathoracic injuries and the Injury Severity Score (ISS) were studied. Significant factors were then entered into a backward stepwise likelihood ratio logistic regression. **Results:** Out of 2573 patients on the registry, 474 patients (18.4%) had chest trauma with a median age of 35 (range 1–90) years; 425 (90%) were male. The main mechanism of injury was road traffic collision in 313 (66%) followed by fall from height in 111 (23.4%); 88 (18.6%) were admitted to the intensive care unit. The median ISS was 5 (range 1–43). In all, 173 patients (36.5%) had isolated chest injury and 130 (27.4%) had head injury. Overall mortality rate was 7.2%. Mortality was significantly increased by a low GCS score ($p < 0.0001$), a high ISS ($p = 0.025$) and low systolic blood pressure on arrival ($p = 0.027$). **Conclusion:** Chest trauma is associated with a significant mortality in Al-Ain City. Mortality is significantly affected by high ISS, reduced GCS score and hypotension on arrival.

Long-term pain prevalence and health related quality of life outcomes for patients enrolled in a ketamine versus morphine for prehospital traumatic pain randomized controlled trial. P. Jennings,* P. Cameron,* S. Bernard,*

T. Walker,[†] D. Jolley,* M. Fitzgerald,[‡] K. Masci.[†] From *Monash University, †Ambulance Victoria and ‡The Alfred Hospital, Melbourne, Australia

Background: There are some data that improved early pain control impacts on the longer term incidence of persistent pain. In a randomized controlled trial, we found that the administration of ketamine decreased pain scores at hospital arrival compared with morphine in patients with prehospital traumatic pain. In this follow-up study, we sought to determine the incidence of persistent pain and whether there were differences in patients who received ketamine or morphine. **Methods:** This study was a long-term follow-up study of the prehospital, prospective, randomized controlled and open-label study comparing ketamine with morphine in patients with trauma and a verbal pain score of greater than 5 after 5 mg of intravenous morphine. Patients were followed up by telephone 6–12 months following enrolment and questioned using the SF-36v2 health-related quality of life survey and the verbal numerical rating pain scale. **Results:** Of 135 patients, 97 (72%) were able to be followed up 6–12 months following enrolment between July 2008 and July 2010. Of these 97 participants, 44 (45%) reported persistent pain related to their injury, with 3 of 97 (3%) reporting persistent severe pain. The prevalence of persistent pain was the same between study groups (ketamine group: 22 of 50, 44% v. morphine group: 22 of 47, 46%). There was no difference in the SF-36v2 scores between study arms. **Conclusion:** There is a high incidence of persistent pain after traumatic injury. Although a small sample, there was no difference between the prevalence of persistent pain or health-related quality of life outcome between groups.

Describing pain following trauma: predictors of persistent pain and pain prevalence. P. Jennings,* B.J. Gabbe,* P. Simpson,* K. Smith,[†] S. Cox,[†] P. Cameron.* From *Monash University and †Ambulance Victoria, Melbourne, Australia

Background: Pain is commonly associated with injury and results in a heavy burden on the individual and society. This study reports the prevalence of pain at 6, 12 and 24 months following trauma, and the factors associated with persistent pain. **Methods:** This cohort study reports on 8254 adults who sustained transport-related injury between January 2007 and December 2010. Data were extracted from the Victorian State Trauma Registry and linked with Ambulance Victoria data. **Results:** The majority of those who sustained trauma were male (73%), younger (median age 46 yr) and were injured as a result of a fall (23%). Persistent pain (≥ 3 of 10) was prevalent: 46% at 6 months and 39% at 24 months. Females were more likely to experience persistent pain (adjusted OR 1.4, 95% CI 1.2–1.6). Older adults had greater odds of experiencing pain compared with 18- and 19-year-olds, especially those in the 40- to 59-year age group (adjusted OR 2.4, 95% CI 1.7–3.4). Compensable patients demonstrated increased odds of reporting persistent pain (adjusted OR 2.5, 95% CI 2.2–2.9) and lower education levels were associated with greater odds of experiencing pain at 12 months (adjusted OR 1.7, 95% CI 1.2–2.3). Compared with isolated orthopedic injury, patients with isolated head injury (adjusted OR 0.4, 95% CI 0.3–0.4) or chest/abdominal injuries (adjusted OR 0.6, 95% CI 0.4–0.7) were less likely to report pain 12 months following injury. **Conclusion:**

High-risk groups for persistent pain included females, older adults, the compensable and those who did not work or study before injury.

Management strategies for hemorrhage due to pelvic trauma: a survey of Canadian general surgeons. B. Mador,* D. Evans.[†] From the *University of British Columbia and the †Vancouver General Hospital, Vancouver, BC

Background: Hemorrhage secondary to severe pelvic fracture is a major cause of mortality in blunt trauma patients. Recent evidence has supported a shift from early angioembolization to preperitoneal pelvic packing, though no comparative studies have yet been completed, and the available literature remains unclear as to the ideal initial management of these critically injured patients. We hypothesized that a significant amount of clinical equipoise exists in the management of pelvic hemorrhage in Canadian trauma patients. **Methods:** A questionnaire survey was prepared and revised based on feedback from physicians outside the target population. The survey was distributed electronically to all trauma-affiliated general surgeons in Canada as identified using available administrative data. **Results:** We received 38 responses from surgeons in 9 provinces; 51% of respondents were trauma fellowship-trained, with 82% working at level 1 trauma centres. For an unstable blunt trauma patient presenting with an isolated major pelvic injury, 53% of respondents stated they would take the patient straight to the operating room and utilize pelvic packing, with the remainder opting for angioembolization. The results for a similar patient with multiple competing injuries were more varied but showed a similar level of equipoise. Seventy-six percent of respondents expressed support for further study. **Conclusion:** These results, along with failure of recent literature reviews to adequately define the role of preperitoneal packing in pelvic hemorrhage, highlight the need for further research in the form of well-designed prospective trials.

Major trauma follow-up clinic: Patient perception of recovery following severe trauma. K. Hoffman,* A. West.[†] From the *Queen Mary University and †Barts Health NHS Trust, London, United Kingdom

Background: Appropriate follow-up for survivors of trauma and their families is important. However, many follow-up clinics focus on single systems of injury and not the overall recovery of the patient. They study examined patient perception of outcome following multiple injuries at a major trauma centre. **Methods:** Semistructured interviews were conducted during trauma follow-up clinic appointments. The World Health Organization International Classification of Function Disability and Health (WHO ICF) was used as a framework to structure questions relating to health outcome following injury. The ICF is a classification of the health components of functioning and disability. Patient comments were mapped onto the ICF using established linking rules. **Results:** Ninety patients attended clinic over a 6-month period, with a 35% nonattendance rate. The median age was 29 years. In all, 70% of patients reported pain and mental health as limitations to recovery. Additional participation restrictions not included in other standardized tools were social and environmental issues fatigue and return to work. Also, 70% of patients required

onward referral to medical, statutory and voluntary service. **Conclusion:** Former patients valued attending the trauma follow-up clinic. Many patients found that increasing pressure on beds resulted in the major trauma centre being unable to address all their psychosocial needs. The ICF was a useful framework to capture a vast range of health components during a follow-up clinic. Further research will investigate which ICF codes are patient centred to enable holistic outcome evaluation of trauma survivors.

Lost opportunities to enhance trauma practice: culture of interprofessional education and sharing among emergency staff. J. Riley, L. Barratt, L. Rozmovits. From St. Michael's Hospital, Toronto, Ont.

Background: The emergency department (ED) is a complex environment with constant demands on time and resources. High patient volumes and acuity, unpredictable traumas and shiftwork schedules afford ED health professionals (HP) and trauma service HPs little time to debrief their clinical experiences collectively to enhance practice. **Methods:** Twelve semistructured interviews were conducted with ED professionals (6 registered nurses, 5 emergency physicians, 1 social worker) in a level 1 trauma, academic, inner city hospital. Constant comparison was used for analysis, including searches for disconfirming evidence. **Results:** While stakeholders reported good interpersonal relationships, current culture for discussion was largely informal, brief, ad hoc and siloed within professions. Despite engaging well during a trauma, ED and trauma HPs quickly returned to duties and potential learning from complex, clinically challenging situations and/or issues with process or teamwork was lost. Formal discussions tended to be physician focused, delayed and not involving all HPs from the clinical event. The absence of inclusive interprofessional education (IPE) was perceived to negatively impact team dynamics, limit team members' understanding of roles and lacked a sense of shared ownership of the event. New IPE opportunities should include timely formal debriefings and simulation to improve patient care, process and communication among all HPs involved in trauma. **Conclusion:** Interprofessional education opportunities to enhance trauma experiences for patient care and HPs must be substantially value-added with high impact to clinical practice, compelling subject matter and accessible to all. Future work will include formation of an IPE Steering Group to program plan innovative activities.

Prehospital airway management in major trauma and traumatic brain injury by critical care paramedics. E. Vu,* B. Livingstone, M. Vu,[†] D. Griesdale,[†] R. Schlamp,* R. Wand.* From the *BC Ambulance Service and the [†]Vancouver General Hospital, Vancouver, BC

Background: Prehospital endotracheal intubation (ETI) in major trauma and traumatic brain injury (TBI) remains contentious. Observational studies have highlighted potential risks associated with prehospital rapid sequence induction, including hypoxemia (arterial oxygen saturation [SpO₂] < 90%), hyperventilation or hypotension (systolic blood pressure [SBP] < 90 mm Hg). We sought to characterize peri-intubation physiology in major trauma and brain-injured patients who underwent ETI by critical care flight paramedics (CCP) whose training is predicated on evidence-based guidelines, targeting specific peri-

intubation oxygenation, ventilation and hemodynamic goals. **Methods:** We performed a retrospective cohort study using the Provincial Airway Database for the British Columbia Ambulance Service. Descriptive statistics were used to characterize consecutive patients who underwent ETI by Vancouver-based CCPs from January 2009 to June 2010. **Results:** Over an 18-month period, 104 patients underwent ETI, of whom 68 sustained major traumas and/or TBI. Of these, 22 were male with a mean age of 38 (range 6–75) years. Overall ETI success rate was 93.2% (95% CI ±4.8). Median attempts at laryngoscopy were 2 (IQR 1–3). Of these patients, 58 (85%) and 53 (78%) had an SBP of 90 mm Hg or greater and/or an SpO₂ of 90% or greater before attempts at ETI, respectively. Initial mean SBP was 136 mm Hg (SD 28.0), mean post-ETI SBP was 133 mm Hg (SD 26.8, $p = 0.74$), and initial median SpO₂ was 98% (IQR 96%–100%), with median post-ETI SpO₂ 97% (IQR 95%–100%, $p = 0.45$). The lowest median documented SpO₂ at any time in this group was 92% (IQR 87%–95%), and the lowest median end-tidal carbon dioxide (ETCO₂) was 32 mm Hg (IQR 28–35 mm Hg). **Conclusion:** We describe the results of a successful prehospital ETI program performed by CCPs demonstrating optimized peri-intubation physiology in a cohort of major trauma and TBI patients. Further studies are needed to assess the functional outcome of such a program in this patient population.

Improving patient selection for angiography and identifying risk of rebleeding after angioembolization in the nonoperative management of high grade splenic injuries. A. Alburakan,* M. Alhabboubi,[†] A. Alrowaili,* H. Alghamdi,[†] P. Fata.* From the *McGill University Health Centre, Montréal, Que., the [†]King Abdul Aziz University Hospital, Jeddah, Saudi Arabia, and the [‡]Imam University College of Medicine, Riyadh, Saudi Arabia

Background: Nonoperative management (NOM) of stable patients with blunt splenic injury (BSI) is still associated with significant sequelae. This study aims to improve patient selection for NOM and identify predictors of rebleeding following angioembolization (AE). **Methods:** We conducted a retrospective study of patients with BSI at the Montreal General Hospital between 2005 and 2011 (241 patients). Early deaths (within 24 h) were excluded. **Results:** Among identified patients, 17.1% required AE and 20.3% required surgery. Of the patients with BSI grade of 4 or greater, 27.6% had angiogram and 51.7% had surgery. Nearly two-thirds of patients with a contrast blush on CT had AE ($p < 0.001$). Analysis of patients who received AE revealed that 40% had a BSI grade of 4 or greater ($p < 0.001$), and 56.1% had at least a moderate amount of hemoperitoneum on CT ($p = 0.015$). Patients undergoing AE were embolized with coil (56.1%), while 34.1% were embolized with gelfoam, 68.3% had superselective embolization, while 31.7% had main splenic artery embolization. Four patients (9.8%) failed AE and required surgery; all of those patients had AE with gelfoam ($p = 0.021$), and 3 had a branch artery embolization ($p = 0.7$). Our in-hospital mortality rate was 4.6%. **Conclusion:** Appropriate patient selection for angiography and embolization during NOM of BSI remains an important determinant of its success. While it appears that the type embolization may not be associated with increased risk of rebleeding, the embolic agent selection may be significantly associated with a higher risk of NOM failure.

Factors predicting the need for angioembolization in solid organ injury. A. Alburakan,* F. Essbahiheen,* M. Alhabboubi,[†] P. Fata.* From the *McGill University Health Centre, Montréal, Que., and the †King Abdul Aziz University Hospital, Jeddah, Saudi Arabia

Background: Angioembolization is an effective adjunct in hemorrhage control and for reducing the risk of rebleeding in the nonoperative management of solid organ injuries. The objective of this study is to determine clinical and imaging factors that predict the need for angioembolization in solid organ injuries. **Methods:** We conducted a retrospective chart review of trauma patients who received angiography at our level 1 trauma centre from 2005 to 2011. **Results:** A total of 58 patients were enrolled. Their median Injury Severity Score was 31, and overall mortality rate was 6.9%. All the patients had angiography, and 89.7% received angioembolization. Only the presence and degree of hemoperitoneum on CT scan was significantly associated with a positive angiography and correlated with the need for angioembolization ($p < 0.0001$). Other imaging findings, specifically the presence of contrast blush, and solid organ injury grade, were not significantly associated. Clinical parameters including initial hemodynamics (heart rate, systolic blood pressure and base excess) were not found to be statistically significant factors associated with selection of patients for angiography or angiographic intervention. **Conclusion:** The degree of hemoperitoneum on CT appears to be the only reliable indicator of the need of angiography and subsequent embolization. Better definition of patients who benefit from angioembolization early may improve the success rate of nonoperative management of solid organ injuries and limit the potential risks with unnecessary imaging. Clearly, this issue requires prospective study with larger patient cohorts.

Prothrombin complex concentrates use in traumatic brain injury patients on oral anticoagulants is effective despite underutilization. A. Alburakan, F. Essbahiheen, J. Chankowsky, T. Razek. From McGill University Health Centre, Montréal, Que.

Background: Traumatic brain injury (TBI) carries a high mortality and morbidity, especially in orally anticoagulated (warfarin) patients. Rapidly reversing coagulopathy in those patients is crucial; our study aims examine use of Octaplex in reversing coagulopathy in TBI patients on warfarin. **Methods:** We conducted a retrospective study of TBI patients on warfarin treated at our centre from March 2007 to March 2011 (61 patients). Patients were divided into 2 groups chronologically: a prothrombin complex concentrant (PCC) group ($n = 33$) included patients treated with PCC ± fresh frozen plasma (FFP), and an FFP group ($n = 28$) comprised of patients treated with FFP only. **Results:** Mortality rate was 24.6%. Admission to the intensive care unit (ICU) was required in 70% of the patients, and 39.3% required operative management. Demographics, initial heart rate, systolic blood pressure, Glasgow Coma Scale score, laboratory values (hemoglobin, platelets, base excess, international normalized ratio), mortality, ICU and hospital length of stay were similar between the 2 groups. In the PCC group, 42.4% of the patients also received FFP, and 15.6% did not receive vitamin K. Median time from presentation to an international normalized ratio less than 1.4 was 7.8 hours (IQR 5.9–13.6) in the PCC group and 12.4

hours (IQR 8.4–27.3) in the FFP group ($p < 0.01$). Median time to the operating room was also less for the PCC group (5.9 h) compared with the FFP group (11.3 h; $p = 0.2$). **Conclusion:** Despite less than ideal utilization of Octaplex, it was more effective in the rapid reversal of coagulation in TBI patients on warfarin. Also, it hastened patient transition to the operating room when required. It appears to be as safe as FFP.

The right treatment at the right time in the right place: early results and associations from the introduction of an all-inclusive provincial trauma care system. J. McKee,* M. Stephens,* C. Vis,[†] K. Belton,[‡] J. Kortbeek,[§] I. Bratu,[¶] B. Dufresne,** J. Guilfoyle,[†] G. Ibbotson,[†] K. Martin,[†] D. Matheson,[†] P. Parks,[†] L. Thomas,[†] A. Kirkpatrick.^{††} From the *University of Alberta, Edmonton, the †Alberta Health Services, Calgary, the ‡Alberta Centre for Injury Control and Research, Edmonton, the §University of Calgary, Calgary, the ¶Stollery Children's Hospital, Edmonton, the **Northern Lights Health Region, Fort McMurray, Alta., and the ††Foothills Medical Centre and University of Calgary, Calgary, Alta.

Background: The Alberta Provincial Trauma Committee (PTC) overseeing an inclusive Provincial Trauma System (PTS) was initiated in 2008 after a decade of planning. The goal was to create an “all-inclusive trauma-care system” to reduce injury, death, disability and economic burden by delivering the right treatment at the right facility in the shortest time. Practical aspects were improved communication and evaluation from a multidisciplinary oversight committee, uplifted infrastructure in the district centres and clear interfacility transfer agreements using defined best practices, enhanced preventative strategies, research, continuing education and community rehabilitation. **Methods:** Province-wide process and outcomes statistics before (2004–2007) and after (2008–2011) the PTS inception were examined using Alberta Trauma Registry data. Trauma centre transfer/admission practices, demographics and performance indicators were examined to assess whether the PTC was achieving its stated goal. **Results:** In the face of steady overall province-wide major traumas, reporting level 3 centres have progressively increased the percentage of major trauma patients (MTPs) cared for at those centres (2008, 3.0%; 2009, 6.7%; 2010, 7.9%) coincident with modest decreases in direct admissions of MTPs to the level 1 centres (2008, 2163 patients; 2009, 2106 patients; 2010, 1981 patients). With this shift in geographic site of care, overall system-wide mortality for these MTPs has decreased from 11.6% to 10%. **Conclusion:** The introduction of an inclusive province-wide trauma system successfully increased the proportion of severely injured patients cared for in their local systems in conjunction with overall improved provincial mortality rates. Future efforts must continue to support the system and ensure continued improvement during system maturation.

A multicentre study of patient experiences with acute and postacute injury care. N. Bobrovitz, M.J. Santana, T. Kline, J. Kortbeek, H.T. Stelfox. From the University of Calgary, Calgary, Alta.

Background: To deliver patient-centred injury care, patient perspectives need to be incorporated into quality measurement and

improvement. **Methods:** We conducted a prospective cohort study of consecutive, injured patients admitted to 3 trauma centres in Alberta to measure patient injury care experiences. Patients/surrogates were approached before hospital discharge and invited to participate in longitudinal surveys using validated Likert-type scales inquiring about experiences with acute injury care (paper-based survey administered 24 hr before discharge) and postacute care (telephone survey 2–3 mo after discharge). **Results:** We approached 290 patients/surrogates, of whom 235 (81%) consented to participate and completed the acute care survey. To date, 40 participants (66% response rate) have completed the postacute survey. Participants were primarily male (73%) with major injuries (median Injury Severity Score 18, IQR 16–22). Among participants who have completed both surveys, the overall quality of acute and postacute care were rated as high by the majority of respondents (63% v. 55%, $p = 0.49$) and low by a small minority of respondents (8% v. 18%, $p = 0.18$). The domains of injury care receiving the most high quality ratings were “patient transfers” (68%) and “information and communication” (63%) during acute care, while those receiving the fewest high quality ratings were patient “comfort” during acute care (48%) and “coordination” of postacute care (35%). **Conclusion:** Preliminary analysis of this prospective cohort study to measure patient experiences with injury care shows that majority of injury patients/surrogates report high ratings of acute and postacute injury care, but there are opportunities to improve the coordination of care and patient comfort.

Population burden of major trauma: Has introduction of an organized trauma system made a difference? *B.J. Gabbe,* R. Lyons,[†] S. Macey,[‡] M. Fitzgerald,[§] R. Judson,[¶] P. Cameron.** From *Monash University, the †DECIPHER UKCRC Public Health Research Centre of Excellence, Melbourne, Australia, ‡Swansea University, Swansea, United Kingdom, §The Alfred Hospital and the ¶Royal Melbourne Hospital, Melbourne, Australia

Background: Integrated trauma systems aim to reduce deaths and disability. While studies have found that regionalization of trauma care reduces mortality, the impact on overall injury burden is not known. This study compared the burden of major trauma over a 10-year period in Victoria, Australia, following the implementation of an integrated trauma system. **Methods:** Data about all trauma related deaths and major trauma (Injury Severity Score > 12) cases were extracted from the National Coroner's Information System and the Victorian State Trauma Registry (VSTR) from July 2001 to June 2011. Major trauma burden was measured using disability-adjusted life years (DALY), which combines years of life lost (YLL) and years lived with disability (YLD). Disability weights and duration of disability were calculated from long-term outcomes follow-up of VSTR cases. The DALY, YLL and YLD calculations were separated by transport status and year. **Results:** There were 27 281 deaths and major trauma cases in the state over the 10-year period, accounting for 278 957 DALYs. Transport-related trauma accounted for 60% of YLDs and 40% of YLLs. Over the 10-year period, YLLs (mortality-related disability) reduced by 38% overall (45% for transport-related trauma), and YLDs (survivor disability) have increased by 13%. The net effect is an average DALY per case decrease; 13.7 in 2001–2002, 10.5 in 2005–2006 and 7.6 in 2010–2011. **Conclusion:**

Since the introduction of the integrated trauma system, there has been a large decline in mortality burden with a relatively small increase in disability burden of survivors. Overall, the average DALY per major trauma case has declined substantially.

Long-term functional and return to work outcomes following blunt major trauma in Victoria, Australia. *B.J. Gabbe, A. Sutherland, M. Hart, M. Morgan, S. McLellan, K. Wilson, P. Cameron.* From Monash University, Melbourne, Australia

Background: Measuring the disability associated with injury is important for quantifying the burden of injury, evaluating the quality of trauma care and for guiding the provision of health care for trauma survivors. The aim of this study was to describe the pattern of recovery and predictors of outcome of blunt, major trauma survivors. **Methods:** Data from the population-based Victorian State Trauma Registry were analyzed. Blunt, adult major trauma (Injury Severity Score [ISS] > 12) patients, with a date of injury from July 2007 to June 2010, who survived to hospital discharge were followed-up at 6, 12 and 24 months postinjury. Return to work (RTW) and functional level (Extended Glasgow Outcome Scale [GOSE]) were collected by telephone interview. Multivariate random effects models were fitted to identify predictors of outcome and analyze change in outcomes over time. **Results:** Of the 4671 eligible cases, 90% were followed-up at 1 time point and 70% at all. Most patients were male (72%), with a mean age of 49.3 (SD 21.8) years. In all, 52% of injuries resulted from road trauma, and the median ISS was 17 (IQR 16–25). At 24 months postinjury, 23% had fully recovered (GOSE 8); 62% were working before injury and 70% had returned to work at 24 months. The adjusted odds of functional recovery and RTW increased from 6 to 12 months, and from 12 to 24 months, respectively. Predictors of outcome were age, sex, nature and intent of injury, injury severity, compensable/insurance status, educational level and comorbid status. **Conclusion:** While ongoing disability was prevalent, major trauma patients continued to show significant improvement in outcomes up to 24 months after injury.

Surgical dilemma in major burns victim: heterotopic ossification of the tempromandibular joint. *J. Hodgkinson.* From the Royal Perth Hospital, Perth, Australia

Background: Heterotopic ossification (HO) is the presence of lamellar bone at locations where bone should not exist. Heterotopic ossification in major burns is not well described or documented in the literature, its incidence is infrequent, and currently no definitive management principles have been established. **Methods:** We present a rare case of HO in the temporo-mandibular joints (TMJ) of a young male burns patient in an attempt to obtain feedback and relevant information from colleagues who may have encountered and successfully managed a similar case. This 17-year-old male sustained 80% total body surface area flame burns at the age of 10. On delayed presentation to our unit, many years after the original injury, he had limited mandibular range of motion and established extensive burn contractures. **Results:** Tomography of the head showed extensive ankylosing HO of bilateral TMJ, with HO of the bilateral medial and lateral pterygoid muscles. The fact that all these complications were established already for several years meant that the

usual management strategies were not appropriate for this case. Management is limited to physiotherapy, radiation therapy, medication and operative excision. Radiation therapy has been used as an adjuvant to surgery, although the efficacy of its therapeutic effect has not yet been fully substantiated. Therefore, the only intervention that has been effective at reducing the amount of HO is surgical resection. **Conclusion:** We believe this is a very rare and rather unique case that deserves an audience of our peers to discuss clinical experience and collective opinion for our patients' best management.

Which radiological modality to choose in a unique penetrating neck injury: a differing opinion. J. Hodgkinson. From the Royal Perth Hospital, Perth, Australia

Background: Penetrating neck injuries (PNI) are considered difficult to manage because of the complex anatomy, immediate proximity of vital structures, and potential for rapid hemodynamic and airway deterioration. **Methods:** A 33-year-old hemodynamically stable man was transferred to a level 1 trauma centre via helicopter after allegedly being shot twice in a home invasion. On intubation for laparotomy repair of small bowel perforations, a third gunshot wound was observed in the soft palate left of the midline. Radiographs showed a large bullet fragment in the proximity of the left internal carotid artery (ICA). Postextubation, the patient exhibited marked expressive aphasia. **Results:** Computed tomographic angiography (CTA) was hampered by extensive scatter artifact from bullet fragments, and digital subtraction angiography (DSA) was therefore used to show a very high-grade (80%–90%) narrowing of left ICA immediately adjacent to the bullet fragment, an intracranial extensive nonocclusive clot in the proximal dominant posterior division that was removed, and a 4.5 mm × 16 mm bare metal stent was placed in the left cervical ICA to obliterate the stenosis. **Conclusion:** CTA is invaluable in excluding major vascular injury in penetrating neck trauma, but artifacts associated with adjacent metallic fragments obscure some significant vascular injury processes. Technology including magnetic resonance angiography, CTA and Doppler study should be used to improve diagnosis in PNI, but DSA proved the modality of choice for both investigation and intervention in this unique and complicated presentation.

The Advanced Trauma Life Support (ATLS) program in Canada. J. Ali,* A. Sorvari.† From the *University of Toronto and †St. Michael's Hospital, Toronto, Ont.

Background: The Advanced Trauma life Support (ATLS) program was introduced in Canada in 1981. We report on its history since then. **Methods:** We conducted a review of American College of Surgeons data files on the ATLS program in Canada. **Results:** The first Canadian ATLS course was a combined provider-instructor course conducted for participants from across Canada in Toronto, June 1981, followed by British Columbia in December 1981; Quebec, Nova Scotia, Saskatchewan and Manitoba in 1982; Alberta in 1983; Newfoundland and Labrador in 1984; New Brunswick in 1985; Prince Edward Island in 1988; Northwest Territories in 2000; and Nunavut 2009. Until October 2012, 2531 courses for 43 271 participants have been conducted across Canada. The number of participants per province (and number of courses) are Ontario 15 953 (961); Quebec 9322 (472);

Alberta, 5576 (379); British Columbia, 4448 (263); Manitoba 2741 (127); Nova Scotia 2047 (121); Saskatchewan 1048 (69); Newfoundland and Labrador 1008 (68); New Brunswick 833 (53); Prince Edward Island 267 (16); Northwest Territories 16 (1); Nunavut 12 (1). There have been 3 winners of the ATLS Meritorious Service award from Canada, 1 chair of the ATLS subcommittee and international ATLS committee, as well as an international ATLS educator who have figured significantly in ATLS international promulgation. The first ATLS program outside North America was conducted by Canadian faculty in 1986 and heralded the beginning of ATLS international promulgation. Data from this program were among the first to document the impact of the ATLS program on trauma education and patient outcome. **Conclusion:** The ATLS program has been the main focus of trauma education in Canada and has steadily expanded over the last 30 years.

The Rural Trauma Team Development Course (RTTDC) in Pakistan: Is there a role? J. Ali,* Z. Chaudhry,† K. Khawaja,† A. Ali,† J. Akhtar,† M. Zubair,† J. Nickow,† A. Sorvari.‡ From the *University of Toronto, Toronto, Ont., the †College of Physicians and Surgeons of Pakistan, Karachi, Pakistan, the ‡American College of Surgeons, Chicago, Ill., and §St. Michael's Hospital, Toronto, Ont.

Background: Delayed definitive care and increased mortality result from trauma occurring in under-resourced rural settings in Pakistan. The RTTDC focus is to improve trauma training in such areas to overcome obstacles to trauma care. We explore its role in Pakistan through conduct of inaugural instructor and provider courses and by obtaining feedback. **Methods:** Components of RTTDC include scenario-based lectures along ATLS concepts, multiple choice questionnaires (MCQ) pre- and post-course, modules on communication and performance improvement and patient safety (PIPS) and questionnaires with comments. An initial instructor course for 8 (4 ATLS-trained, 4 non-ATLS trained) was followed by a provider course for 12. Multiple choice questionnaire performance was compared by *t* tests, evaluation responses (16 items), questions on the relevance and applicability of PIPS, and communication modules were analyzed using 5-point Likert scales. **Results:** Mean MCQ scores (lower in the provider group), improved postcourse (69.2% pre- and 80.6% postcourse, *p* < 0.01). Regarding the high educational value of RTTDC, 60%–85% of respondents strongly agreed, 10%–40% agreed and 5% were neutral. The PIPS and communication modules were graded very relevant by 80% of faculty and 95% of providers. Both providers and faculty considered the scenarios very relevant (65%–85%) but commented that modifications to suit their environment was desirable. **Conclusion:** The RTTDC shows great potential for improving rural trauma care in Pakistan and was enthusiastically supported by both providers and faculty. Consideration for countrywide dissemination is underway.

Novel deployment of BC mobile medical unit for coverage of BMX world cup sporting event. M. Grant. From the University of British Columbia, Vancouver, BC

Background: Bicycle motocross (BMX) is a sport with a high risk of multisystem traumatic injuries. The potential acuity of

these injuries was taken into consideration when planning the event medical coverage for the recent UCI BMX Supercross World Cup, a high-calibre international event, held in Abbotsford, British Columbia. **Methods:** The Mobile Medical Unit (MMU), a legacy of the Vancouver 2010 Winter Olympics, and now a British Columbia provincial resource, was deployed for this event in collaboration with the British Columbia Ambulance Service (BCAS). The MMU is capable of providing up to critical care-level services. **Results:** A multidisciplinary team of volunteers, including physicians, nurses, respiratory therapists and the MMU operations team staffed the MMU. On-site simulations each morning allowed for an educational opportunity and improved the level of care delivered in the high-acuity situations that arose. The BCAS was a valuable resource for this event, providing on-scene ("trackside") medical coverage, hospital transport, logistic expertise, and communication capability both on-site and in liaison with the provincial dispatch service. **Conclusion:** Overall, the MMU/BCAS collaboration was felt to be very successful, allowed immediate and appropriate care of injuries at this event and reduced the event's impact on local hospital facilities by reducing the number of transfers required. This model of event coverage has proven to be feasible and effective, and should be considered for future events of this nature.

Incidence and prevalence of intra-abdominal hypertension and abdominal compartment syndrome in critically ill adults: a systematic review and meta-analysis. *D. Roberts,* J. Holodinsky,† R. Jaeschke,‡ C. Ball,§ A. Reintam Blaser,¶ J. Starkopf,¶ D. Zygun,§ A. Kirkpatrick.‡* From *Dalhousie University, Halifax, NS, the †University of Calgary, Calgary, Alta., ‡McMaster University, Hamilton, Ont., the §Foothills Medical Centre and University of Calgary, Calgary, Alta., and the ¶University of Tartu, Tartu, Estonia

Background: There is an extensive yet inconsistent body of literature regarding the incidence and prevalence of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS). We sought to explore heterogeneity in the pooled incidence and prevalence of these conditions among critically ill adults. **Methods:** We searched electronic databases, article bibliographies and conference proceedings for studies reporting incidence or prevalence of IAH (intra-abdominal pressure [IAP] ≥ 12) and ACS (IAP > 20 with new organ dysfunction) among critically ill adults. Pooled incidence and prevalence estimates were calculated using random effects models. **Results:** We identified 19 studies meeting inclusion criteria, which enrolled 2236 critically ill adults. The pooled incidence and prevalence of IAH among these patients was 62.2% and 32.3%, respectively. The pooled incidence of grades I (IAP 12–15), II (IAP 16–20), III (IAP 20–25) and IV (IAP > 25) IAH were 19.3%, 19.2%, 7.7% and 2.8%, respectively, while the pooled incidence and prevalence of ACS was 9.1% and 6.7%, respectively. Significant heterogeneity was observed in the pooled incidence of IAH, which was explained in metaregression by the patients' diagnosis ($p < 0.001$) and duration of IAP monitoring ($p = 0.033$). Using stratified analysis, the incidence of IAH among patients with mixed diagnoses (7 studies), surgical or traumatic conditions (2 studies), medical conditions (2 studies) and severe acute pancreatitis (4 studies) were 49.3%, 77.2%, 82.4% and 69.0%, respectively.

Conclusion: Both IAH and ACS are frequent findings among critically ill adults. Variability in the estimated incidence of IAH across studies may be due to differences in study patient diagnoses and duration of IAP monitoring.

Risk factors for intra-abdominal hypertension and abdominal compartment syndrome in critically ill or injured adults: a systematic review and meta-analysis. *J. Holodinsky,* D. Roberts,† C. Ball,‡ A. Reintam Blaser,§ J. Starkopf,§ D. Zygun,‡ R. Jaeschke,¶ A. Kirkpatrick.‡* From the *University of Calgary, Calgary, Alta., †Dalhousie University, Halifax, NS, the ‡Foothills Medical Centre and University of Calgary, Calgary, Alta., the §University of Tartu, Tartu, Estonia, and ¶McMaster University, Hamilton, Ont.

Background: Identifying risk factors for intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) could inform screening decisions. We therefore conducted a systematic review to identify risk factors for IAH and ACS among critically ill adults. **Methods:** We searched MEDLINE, PubMed, EMBASE, Web of Science, the Cochrane Database, personal files and reference lists of included articles. Two authors independently reviewed citations, selected studies, abstracted data and assessed methodological quality. Odds ratios (ORs) were pooled using random effects models. **Results:** Among 1018 citations, we identified 8 cohort studies, 2 case-control studies and 1 cross-sectional study, which enrolled 1738 critically ill adults. These studies reported 55 unique risk factors (37 for IAH, 18 for ACS), which could be conceptualized into 3 themes, including patient characteristics (demographics, diagnosis and disease severity), systemic physiology (shock, metabolic derangement and respiratory status) and large-volume fluid resuscitation. Sepsis (OR 2.38, 95% CI 1.34–4.23), abdominal infection (OR 2.49, 95% CI 0.48–13.0), abdominal surgery (OR 1.97, 95% CI 1.17–3.33) and obesity (OR 6.90, 95% CI 1.49–31.90) were associated with increased pooled risk for IAH among mixed populations of critically ill adults. Among trauma patients, large-volume crystalloid resuscitation before admission to the intensive care unit was associated with an increased pooled risk for ACS (OR 1.91, 95% CI 1.27–2.87). **Conclusion:** While sepsis, abdominal surgery and obesity are associated with an increased risk for IAH among mixed populations of critically ill adults, large-volume crystalloid resuscitation appears to increase risk for ACS among trauma patients.

A comparison of quality improvement practices at adult and pediatric trauma centres *C. Cooper, M.J. Santana, H.T. Stelfox.* From the University of Calgary, Calgary, Alta.

Background: We compared the quality improvement programs used in adult and pediatric trauma centres by performing a reanalysis of our recent survey of trauma quality improvement practices in Canada, the United States, Australia and New Zealand. **Methods:** We surveyed 184 trauma centres verified by professional trauma organizations in the United States, Canada and Australasia regarding their quality improvement programs. Centres were classified according to their accreditation to treat adult, adult and pediatric or pediatric patients, and quality improvement programs were compared using descriptive statistics.

Results: Most trauma centres reported engagement in quality improvement activities. Structure indicators were measured by fewer than half of centres (adult 36% v. adult and pediatric 17% v. pediatric 21%, $p = 0.058$), while outcome indicators were measured by the majority of centres (adult 89% v. adult and pediatric 83% v. pediatric 95%, $p = 0.456$). Centres caring for adult patients were more likely to use indicators to measure safety of care (50% v. 52% v. 37%, $p < 0.001$), while pediatric centres were more likely to use indicators to measure timeliness of care (20% v. 24% v. 30%, $p < 0.001$). Few centres used quality indicators to measure the patient-centred nature of care, long-term outcomes or secondary injury prevention. **Conclusion:** Opportunities for the improvement of pediatric quality improvement programs exist, including a need to determine the optimal structure for trauma quality improvement, develop patient-centred quality indicators of injury care, measure long-term outcomes and create measures of secondary injury prevention.

International trauma centre survey to evaluate content validity, usability and feasibility of quality indicators. M.J. Santana, H.T. Stelfox. From the University of Calgary, Calgary, Alta.

Background: The objective of the study was to evaluate the content validity, usability and feasibility of recently developed quality indicators in adult injury care using an international survey of trauma centres. **Methods:** We surveyed medical directors and program managers from 133 trauma centres verified by professional trauma organizations in the United States ($n = 104$), Canada ($n = 20$) and Australia ($n = 9$) regarding their perceptions of 31 quality indicators developed by the Trauma Quality Indicator Consensus Panel. Participants were presented with a description of each quality indicator (definition, supporting evidence, current utilization) and asked to rate the indicators on 4 dimensions: targets important improvements, easy to interpret, easy to implement and globally is a good indicator, using the validated RAND/University of California appropriateness method 9-point scale. **Results:** We received survey responses from 101 trauma centres (76%). Trauma centres overall rated the quality indicators as targeting important improvements (median 9, IQR 8–9), easy to interpret (median 8, IQR 8–9), easy to implement (median 8, IQR 7–8) and globally good indicators (median 8, IQR 8–9). Quality indicators of structure ($n = 5$), process ($n = 21$) and outcome ($n = 5$), assessing prehospital ($n = 8$), hospital ($n = 19$), posthospital ($n = 2$) care and secondary injury prevention ($n = 1$) were rated by the trauma centres as necessary. **Conclusion:** The indicators of adult injury care developed by the Trauma Quality Indicator Consensus Panel appear to have content validity, be usable and feasible to implement. They can be used as performance measures to guide injury care quality improvement practices.

Long-term functional recovery following decompressive craniectomy for severe traumatic brain injury. K. Kruger. From the Sir Charles Gardiner Hospital, Perth, Australia

Background: Traumatic brain injury (TBI) is a major public health problem, and despite improvements in clinical management, patients often face a long and protracted recovery, with few regaining full independence. Decompressive craniectomy involves temporary removal of a skull segment to accommodate

for raised intracranial pressure following TBI. To date, relatively little is known about the long-term recovery made by patients following decompressive craniectomy; therefore, the purpose of this study is to assess the impact of severe TBI on daily life and the problems that patients, their families and caregivers may have, many years after the surgery. **Methods:** A cohort study design was used to interview 16 patients and their caregivers at least 2 years post-TBI involving decompressive craniectomy. Level of independence with activities of daily living (ADLs) was assessed with the Barthel Index, Modified Rankin Scale and the Extended Glasgow Outcome Scale. Quality of life was measured using the SF-36 questionnaire, and the Zarit Burden Interview analyzed caregiver burden. A qualitative interview was used to obtain level of awareness at time of injury of likely outcomes and to gain retrospective consent of patients and caregivers. **Results:** Patients with severe TBI require moderate to maximal assistance with all ADL tasks and rarely return to work, social and leisure activities, with a negative impact on psychosocial well-being and relationships. **Conclusion:** Patients with severe TBI have poor outcomes, quality of life and are not able to return to their previous lifestyles.

Morbidity and mortality associated with free falls from a height among teenage patients: a 5-year review from a level 1 trauma centre. J. Hodgkinson. From the Royal Perth Hospital, Perth, Australia

Background: In Australia, falls are the second most common mechanism of lethal unintended injury, while the Australian Bureau of Statistics shows an increase in the national death rate resulting from falls. Adolescence is a particularly vulnerable period of time for intentional and unintentional injuries characterized by risk-taking behaviour. Injuries encountered from falls are unique due to the sudden acute vertical deceleration. The musculoskeletal system is the most commonly involved site, extensive visceral injuries are the major reason for most deaths, head trauma is a significant contributor to mortality, and retroperitoneal injuries are the primary source of hemodynamic instability in survivors. **Methods:** This was a retrospective case series study using the Western Australian State Trauma Registry data for falls admissions to Royal Perth Hospital, a level 1 trauma centre, between 2007 and 2012. **Results:** There were 62 admissions in the 5-year period, with an age range from 14 to 19 years (mean 17.3, SD 1.32 yr). The mean height of the falls was 2.2 m (SD 0.89 m, maximum 6 m, minimum 1 m), ethyl alcohol was involved in 43.5% of cases, 11.3% were work-related and 3.2% occurred on school premises. The mean Injury Severity Score (ISS) was 6.82 (SD 5.6, maximum 30, minimum 1), and the average length of stay was 4.9 days (SD 5.6, maximum 25, minimum 1). **Conclusion:** The height of a fall is a strong predictor of ISS and outcome prognosis. The height of the fall correlated highly with the incidence of intoxication and severity of injury, the need for operation, the length of hospitalization and mortality.

A comparison of adverse events between trauma patients and general surgery patients in a level 1 trauma centre. M. Waggott. From The Ottawa Hospital, Ottawa, Ont.

Background: Advances in trauma management have increased patient survival; however, this increase in survival means more

patients are potentially at risk of experiencing adverse events. A better understating of the rate of adverse events is vital, because these complications significantly impact patients and increase costs. A comparison of adverse event rates between trauma patients and general surgery patients was conducted to determine which population is at greater risk. Factors associated with the complications were identified, and strategies to address these rates will be discussed. **Methods:** This study involved analysis of patient data from the Trauma Database and Discharge Abstract Database at a level 1 trauma centre between Apr. 1, 2007, and Mar. 31, 2012. Demographic information (sex, age), Injury Severity Score, hospital and intensive care unit length of stay, emergency procedures (operation, angiography, intubation), injuries, diagnosis and discharge disposition were collected on all admitted trauma and general surgery patients who experienced the following adverse events: urinary tract infection (UTI), ventilator-associated pneumonia, deep vein thrombosis/pulmonary embolism, central line infection, pressure ulcers. **Results:** Of 3230 trauma patients, 369 (11.4%) experienced 1 or more adverse events. Of 6560 general surgery patients, 244 (3.72%) experienced 1 or more adverse events ($p = 0.0001$). The most prevalent of the adverse events for both groups was UTI: trauma 184 (49.9%) and general surgery 111 (45.5%). The mortality rate for these 2 groups experiencing an adverse event was 12.2% and 10.7% respectively. **Conclusion:** Significant differences exist between trauma and general surgery populations with respect to prevalence of adverse events, suggesting consideration should be given to determining the cause and identifying potential preventive measures in trauma patients.

Procoagulation, anticoagulation and fibrinolysis in severely bleeding trauma patients: a laboratorial characterization of the early trauma coagulopathy. L.T. Da Luz, S. Rizoli. From the Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: Early trauma coagulopathy (ETC) is complex and associated with poor outcome. Very little is known on its mechanisms, but it is estimated that 25% of all severely injured patients are coagulopathic on arrival. This observational study measures key coagulation elements believed to be responsible for ETC on an hourly basis for the first 12 hours postinjury, to try to understand this process. **Methods:** The study was performed in patients enrolled in the Trauma Formula-Driven Versus Laboratory-Guided (TRFL) study, a feasibility single-centre randomized controlled trial at Sunnybrook Health Sciences Centre. Blood samples of 55 patients were analyzed in a reference laboratory of hemostasis. Factor V, fibrinogen, activated protein C (APC), tissue plasminogen activator (TPA), plasminogen activator inhibitor 1 (PAI-1), thrombin activatable fibrinolysis inhibitor (TAFI), tissue factor pathway inhibitor (TFPI) and endogenous thrombin potential (ETP) were measured. A descriptive analysis was performed. **Results:** Fibrinogen was diminished during all time points, more notably in the coagulopathic patients. There was a massive release of APC and TPA in the first 3–4 hours after trauma, particularly in coagulopathic patients. A strong negative correlation between factor V and APC was found. Activity of TAFI and TFPI was inhibited during the entire period. PAI-1 activity was inhibited in the first 3 hours postinjury, reaching supranormal levels after that time point. **Conclusion:** Clotting

elements involved in the ETC were demonstrated. Hypofibrinogenemia and fibrinogenolysis were found, supporting the need for more liberal use of fibrinogen. The antifibrinolytic system was severely inhibited during the first 3 hours postinjury, suggesting that antifibrinolytics are useful during this period. This study is the first to demonstrate the sequential and evolving nature of ETC in severely bleeding trauma patients, improving its understanding and proposing ways to improve its management.

The use of mobile technology to facilitate surveillance and improve injury outcome in sport and physical activity. J. Banfield, B. Tanenbaum. From the Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: The Play Safe Initiative (PSI) is a collaborative approach to reducing injury risk in sport and physical activity. Surveillance methods to date have failed to capture true injury rates or causal factors in sport, recreation or school-based physical activity. The PSI aims to advance mobile technology as a viable approach to injury surveillance and facilitation of injury information promoting prevention, management and recovery. **Methods:** The PSI delivered a surveillance strategy at the 2012 Ontario Summer Games in Toronto. This multisport event engaged more than 2500 youth athletes in 28 various sporting activities in 22 different event venues. Concurrently, PSI released the first sport and physical activity mobile application aimed at participants, parents, coaches, teachers and others. **Results:** Using technology to capture injury data remotely, securely and simultaneously proved an effective method for understanding injury at a multisport event. The data collection process provided a rich database of injury samples in real-time for the research team to review throughout the event and facilitated appropriate deployment of resources (human and supplies) by the Medical and Injury Prevention Committee. Injury data were based on a clear and concise definition of injury and included standardized injury characteristics and causal factors. In addition, the Play Safe App provided an injury tracker, symptom checker, hospital locator, education and an opportunity to capture near misses. **Conclusion:** Web-based and mobile technology offer new opportunities to capture injury data in environments where traditional methods have proven ineffective and provide new avenues for sharing injury prevention, management and return-to-activity information.

Integrated knowledge translation for injury quality improvement: a partnership between researchers and knowledge users. M.J. Santana, H.T. Steffox. From the University of Calgary, Calgary, Alta.

Background: We want to develop a tool to allow activities of integrated knowledge translation where researchers and knowledge users will play an integral role in the entire research process. This tool, the Quality of Trauma Adult Care website (QTAC) will enhance practice by: (1) providing a communication platform to researchers, trauma specialists and stakeholders; (2) linking trainees and mentors to collaboratively advance quality of trauma care; and (3) partnering with national and international trauma groups to maintain and evolve the standards of performance measures in trauma care. **Methods:** We will invite leaders from accredited trauma centres (TCs) in Canada that contribute data

to the National Trauma Registry to visit the newly developed website. The website hosts information about quality improvement activities including 31 quality indicators of adult injury care. As an introduction to the website, a link will be sent to TCs. Visitors will be asked about their experiences: (1) How did you learn about the site? (2) How often have you accessed the site? (3) How useful was the information presented? An open text question will solicit advice from all participants on how to improve quality indicators and performance improvement. The site will include a chat window to provide opportunity for discussion. **Results:** The website has been developed and is available at www.qualitytraumacare.com. Links will be sent to TCs by Jan. 3, 2013. Evaluation will be finished by Mar. 30, 2013. **Conclusion:** The newly developed QTAC website may be used as a communication platform of quality performance measures to guide quality improvement practices in adult injury care.

The impact of a prevention project in trauma with young and their learning. *A. Dorigatti, B. Ribeiro Redondano, L. Simakawa Jimenez, T. Zago, R. Barros de Carvalho, T. Araujo Calderan, G. Fraga.* From the University of Campinas, São Paulo, Brazil

Background: The PARTY project (Prevent Alcohol and Risk-Related Trauma in Youth), created in Canada 20 years ago, is now being developed in several locations around the world. In Campinas, it is conducted by medical students of the University of Campinas (UNICAMP). The program aims to prevent trauma in adolescents who are attending high school. Students spend 4 hours at the UNICAMP Clinics Hospital where they can observe various aspects of trauma disease. This study aims to determine the occurrence of behavioural change, increased knowledge in the long run and transmitted concepts. **Methods:** Between 2010 and 2012, students who attended the PARTY project answered 2 Likert questionnaires, before and after the project completion. **Results:** In all, 1028 students who attended the PARTY project responded to a pretest and 857 responded to a post-test. Their average age was 16 (range 12–34) years, with only 6.9% older than 18 years; 2% already drove. Before the project, 11.3% thought that drunk driving was not a risk, and only 3.6% knew the alcohol effects. After the project, 43% (relative risk reduction [RRR] –2.8, –3.59 to –2.15) began to consider drunk driving a risk, and 18.8% (RRR –4.21, –6.37 to –2.69) knew the alcohol effects when driving. In all, 93.3% considered that prevention projects had a huge impact on their formation. **Conclusion:** Young people who joined in PARTY are not careful enough about the risks and do not have appropriate knowledge of prevention measures in trauma. However, prevention projects can act as trainers' knowledge and reduce risk exposure.

Intraosseous vascular access in adult trauma patients: a systematic review. *K. Birn, S. Campbell, S. Widder, D. Paton-Gay, P. Engels.* From the University of Alberta, Edmonton, Alta.

Background: The use of intraosseous devices for intravascular access is well described in the pediatric population. Recently, there has been increasing usage of intraosseous techniques in adults, in both trauma and nontrauma patients. Intraosseous access was used in trauma resuscitation during the Second World War, but its use subsequently declined. Recently, the utility of

intraosseous access in adult trauma has been rediscovered, and it is included in the Advanced Trauma Life Support curriculum. Intraosseous access appears to be a quick and safe method of intravascular access when peripheral access is not readily attainable and time is of the essence. While the safety and efficacy of this technique seems evident from the available literature, the evidence for intraosseous access in adult trauma patients has not been well summarized. The purpose of this study is to review the existing evidence for intraosseous access in this population, serving to further validate this technique as a valuable vascular access method and to guide further high quality studies. **Methods:** Searches were done in MEDLINE, EMBASE, Scopus, the Cochrane Library and CINAHL using both controlled vocabularies (MeSH, Emtree) where available and keywords. Concepts were searched using terms such as (intraosseous or “intraosseous”) adj2 (needle* or technique* or inject* or administ* or catheter* or access or drug or infus* or device*).ti,ab. or (ez-io or “bone injection gun*” or ezio).mp.) and (trauma* or resuscitat* or wound or injur*). The search excluded pediatric and animal subjects. No other limits were applied. There are no results or conclusions as the study is ongoing.

Thematic analysis of patient reported experiences with acute and post-acute injury care. *N. Bobrovitz, M. Ferri, M.J. Santana, T. Kline, J. Kortbeek, H.T. Stelfox.* From the University of Calgary, Calgary, Alta.

Background: To deliver injury care that meets the needs of patients, we must understand patient experiences with health care. **Methods:** We conducted a prospective cohort study to measure the injury care experiences of patients admitted to 3 trauma centres in Alberta. Patients/surrogates were approached before hospital discharge and invited to participate in longitudinal surveys inquiring about experiences with acute injury care (paper-based survey 24 hr before discharge) and postacute care (telephone survey 2–3 mo postdischarge). Each survey included 4 open-ended questions that asked patients to describe the best/worst aspect of their care, perceived unsafe care and suggestions to improve care. Two reviewers conducted a thematic analysis and independently categorized responses into themes (kappa = 0.83) until no new themes emerged. **Results:** We analyzed responses from the first 40 participants who completed both survey components ($n = 235$ total) and identified 20 themes. “Interpersonal characteristics/professionalism of healthcare staff” was the most common theme for both the best (28%) and worst (13%) aspect of acute care and was also the most frequent theme for the best aspect of postacute care (23%). “Access to follow-up care” (13%) and “information transfer between health care providers” (10%) were most commonly identified as the worst aspects of postacute care and targets for improving care (28% and 18%, respectively). Overall, 15% of participants reported experiencing unsafe acts of care. **Conclusion:** This qualitative analysis highlights that “interpersonal characteristics/professionalism of health care staff” is important for patient perceptions of injury care and that opportunities exist to improve “access to follow-up care,” “information transfer between health care providers” and the safety of care.

An evaluation of a world health organization trauma care checklist quality improvement pilot program. *R. Zakirova,* A. Nathens,* A. Lashofer,† A. McFarlan,**

N. Ahmed.* From ***St. Michael's Hospital, Toronto, Ont., and the †World Health Organization Department of Violence and Injury Prevention**

Background: Research has revealed an average reduction in mortality and morbidity by implementing a range of checklists. The World Health Organization (WHO) Trauma Care Checklist (TCC) has been developed with a set of minimum tasks that are likely to be forgotten by a trauma team and should be performed or assessed in all trauma patients. The study evaluated a quality improvement program and adherence to accepted practices in trauma care during the initial evaluation and resuscitation of severely injured patients through the provision of the TCC. Our goal was to assess whether the WHO TCC improves the process of care and decreases complication rates for injured patients. **Methods:** This observational study included 560 adult trauma patients, 90 of them observed during resuscitation in the emergency department of a trauma level 1 hospital during the 12 months before and after TCC implementation. Hospital administrative and electronic patient records were used to obtain follow up data. **Results:** The data analysis showed no impact on the mortality and morbidity rate after TCC implementation. Bivariate analysis of observed process measures found significantly increased distal pulses all 4 limbs examined ($p = 0.052$), abdominal physical exam performed ($p = 0.016$) and patient log rolled to examine spine ($p = 0.022$). **Conclusion:** Implementation of the WHO TCC did not impact on the mortality rate in the hospital setting with an established trauma system. However, the WHO TCC improved the communication and overall satisfaction among the trauma team, which improved the process of care.

Prospective validation of the modified pediatric trauma triage tool. **D. Davies, J. Booy, D. McDowell, A. Nasr, P. Wales.** From **The Hospital for Sick Children, Toronto, Ont.**

Background: Previously, we retrospectively evaluated and modified the pediatric trauma triage score (mPTS) described by Simon and colleagues (*Pediatr Emerg Care* 2004;20:5-11). Our 7-point score using physiologic parameters and physical findings to identify trauma patients at low risk of having serious injury had good sensitivity (99%) and positive predictive value (PPV; 46%). The objective of this study was to prospectively evaluate our mPTS. **Methods:** We completed a prospective cohort study of all trauma team activations at our level 1 pediatric trauma centre (2010–2012). The trauma team leaders (TTLs) were asked to score each patient upon their arrival. Patients were followed to determine if they had significant injury (Injury Severity Score [ISS] ≥ 12) or required intervention (surgery, blood products, intensive care unit or intubation). **Results:** In all, 290 trauma team activations occurred over the study period: 204 (70%) were scored by the TTL and followed 133 (65%) males, median age 9 (4–13) yr, median ISS 14 (5–20). Of these, 119 (58%) patients had an ISS of 12 or greater or required intervention. The mPTS was 96% sensitive and had a PPV of 62%. Four patients were found to have significant injuries or require intervention despite an mPTS of 7. Two had isolated head injuries and on review were scored incorrectly by the TTL. One was free of injury but required intubation for CT scan to rule out injury. The last had a liver laceration and concussion requiring observation. **Conclusion:** Our

mPTS is a safe and useful tool to identify which trauma patients should be evaluated by a trauma team. This score is easy to apply and can safely reduce unnecessary trauma team activations by 18%.

The 16-year evolution of a Canadian level 1 trauma centre: growing up, growing out, and the impact of a booming economy. **D. Das,* D. Roberts,† M. Mercado,‡ C. Vis,* J. Kortbeek,* A. Kirkpatrick,§ R. Lall,* H.T. Stelfox,* C.Ball.‡** From the ***University of Calgary, Calgary, Alta., †Dalhousie University, Halifax, NS, ‡Alberta Health Services, Edmonton, and the §Foothills Medical Centre and University of Calgary, Calgary, Alta.**

Background: Evolution of a trauma centre is reliant, in part, on improvements in prevention programs, human resources (transition to trauma fellowship-trained faculty and subspecialty nursing), trauma systems (prehospital, inpatient and discharge) and the physical plant. The purpose of this study was to evaluate the evolution of a Canadian level 1 trauma centre. **Methods:** A detailed audit of all injured patients over 16 years (1995–2011) was completed using a validated trauma registry. These patterns were also evaluated in the context of fluctuating provincial economic indicators. **Results:** Over the past 16 years, major trauma (Injury Severity Score ≥ 12) admissions have increased (150%) significantly despite a 56% reduction in motor vehicle collision and a 64% increase in fall mechanisms ($p < 0.05$). Falls are now the most common mechanism (41%). Injury severity score (mean 25), transport mode, mechanism (5% penetrating), hypotension on arrival (6%), discharge destination (60% home) and mortality (12%) remained constant over time ($p > 0.05$). Concurrent increases in mean patient age (41–49 yr), all-terrain vehicle (3-fold increase) and all off-road vehicle (4-fold increase) related injuries were noted ($p < 0.05$). Off-road injuries also fluctuated with provincial economic indicators. A decrease in the number of patients requiring a laparotomy (3-fold decrease) and hospital length of stay was also noted ($p < 0.05$). **Conclusion:** At a high-volume trauma centre, (1) the number and age of the patients, (2) the percentage of falls and (3) the proportion of off-road/toy vehicle-related injuries have all increased, while (4) the number of laparotomies and (5) the length of inpatient stay have decreased.

A 20-year review of trauma related literature: What have we done and where are we going? **G. Gamme,* D. Niven,† E. Dixon,† H.T. Stelfox,* A. Kirkpatrick,† G. Kaplan,* M. Hameed,‡ C. Ball.†** From the ***University of Calgary, the †Foothills Medical Centre and University of Calgary, Calgary, Alta., and the ‡Vancouver General Hospital, Vancouver, BC**

Background: Subspecialty peer-reviewed literature naturally fluctuates with regard to methodology, subject matter and volume. Multiple factors are responsible for this evolution over time, including changes in content access, clinical advancements and academic motivators. The purpose of this study was to evaluate the evolution of all trauma-related literature in the context of methodology, topic, mechanism and volume. **Methods:** A detailed audit of all trauma-/injury-related peer-reviewed manuscripts over the past 20 years (1991–2011) was completed using the leading trauma and general surgical journals (10). Manuscripts were classified by methodology, type and subject matter category. **Results:** A significant increase in

the overall volume of published injury-related manuscripts was noted (85% increase). The proportion of prospective original (28%) and basic science (19%) research remained constant across decades. Surveys and reviews each comprised only 2% of all publications. The proportion of publications focused on penetrating mechanisms decreased over the first decade (1991–2001) to reach an eventual steady state of 5% (2001–2011). More manuscripts are now topical to traumatic brain injury (3% increased to 15%), resuscitation (3% increased to 8%), acute care surgery (< 1% increased to 3%) and spinal fractures (< 1% increased to 2%; $p < 0.05$). Manuscripts related to diagnostic imaging (12% decreased to 4%), pelvic fractures (5% decreased to 2%) and technical/operative management (18% decreased to < 1%) decreased ($p < 0.05$). **Conclusion:** Over the past 20 years, the dominant journals publishing peer-reviewed manuscripts on injury have increased their overall volume despite decreased discussion of technical/operative management, penetrating mechanisms and diagnostic imaging. An increase in prospective, nonregistry studies is needed.

Management of traumatic flail chest: a systematic review of the literature. *F. Pervaz,* M. Qadura,* N. Sne,† S. Reid,* A. Coates,† S. Faidi.†* From *McMaster University and the †Hamilton Health Sciences Trauma Program, Hamilton, Ont.

Background: Currently there is no validated treatment protocol for the management of flail chest. The purpose of this systematic review is to reappraise what the current literature suggests regarding the management of flail chest due to trauma. **Methods:** We used EMBASE, MEDLINE and the Cochrane Registry, covering the period from January 1946 to August 2012, to search for all clinical studies assessing management of traumatic flail chest. Five prospective studies ($n = 91$ patients) comparing nonsurgical management strategies for traumatic flail chest qualified for final analysis. One study compared continuous positive airway pressure (CPAP) with intubation. Four studies compared intubation with analgesia. **Results:** Only 1 study was judged to be of medium/high quality. Four studies were found to be of low/medium quality. The medium/high quality study suggests reduced mortality with CPAP versus intubation (33% v. 9%, 95% CI, $p = 0.05$). The remaining studies ($n = 69$ patients) found analgesia superior to intubation, with reduced mortality and pneumonia. **Conclusion:** After reappraisal of the full data set, no study provides conclusive results indicating optimal management for traumatic flail chest patients. One randomized controlled trial and 1 prospective study suggest that intubation worsens outcomes in patients not requiring intubation. Current management of nonintubated flail chest is analgesia with or without CPAP. There is no current evidence comparing CPAP with analgesia. A high-quality randomized study assessing the use of CPAP versus analgesia is necessary to determine the optimal way of managing patients with traumatic flail chest who do not meet criteria for intubation.

Operative versus nonoperative management of flail chest. *Y. Almarhabi.* From the Vancouver General Hospital, Vancouver, BC

Background: The standard of care for flail chest and rib fracture injuries at most centres in North America includes a progressive nonoperative algorithm of adequate analgesia, mechanical venti-

lation and tracheostomy. Surgical management of multiple, displaced rib fractures has previously been reserved for refractory cases unable to wean from mechanical ventilation or severe chest wall instability. However, the use of surgical stabilization of the chest wall has demonstrated reductions in intensive care unit (ICU) length of stay, duration of mechanical ventilation, and the incidences of pneumonia, tracheotomy and reintubation. The objective of our study will be to retrospectively review those patients treated with MatrixRIB fixation and compare them to matched controls from the BC Trauma Registry. The intention is to compare outcomes between the 2 groups with respect to total ventilator days (VLOS), intensive care unit length of stay (ICU LOS), hospital resources used, total length of stay (LOS), pulmonary function, modes of analgesia, rate and nature of complications, quality of life and the overall mortality. **Methods:** This will be a retrospective cohort study. We will identify patients with blunt chest trauma in the BC Trauma Registry who received treatment at Vancouver General Hospital and the Fraser Health Authority from January 2010 to March 1, 2012. Patients receiving operative fixation of rib fractures with the MatrixRIB system and who also fulfill the inclusion criteria will be compared with the patients from multiple rib fractures with flail chest who were treated nonsurgically. **Results:** Our primary outcome will be VLOS. Secondary outcomes will include overall hospital LOS, ICU LOS, days in high acuity care, consulting services used (i.e., POPS [Proactive care of Older People undergoing Surgery], acute pain, etc.), the total number of diagnostic imaging procedures performed (chest radiograph, chest CT, MRI) pulmonary function tests including forced vital capacity and arterial blood gases, complications (deep venous thrombosis, ventilator-associated pneumonia, prolonged pain syndromes, reintubation, tracheostomy, other), use of analgesics (type, amount and mode of administration) and mortality. Investigators will obtain these data about cases and controls through chart reviews. Additionally, we will also be collecting details regarding the quality of life and the time needed to return to full work. The data about surgical intervention such as the number of ribs fixated used the MatrixRIB system and cost of the plates used in the procedure will be collected.

Emergency department performance of a clinically indicated and technically successful emergency department thoracotomy and pericardiotomy with minimal equipment in a New Zealand institution without specialized surgical backup. *A. Brainard.* From Middlemore Hospital, Papatoetoe, New Zealand

Background: An emergency department thoracotomy (EDT) following thoracic trauma is a rare procedure. There is some question as to the appropriateness and technical feasibility of the emergency department (ED) team's ability to perform this procedure in institutions without specialized surgical infrastructure. **Methods:** This case report illustrates an example of a technically successful EDT in an ED without specialized surgical equipment or backup. **Results:** A female in her twenties presented via ambulance to the ED with stab wounds to her neck and left anterior chest. She had a Glasgow Coma Scale core of 4, with detectable vital signs and a small pericardial effusion on ultrasound. After immediate intubation, a brief exam, left chest tube insertion, central line placement and rapid blood transfusion, her pulse became undetectable. With minimum delay, using only a disposable

scalpel and hand retractors, the emergency department team performed a lateral thoracotomy and pericardiotomy, releasing a pericardial tamponade. The patient then became conscious and required sedation. She was urgently transferred to the operating theatre for continued treatment by the general surgery team. The ED door-to-theatre time was 22 minutes. Unfortunately, the patient later died of exsanguination from multiple pulmonary and carotid artery wounds. **Conclusion:** An EDT can be performed with little risk, minimal expense and much potential benefit even in situations without a full EDT instrument set or immediate specialized surgical expertise. The necessary skills required are an adequate understanding of the mechanism, anatomy and physiology of thoracic trauma, the ability to use a scalpel, and an organized and an effective emergency resuscitation team.

British Columbia's mobile medical unit — an emergency health care support resource. *R. Brown,* J. Veenstra,† P. Hennecke,† R. Gardner,† L. Appleton.‡* From the *Vancouver General Hospital, the †Provincial Health Services Authority and the ‡Vancouver Coastal Health Authority, Vancouver, BC

Background: A self-sufficient hospital on wheels, British Columbia's Mobile Medical Unit (MMU) consists of a hospital vehicle, support vehicle and auxiliary equipment. The MMU originally provided critical care and emergency surgical capability at the Whistler Athletes' Village during the 2010 Olympic and Paralympic Games. Subsequently, it was purchased by the Ministry of Health to improve provincial clinical response capacity. **Methods:** A team was assembled and tasked with the design and maintenance of an MMU program that would be integrated with health emergency response and business continuity plans within each of the 6 provincial health authorities. The core MMU team of 5 individuals and a Provincial Advisory Committee were tasked with ensuring the MMU was activated on preplanned deployments throughout the province in its first operational year, while maintaining a state of readiness for emergency deployment. **Results:** In its first 18 months, the MMU deployed to 17 sites across 5 health authorities, fulfilling 5 key roles: renovation support, public health outreach, mass gathering event support, medical education and disaster recovery. Roles 1–3 included direct patient care, while 4 and 5 were training exercises including simulation. **Conclusion:** The MMU has demonstrated its ability to deploy as a flexible resource capable of delivering a broad range of patient care and clinical education across BC. Using the MMU throughout the year has provided valuable deployment experience, thus improving preparedness for emergency deployments.

Routine versus ad hoc screening for acute stress: Who would benefit and what are the opportunities for trauma care? *N. Bell,* B. Sobolev,* R. Simons,† R. van Heest,‡ M. Hameed.†* From the *University of British Columbia and the †Vancouver General Hospital, Vancouver, and the ‡Royal Columbian Hospital, New Westminster, BC

Background: Routine screening for acute stress is not currently part of trauma care owing in part to high variability of acute stress symptoms in identifying later onset of posttraumatic stress disorder (PTSD). Despite known limitations of available measures, it is not clear whether routine screening for acute stress offers a

superior alternative to ad hoc referral practices for identifying persons at risk of PTSD. **Methods:** We conducted a prospective observational study of a sample of hospitalized trauma patients over a 4-month period at a level 1 hospital in Canada. Baseline assessments of acute stress disorder (ASD) were measured using the Stanford Acute Stress Reaction Questionnaire. In-hospital psychiatric consultations were identified from patient discharge summaries. Symptoms of PTSD were measured at 1 and 4 months using the Posttraumatic Stress Disorder Checklist, stressor-specific version. Postdischarge health status and health services utilization surveys were also distributed. **Results:** Early identification of PTSD symptoms using the sub-syndromal ASD diagnosis improved from 18% ($\chi^2 = 3.95$, $p = 0.05$) when identified on an ad hoc basis to 73% ($\chi^2 = 7.88$, $p = 0.00$) when identified from routine screening, and improved from 9% ($\chi^2 = 1.04$, $p = 0.31$) to 45% ($\chi^2 = 3.93$, $p = 0.05$) using the full ASD diagnosis. **Conclusion:** An ad hoc psychiatric referral process for acute stress is a conservative approach for identifying persons who are at risk of PTSD. Despite known limitations of available measures, routine patient screening would better position trauma centres to prevent or manage psychological problems following injury.

A geographical analysis of the Early Development Instrument (EDI) and childhood injury. *N. Bell,* B. Sobolev,* R. Simons,† R. van Heest,‡ M. Hameed.†* From the *University of British Columbia and the †Vancouver General Hospital, Vancouver, and the ‡Royal Columbian Hospital, New Westminster, BC

Background: Although mental and physical indicators of poor childhood development have been shown to increase later risk of injury, there is limited research connecting traumatic events with national indicators of early childhood development. The objective of this research was to explore the correlation between EDI scores and incidence rates of childhood injury. **Methods:** We conducted retrospective data analysis linking child injury records (aged ≤ 14 yr) from the British Columbia Trauma Registry with 3 data collection waves of the EDI between calendar years 2003 through 2011. Relative risk of hospitalization from intentional and unintentional injury against the 5 domains of the EDI was assessed at the neighbourhood, school district and local health area geographies. **Results:** Despite our efforts to reduce childhood injury, our results demonstrate that inequalities in early childhood development pose systematic barriers to these efforts. The relationship between injury and vulnerability scores of early childhood develop follow well-known social gradients. This relationship is observed at multiple spatial scales. **Conclusion:** Existing research in the area of early childhood development suggests that early inequalities in physical and mental health have long-term consequences to health. However, whether these indicators similarly translate into increased injury risk has not been studied substantially. Study findings provide opportunities to partner with communities to frame injury prevention and reporting initiatives.

Development of a pediatric spinal cord injury nursing course. *H. Jowett,* C. Palmer,* C. Bevan,† J. Cramer.†* From *The Royal Children's Hospital, Melbourne, Australia, and †The Royal Alexandra Children's Hospital, Sussex, United Kingdom

Background: Children with spinal cord injury (SCI) experience multiple unique health care needs. At the Royal Children's Hospital Melbourne (RCH) we have responded to an increasing demand in caring for pediatric SCI patients and families, with a number of initiatives and strategies being developed and implemented to provide staff with appropriate tools for managing this unique cohort of patients. Despite these new resources, there was an identified need for specific pediatric spinal education of all relevant staff.

Methods: Collaborative meetings were initiated with the Victorian Spinal Cord Injury Service, the Victorian Paediatric Rehabilitation Service and the multidisciplinary team at RCH. We also conducted a hospital-wide survey on SCI knowledge and skills. As a result of these, a decision was made to develop a pediatric-specific spinal cord injuries nursing course. **Results:** A 3-day course was piloted in 2011, with 22 nurses from 11 disciplines across RCH attending. There were significant improvements in self-reported knowledge, skills and confidence among course participants. Participants' confidence in management of SCI patients also significantly increased, both overall and in the specific areas such as initial management, respiratory management, bowel and bladder care, and discussing sexuality and fertility with patients and families. **Conclusion:** Ongoing education is required to provide sustainable learning so that our patients continue to benefit from the skills and knowledge acquired from the course. The course will now be offered to the wider Australasian trauma community, and will also expand to include allied health professionals.

"Kids die in driveways" — an injury prevention campaign. *H. Jowett,* C. Palmer,* D. Hogan,† L. Grealy.†* From *The Royal Children's Hospital, Melbourne, and the †Coroners Court of Victoria, Australia

Background: Pediatric run-over incidents typically occur in the driveways of homes. The majority of incidents involve a reversing vehicle, driven by a parent, family member or friend. A spike in run-over deaths in 2011 prompted a review of the epidemiology of this type of injury to develop an appropriate injury prevention strategy. **Methods:** The trauma registry at the Royal Children's Hospital Melbourne (RCH) and the Victorian Coronial database were searched to identify patients killed or admitted to RCH following run-over-related trauma between 2000 and 2011. Risk factors particular to these incidents were identified. **Results:** Thirteen children died following run-overs in residential driveways in Victoria. Six of these occurred in an 18-month period during 2010 and 2011, and 92% of cases resulting in the death of a child occurred at the child's home. An additional 73 children were admitted to the RCH during this time. Four-fifths of patients were under 6 years of age, and the peak was between 1 and 2 years. Incidents predominantly occurred during warmer months. There was a peak in incidence between 3 pm and 6 pm in the afternoon. Four-wheel drives, utility vehicles, trucks and vans were over-represented in run-over incidents. **Conclusion:** Young children are particularly at risk from run-over as they are small, unpredictable, inquisitive and mobile. A state-wide safety campaign was launched, reinforcing the need to know where the child is at all times when vehicles are entering and exiting properties.

Epidemiology of traumatic spine injuries in children. *S. Bressan,* C. Bevan,† C. Palmer,* H. Jowett.** From *The Royal Children's Hospital, Melbourne, Australia, and †The

Royal Alexandra Children's Hospital, Sussex, United Kingdom

Background: Traumatic spinal injuries (TSI) are uncommon in children but may be devastating if missed. They may go unrecognized in multiple trauma patients if initial management is focused on treatment of life-threatening injuries. In addition to a thorough secondary survey, knowledge of the epidemiology of these injuries in children will help in the identification and management of these injuries in children. **Methods:** Data from patients with a diagnosis of TSI admitted at the Royal Children's Hospital Melbourne between 2002 and 2008 were retrieved from the hospital trauma registry. **Results:** In all, 538 patients presented with 1 or more TSIs. Of these, 210 (39%) had a radiologically identifiable injury: 113 (54%) of TSI patients had cervical involvement, and 61 (26%) and 58 (25%) patients had TSI in the thoracic and lumbar regions, respectively. The most common injuries were isolated fractures, occurring in 96 patients. Spinal cord injury at 1 or more levels was present in 29 patients (14%); this included 23 cervical TSI patients, 5 thoracic and 3 lumbar. In 98 patients, the TSI was associated with 1 or more nonspinal injuries. Cervical and thoracic TSI were most commonly associated with head injuries, and lumbar TSI with abdominal injuries. **Conclusion:** Traumatic spinal injuries are uncommon in children and are mainly sustained in the cervical region. This region is also more likely to involve an injury of the spinal cord. Health professionals should be aware of their frequent association with other severe injuries and maintain a high index of suspicion for TSI in multiple traumas.

A collaborative approach to reducing injuries in New Brunswick: acute care and injury prevention. *A. Hogan.* From the New Brunswick Trauma Program, Miramichi, NB

Background: Over 90% of injuries are preventable, but injury remains a leading cause of hospitalization and death for all ages in New Brunswick. Since 1998, injury prevention has been an integral part of the Saint John Regional Hospital (SJRH) Trauma Program, now part of the New Brunswick Trauma Program (NBTP). A goal of the trauma program is reduction in the burden of injury through prevention. **Methods:** Under the leadership of the Trauma Program, healthcare clinicians have been linked with community stakeholders locally, regionally, provincially and nationally. Since 2010, the NB Trauma Program has worked to formalize an inclusive, provincial program, including an injury prevention subcommittee that deliberately links the acute care and community sectors. **Results:** Since 1998, injury prevention stakeholders in New Brunswick have been actively linked by those working within the acute care sector. This has resulted in the successful implementation of regional programs, including children, youth and seniors. Between 2004 and 2009, there was a 57% reduction in admissions to SJRH of children under 16 years old with an Injury Severity Score greater than 12. Between 2005 and 2011, seniors 65 years and older showed a 7% reduction in hospitalizations through the SJRH emergency department for a fracture hip. The NBTP Injury Prevention Subcommittee contributions reaffirm the value of interdisciplinary representation for successful injury prevention initiatives. **Conclusion:** Reducing injuries requires a collaborative approach with a strong foundation and cooperation from all stakeholders.

Impact of changes to a provincial field trauma triage tool in New Brunswick. *I. Watson,* R. Boulay,† A. Chisholm,* E. Beairsto,† E. Goulette,† M. Martin.** From the *New Brunswick Trauma Program, Miramichi, and †Ambulance New Brunswick, Moncton, NB

Background: Changes to the bypass-qualifying criteria of the provincial Field Trauma Triage Guidelines (FTTG) in New Brunswick were introduced in August 2012, aimed at enhancing capture of trauma patients with associated respiratory distress, potential chest wall instability, potentially significant head injuries, pulseless extremities and pregnant patients with torso trauma. **Methods:** All Ambulance New Brunswick paramedics were provided with computer-based distance education to review the August 2012 changes to the FTTG. Participants were required to successfully complete this education before FTTG changes were implemented across the province on Aug. 15, 2012. All FTTG activations in September 2011 were compared with the same month in 2012 to evaluate if qualifying criteria, hospital destination or relevant time intervals were altered as a result. **Results:** In all, 271 FTTG activations were considered. The rate of bypass of level 5 designated centres increased from 8.9% to 14.8%; however, the average interval to arrival at level 1, 2 or 3 trauma centres remained statistically unchanged. A mortality rate of 0 during EMS transport of qualifying patients was maintained throughout the study. **Conclusion:** Although changes to FTTG did increase the rate of level 5 bypass in this inclusive, provincial trauma system, the interval from ambulance on scene to arrival at hospital did not increase significantly, and in-transport mortality was maintained at 0%, lending support to continued inclusion of revised criteria in the FTTG tool now used in New Brunswick.

Ensuring quality of field trauma triage in New Brunswick. *S. Woodford,* S. Benjamin,* R. Boulay,† I. Watson.** From the *New Brunswick Trauma Program, Miramichi, and †Ambulance New Brunswick, Moncton, NB

Background: The Field Trauma Triage (FTT) tool used in New Brunswick is based on an internationally recognized and evidence-based tool. This tool provides paramedics with destination guidance based on the initial assessment of the trauma patient. First introduced for provincial use in November 2010, potentially seriously injured patients are preferentially transported to higher resourced trauma centres. All FTT activations are verified by phone between the paramedic and the trauma desk with per-case information captured on an FTT audit sheet. Ongoing performance monitoring is accomplished through sharing of these data between the New Brunswick Trauma Program and Ambulance New Brunswick (ANB). **Methods:** From April to September 2012, all FTT audit sheets on admitted patients were reviewed at level 1 and 2 sites for activation appropriateness, initial destination decision and accuracy of application. Deviations from the 4-step tool are noted, trended and reported for follow-up back to ANB leadership. **Results:** A significant proportion of admitted patients at level 1 and 2 sites over the study period did not have an FTT activation as expected. The results do, however, demonstrate an improving trend in FTT activation rates. Occasional detection of inappropriate destination decisions and FTT misapplication continue to be identified. **Conclusion:** Identifying these areas for quality improvement resulted in ANB

performing a 3-month self-audit for FTT activation. Ongoing education and monitoring of the FTT tool is an important part of the evaluation process.

Benefits of a provincial trauma transfer referral system: beyond the numbers. *A. Hogan,* R. Boulay,† I. Watson.** From the *New Brunswick Trauma Program, Miramichi, and †Ambulance New Brunswick, Moncton, NB

Background: New Brunswick has 20 designated trauma centres ranging from level 1 to level 5. In June 2010, the NB Trauma Program introduced a single, toll-free trauma referral system (TFTRS) to provide medical direction and oversight for trauma transfers. Information obtained from TFTRS callers is needed by trauma control physicians (TCPs) to offer clinical guidance and decide the most appropriate destination for the major trauma patient. Critical care transport coordinators (CCTCs) coordinate all requests initiated through the TFTRS. **Methods:** Between June 2010 and October 2012, there were 563 trauma calls processed through the TFTRS. These recordings were reviewed by an experienced trauma coordinator to ensure that patient information was relayed accurately. Preset questions and guidelines were used by the CCTC and the TCPs. **Results:** Analysis of TFTRS calls identified specific areas of communication that require improvement including basic patient information such as time of injury, time of arrival at facility and name of the patient. This review allowed for targeted improvement efforts as well as more insight into specialist and subspecialty availability throughout the province. The information obtained from the review was used to revise the data collection sheet for CCTCs, implement a report form for the TCPs, and revise the trauma transfer guidelines and checklist used by sending facilities. **Conclusion:** Analysis of TFTRS calls is an effective tool for identifying opportunities for improvement in communication and process for the transfer of trauma patients.

The field trauma triage landscape in New Brunswick. *R. Boulay,* I. Watson,† J. Savoie,* S. Benjamin,† M. Martin.†* From *Ambulance New Brunswick, Moncton, and the †New Brunswick Trauma Program, Miramichi, NB

Background: Prior to November 2010, all trauma patients were transported by default to the closest emergency department regardless of injury severity. Implementation of the provincial Field Trauma Triage Guidelines (FTTG) in November 2010 allows paramedics to stratify patient presentations within a 5-step tool ranging from immediate life threats to special considerations, allowing them to bypass level 5 trauma centres for qualifying patients. **Methods:** All Ambulance New Brunswick paramedics have participated in FTTG training and have been using the FTTG tool to help triage their trauma patients in the prehospital setting since November 2010. We analyzed 1482 FTTG activations that occurred between October 2011 and September 2012 by qualifying step of the FTTG. **Results:** The FTTG activations were distributed as follows: criteria 1A (immediate life threats) 6.1%, criteria 1 (physiologic) 5.6%, criteria 2 (anatomic) 6.2%, criteria 3 (mechanism) 35.5% and criteria 4 (special considerations) 33.3% (13.3% of FTTG activations did not have any qualifying criteria). **Conclusion:** In this review, 47.3% were suspected of having significant, bypass-qualifying criteria on initial

emergency medical service assessment, while 52.7% were found to have only special consideration criteria or an immediate life threat requiring transport to the closest available emergency department. Further study is warranted to ensure that patients who did not qualify for bypass did not actually have bypass-qualifying injuries or mechanisms.

Impact of the Rural Trauma Team Development Course (RTTDC) on trauma transfer intervals in a provincial, inclusive trauma system. I. Watson,* A. Hogan,* S. Woodford,* S. Benjamin,* A. Chisholm,* H. Ondiveeran,[†] M. Martin.* From *Ambulance New Brunswick, Moncton, and the [†]Saint John Regional Hospital, Saint John, NB

Background: The NB Trauma Program provided the American College of Surgeons' Rural Trauma Team Development Course (RTTDC) to 11 level 5 designated trauma centres in New Brunswick in the spring of 2012. Each level 5 designated centre completed 1 RTTDC course. Participants included physicians, nurses, paramedics and other allied health professionals. We then undertook analysis of time intervals for qualifying trauma patients at level 5 trauma centres. **Methods:** All calls to the provincial Toll-Free Trauma Referral System from level 5 designated trauma centres in New Brunswick during the months of June, July and August, 2011, were compared with equivalent data points from the same period in 2012. Time to first activation of the Toll Free Trauma Referral System and the total interval from arrival at a level 5 site to arrival at secondary (level 3, 2 or 1) site was compared. **Results:** Overall, completion of 1 RTTDC per level 5 designated trauma centre in NB did not significantly reduce the time to activate the Toll Free Trauma Referral System or the total interval to definitive care. **Conclusion:** Further study is required to determine if additional RTTDC course offerings or specific RTTDC course composition is correlated to shorter intervals to activation or definitive care.

Trauma and stress: a critical dynamics study of burnout in trauma centre healthcare professionals. M. Howlett,* P. Atkinson,* K. Doody,* J. Fraser,[†] D. Leblanc-Duchin,* B. Strack.* From the *Saint John Regional Hospital, Saint John, and the [†]New Brunswick Trauma Program, Miramichi, NB

Background: Previous studies suggest elevated levels of burnout in emergency department health professionals (EDHP). This multicentre survey examined levels of burnout and its correlation with psychological coping strategies used by EDHP at 7 trauma centres in the New Brunswick (NB) Trauma Program. **Methods:** A survey of all EDHP at 7 trauma centres was performed over a 3-month period. A demographics questionnaire, the Maslach Burnout Inventory (MBI, a validated tool measuring emotional exhaustion [EE], depersonalization [DP] and personal accomplishment [PA]), the Coping Inventory for Stressful Situations (CISS, measuring task-oriented [TO], emotion-oriented [EO] and avoidance-oriented [AO] coping styles) were completed anonymously. **Results:** Response rate was 60% ($n = 315$). The MBI and CISS scores were examined using χ^2 and Pearson correlation (r). Overall, MBI scores revealed levels burnout in the average normative range for EE. The PA and DP scores reflected low levels of burnout compared with the normative group (PA,

$\chi^2 = 41.87, p < 0.01$; DP, $\chi^2 = 14.07, p < 0.01$). The CISS revealed a significant inverse correlation between TO and burnout on all 3 MBI scales (DP, $r = -0.20$; EE, $r = -0.21$; PA, $r = 0.34$) and a significant positive correlation between EO and burnout (DP, $r = 0.31$; EE, $r = 0.35$; PA, $r = -0.28$). **Conclusion:** Burnout levels in NB trauma centres were lower than expected. Task-oriented copers showed less burnout. Emotionally-oriented copers showed more burnout. Analysis of coping strategies used by trauma centre health professionals may be useful in predicting burnout and providing protective interventions.

Ultrasound-guided pediatric forearm fracture reduction with sedation in the emergency department. P. Atkinson, A. Naveed, L. vanRensburg, R. Madan. From the Saint John Regional Hospital, Saint John, NB

Background: Displaced forearm fractures in children are a common emergency department (ED) presentation, often resulting in admission to hospital for manipulation under general anesthetic. We describe the use of ultrasound to guide fracture reduction in the ED. **Methods:** We report a case series of patients who attended the ED with isolated forearm injuries. Following sedation, imaging of the fracture alignment was performed using a high-frequency linear-array probe, placed longitudinally over the fracture site, before and after manipulation. Ultrasound was used to determine if the position was acceptable before application of a cast. Postreduction radiographs were obtained. **Results:** Six patients, ages 7 to 14 years, were included, all with isolated deformed closed distal radial fractures. In 4 of the 6 cases, ultrasound demonstrated adequate reduction, which was maintained to follow-up at clinic. In 2 cases, ultrasound demonstrated that despite repeated attempts, fracture reduction was unsatisfactory, and the patients were admitted for further manipulation under a general anesthetic. In all cases, the postreduction ultrasound gave an accurate impression of the fracture position when compared with the plain radiograph, as judged by an independent orthopedic consultant. **Conclusion:** In our small case series, we demonstrate that ultrasound can be used to accurately assess manipulation of distal forearm fractures in the ED both as a positive and negative predictor of success. A further larger trial and economic analysis is needed to confirm the benefits of using ultrasound to assist in manipulation of forearm fractures in the ED.

Block first, opiates later? The use of the fascia iliaca block for patients with hip fractures in the emergency department: a systematic review. A. Chesters,* P. Atkinson.[†] From the *Cambridge University Hospital, Cambridge, United Kingdom, and the [†]Saint John Regional Hospital, Saint John, NB

Background: To determine the efficacy of the fascia iliaca block in providing analgesia to patients with a hip fracture in the emergency department. **Methods:** EMBASE, PubMed, CINAHL and Google Scholar were searched. Free text keywords for population, intervention and outcome were identified to create a search string. The reference lists from articles identified in the primary electronic search were hand-searched. The search strategy was repeated using the System for Information on Grey Literature in Europe. Potentially eligible studies were identified based on review of the title and abstract. If eligibility was unclear

from the title and abstract, the full text was examined. Randomized controlled trials comparing the fascia iliaca block with standard analgesia were included. A standardized appraisal of the methodological quality of the studies was performed. **Results:** In all, 39 articles were identified, of which 13 were duplicates. Of the remaining 26, 14 were relevant to the question and suitable for further sorting. Of these 14 papers, 2 were randomized controlled trials, 5 were cohort studies, and 4 were reports of audits of practice. There were 3 abstracts of conference submissions, which were descriptions of reviews or service development projects. The 2 randomized controlled trials showed statistically significant superior or equal pain relief between the fascia iliaca block and other forms of acute pain relief. **Conclusion:** The fascia iliaca block could have an important role in first-line pain control for patients presenting to the emergency department with a hip fracture. There is potential to reform the acute management of this common group of patients.

Rural trauma systems — demographic and survival analysis of remote traumas transferred from northern Quebec. *F. Hamadani,* K. Boulva,† D. Deckelbaum,* K. Khwaja,* P. Fata,* T. Razek.** From the *McGill University Health Centre and the †Université de Montréal, Montréal, Que.

Background: Studies have shown mortality and morbidity rates from traumatic injury to be higher in remote and rural populations compared with urban areas. In remote, northern Quebec communities, transport to the Montreal University Health Centre (MUHC), a level 1 trauma centre, is the only option for complex trauma care. This study aims to provide: (1) demographic analysis northern Quebec, emphasizing the available health care infrastructure; (2) mechanisms and rates of injuries in the north requiring transfer; (3) comparison of outcomes, for the same Injury Severity Score (ISS), between urban traumas arriving to the MUHC and northern traumas. **Methods:** We performed a retrospective analysis of patients with an ISS of 16 or more who were entered into the MUHC trauma registry from January 2005 to December 2009, identifying patients transported from the north separately. Data collected from both groups were analyzed to derive frequencies, means and percentages for the various parameters, which were then used to calculate the standardized mortality ratio (observed/predicted) for both populations. **Results:** A demographic assessment of available health services in northern Quebec was performed. There were 3772 local traumas with an ISS greater than 16 compared with 172 that arrived from northern Quebec. The mean age for both groups was over 40 years with a predominantly male population, the majority of whom had sustained blunt trauma. Motor vehicle collision was the most common mechanism in both groups, averaging 40% for both populations. Penetrating trauma was the cause of 12% of all transports from the north, whereas it represented 7% of the injuries seen in the local population. Patients transferred from the northern region with an ISS greater than 16 had a significantly higher mortality rate. **Conclusion:** The study is a comparison between remote and urban populations in a single trauma network. Trauma patients from this remote area in northern Quebec with ISS greater than 16 had a significantly higher mortality rate than those from the urban environment. This study delineates the reasons for this stark difference.

Simulation in trauma ultrasound training. *P. Atkinson,* J. Fraser,† G. Verheul,* A. Parks,‡ J. Milne.‡* From the *Saint John Regional Hospital, Saint John, the †New Brunswick Trauma Program, Miramichi, NB, and ‡Dalhousie University, Halifax, NS

Background: Trauma ultrasound (FAST) training can be limited by the availability of patients with pathology. Simulation may provide a more efficient way of training. We assessed ultrasound simulation for teaching ultrasound technique, and also for how realistic it appeared for normal anatomy and pathology. **Methods:** In all, 42 physicians participated in educational sessions that included didactic learning followed by supervised scanning of normal volunteers and patients with pathology using portable ultrasound machines (GE and SonoSite). Participants also performed focused ultrasound scans using a high-fidelity ultrasound simulator (VIMEDIX) of the pericardium, pleural and peritoneal spaces for free fluid (extended FAST). All participants were then surveyed using a standardized 5-point Likert scale for teaching technique, on how realistic simulation was for normal anatomy and pathology, and for training overall. Data were analyzed using paired *t* test (GraphPad Prism). **Results:** All 42 surveys were completed; 27 (64.3%) had previous ultrasound training, and 2 (4.8%) had previously used the ultrasound simulator. As a method of teaching ultrasound technique, there was no significant difference in median mean scores between patient/volunteers and the simulator for pleural fluid (4.4 v. 4.3, *p* = 0.5392), peritoneal fluid (4.6 v. 4.3, *p* = 0.0620) or cardiac (4.5 v. 4.4, *p* = 0.4124). Of participants, 41 (97.6%) would use high-fidelity ultrasound simulation to further develop and maintain skills. **Conclusion:** Simulated ultrasound compared favourably to real ultrasound for teaching technique, normal anatomy and pathology for focused trauma applications. It is likely that ultrasound simulation will have an increasingly important role in trauma ultrasound education and skills maintenance.

Incidence of clinically significant intra-abdominal injuries in stable blunt trauma patients. *M. Azzam, J. Nemeth, P. Fata, J. Correa, D. Deckelbaum, B. Bernardin, B. Al Bader, K. Khwaja, T. Razek.* From the McGill University Health Centre, Montréal, Que.

Background: Identifying intra-abdominal injury (IAI) in hemodynamically normal blunt trauma patients while minimizing CT scan exposure presents a serious challenge, and there is little evidence to guide clinical decision-making. We hypothesized that in a low-risk patient population (Injury Severity Score < 12), a percentage of patients will have considerably significant IAI. Our primary goals were to describe the incidence of clinically significant IAI in these patients, and to assess the sensitivity and specificity of physical exam and FAST as screening tools to pursue further CT imaging. **Methods:** We conducted a prospective cohort study of consecutively adult stable blunt trauma patients. We excluded patients with a Glasgow Coma Scale score lower than 14, penetrating trauma, hemodynamic instability and previously identified IAI before enrollment. **Results:** We enrolled 150 blunt trauma patients; 10 of 150 patients had IAI. All of the 10 patients had positive abdominal exam; 9 of the 10 patients (90%) had clinically significant injuries. Two of 150 patients (1.3%) had therapeutic laparotomy based on CT findings. The

sensitivity and specificity of physical exam was 100% (CI 71%–100%) and 63% (CI 55%–70%) in detecting IAI. The sensitivity and specificity of FAST was 25% (CI 7%–59%) and 97% (CI 91%–99%). **Conclusion:** In the low-risk patient population, there is a significant incidence of IAIs that can be missed without definitive imaging. Future studies should focus on identifying predictors for detecting IAIs. In our study, physical exam was felt to be promising as a predictor for detecting IAI.

Wake up: head injury management around the clock. *J. Fraser,* P. Atkinson,† S. Benjamin,* E. Sproul,‡ A. Mehta.‡* From the *New Brunswick Trauma Program, Miramichi, the †Saint John Regional Hospital, Saint John, NB, ‡Dalhousie University, Halifax, NS, and §Memorial University, St. John's, NL

Background: We aimed to determine whether the time of day and the severity of the injury affected the time to CT scan of patients with head injury presenting to the emergency department at a level 1 trauma centre. **Methods:** The study was a retrospective chart review ($n = 904$). Our primary outcome was time from emergency physician assessment to CT scan. Data were analyzed according to severity of head injury, time of presentation and disposition using nonparametric tests (GraphPad Prism). **Results:** Mild head injury (Glasgow Coma Scale score [GCS] 13–15) median times to CT (68 min) were longer than moderate (GCS 9–12, 50 min) and severe (GCS 3–8, 53 min) head injuries, respectively (Kruskal–Wallis test $p < 0.05$). There was a significantly longer median time to CT scan overnight (midnight to 8 am) for all patients (79 min) when compared with day and evening presentations (63 min; Mann–Whitney U test $p < 0.0001$). For clinically significant head injuries (defined as moderate or severe, GCS 3–12), there was also a significantly longer median time to CT scan overnight (59 min v. 47 min; Mann–Whitney U test $p = 0.044$). For patients who died, went to the operating room or to intensive care, there was a trend toward longer median times to CT overnight (59 min v. 55 min; Mann–Whitney U test $p = 0.051$). **Conclusion:** Severity of head injury and arrival to hospital after midnight were associated with significantly longer times to head CT in this level 1 trauma centre. Further investigation is indicated to determine what factors contribute to this delay.

Damage control laparotomy for combat casualties in forward surgical facilities. *J. Doucet,* M. Galarneau,† P. Mahadevan,* V. Bansal,* J. Dye,† P. Hollingsworth-Fridlund,† P. Stout,* B. Potenza,* R. Coimbra.** From *UC San Diego and the †Naval Health Research Center, San Diego, Calif.

Background: Current conflicts are the first to utilize damage control laparotomy (DCL) in forward surgical facilities (Echelon II). This study intends to characterize use of DCL in Echelon II surgical facilities on casualties in Iraq and Afghanistan. **Methods:** We reviewed 20 703 records from the US Navy's Triservice Combat Trauma Registry from 2004 to 2010 for laparotomy at Echelon II facilities before evacuation to Echelon III. Conventional laparotomy (CL) patients underwent definitive procedures with sutured fascia abdominal closure. Damage control laparotomy patients underwent hemorrhage and contamination control pro-

cedures with temporary abdominal closure before evacuation. Mortality, wound locations, vital signs, transfusions, Abbreviated Injury Scale score, Injury Severity Score, procedures, operative findings, re-explorations and definitive closures were recorded. **Results:** There were 47 laparotomies at Echelon II facilities that were subsequently evacuated to higher Echelon facilities: 27 were DCL and 20 were CL. The DCL cases were more likely to present in shock (blood pressure < 90 mm Hg; 8 of 23, 34.7% v. CL, 0 of 16, 0%; $p < 0.0001$). Patients who underwent DCL had a higher ISS than CL patients (22.75 ± 10.4 v. 11.89 ± 7.0 , $p < 0.0001$). Patients who underwent CL had unplanned reopening in 2 of 20 (10%) cases at Echelon III facilities. Closure of DCL was successful in 22 of 27 (81%) cases before leaving Echelon III facilities. There was no mortality in patients reaching Echelon III facilities after DCL. **Conclusion:** Damage control laparotomy was highly successful in management of abdominal injury in USMC/USN casualties in forward surgical facilities. Patients who underwent DCL were significantly more injured than CL patients. Most DCL patients were closed before evacuation out of the combat theatre.

Detection of soft tissue foreign bodies by nurse practitioner performed ultrasound. *P. Atkinson, R. Madan.* From the Saint John Regional Hospital, Saint John, NB

Background: This study aimed to evaluate the accuracy of emergency nurse practitioner (NP) performed point-of-care ultrasound (POCUS) for the detection of soft tissue foreign bodies. **Methods:** Following a 2-hour training session, 10 NPs were assessed on their ability to detect various foreign bodies in an experimental model. Foreign bodies (wood, metal and plastic) were inserted randomly into 8 experimental models (uncooked chicken thighs) by an independent observer. Control experimental models had no foreign body inserted, but all had a 1 cm incision made on their surface. The NPs, blinded to the type of model, were then assessed on their ability to detect the foreign bodies by ultrasound examination using high-frequency linear transducers (Nemio; Toshiba). Models were also scanned by 2 experienced emergency physicians (EP) as a further control. **Results:** Overall, NPs performing POCUS detected 47 of the 60 foreign bodies with a sensitivity, specificity, positive and negative predictive values of 78.3%, 50%, 82% and 43%, respectively, compared with 83.3%, 75%, 90.9% and 60% for EPs. Sensitivity for detecting specific types of foreign bodies was 95%, 85% and 50% for wood, metal and plastic, respectively, for NP-performed POCUS, compared with 100%, 100% and 50% in the EP group. **Conclusion:** The NPs with no previous ultrasound experience can detect soft tissue foreign bodies with accuracy comparable to that of EPs in an experimental model. Test sensitivity was high for wood and metal foreign bodies. Specificity was generally low.

Antihypertensive medications and walking devices are associated with falls from standing. *F. Muakkassa, R. Marley, A. Salvator, D. Pisciotta.* From the Akron General Medical Center, Akron, Ohio

Background: Falls are an increasing cause of injuries. This study looks at potential causes of falls in different age populations. **Methods:** From July to October 2012, each patient admitted to the hospital for injuries related to a fall was prospectively administered

a survey regarding the circumstances that caused the fall. **Results:** There were a total of 111 surveys completed, with a 67% response rate. The mean age was 68.24 ± 19.8 , and 42.5% were male. The most significant common fall was from a standing height (64%), then a height of less than 10 feet (25%) and 10–20 feet (11%; $p = 0.0001$). The respondents who fell from standing were stratified into 2 subgroups by the sample median age of 72 years: age less than 72 (age < 72) and age greater than or equal 72 (age \geq 72). Those who were 72 or older had significantly higher rates of use of walking devices (82% v. 40%, $p = 0.004$), of being discharged to rehabilitation or skilled nursing facilities (72% v. 48%, $p = 0.047$) and use of antihypertensive medications (79% v. 48%, $p = 0.007$). Those who were under 72 trended toward a significantly higher rate of narcotic prescription use and blood alcohol level above 80 mg/dL than those who were 72 and older (44% v. 24%, $p = 0.08$), respectively. **Conclusion:** Antihypertensive medications and walking devices are significantly associated with falls in patients older than 72 years of age. The results of the hospitalization led to increased admissions to rehabilitation facilities and nursing homes. Further investigation is warranted for possible fall prevention.

The transfer process: perspectives of transferring physicians. N. Sathivel,* J. Bridge,[†] S. Lin,* H. Ovens,* A. Nathens.[†] From *St. Michael's Hospital, the [†]Sunnybrook Health Sciences Centre and ‡Mount Sinai Hospital, Toronto, Ont.

Background: As many as 40% of all severely injured patients require transfer to a trauma centre from a nontrauma centre for definitive care. To improve the transfer process, we explored the main challenges faced by emergency medicine physicians in transferring these patients. **Methods:** An online survey was conducted with 107 Ontario physicians who worked in emergency departments (ED) that were not in designated level 1 or level 2 trauma centres. Physicians were emailed invitations for the study through ED Local Health Integration Network (LHIN) leads and the Canadian Association of Emergency Physicians (CAEP). The survey included a series of questions about the management and transfer of trauma patients. The margin of error for the total sample is $\pm 9.45\%$, 19 times out of 20. **Results:** The ED physicians from nontrauma centres were asked to identify on an open-ended basis their top 3 challenges with the management and transfer process for trauma patients. The most commonly cited challenges centred on the following: bed availability (32%), staffing/availability of human resources (32%), having knowledge/skills to manage trauma patients (30%), the process/protocols and time involved with contacting sites/trauma team leaders (28%) and patient transport (25%). **Conclusion:** By providing an opportunity to identify challenges on an unprompted, open-ended manner, it is evident that no single transfer issue dominates on a top-of-mind basis. This suggests that a strategy for trauma system improvement should address transfer challenges on a variety of levels, including improvements to process/protocols, physician education, patient transport and resources.

Development of a rodent model for the study of abdominal compartment syndrome. S. Chadi,* H. Abdo,* R. Dencev-Bihari,* N. Parry,[†] A. Lawendy.* From the *University of Western Ontario and the [†]London Health Sciences Centre, London, Ont

Background: Abdominal compartment syndrome (ACS) is associated with an increased rate of multiple organ dysfunction and is an independent marker for mortality. Our objective was to develop an animal model to study the mechanisms of tissue and microvascular injury associated with ACS at the microscopic level.

Methods: Wister rats were randomized into either a control (5) or an experimental group subjected to ACS (9). Abdominal compartment syndrome was established with CO₂ insufflation at 20 mm Hg for 2 hours. Hepatic volumetric flow, the inflammatory response and cell death were quantified in exteriorized livers. Respiratory and renal dysfunction was also assessed biochemically and morphologically. **Results:** The percentage of continuously perfused sinusoids was found to be significantly lower in the ACS group ($81.4 \pm 2.4\%$ v. $99.6\% \pm 0.50$), with an increase in nonperfused and intermittently perfused sinusoids in the ACS group ($p = 0.002$). The number of rolling and adherent leukocytes identified in postsinusoidal venules (PSV) was found to be significantly higher, with an 18-fold increase in the ACS group (18.03 ± 3.6 v. 1.2 ± 1.6 , $p = 0.04$). Furthermore, there was a 7-fold increase in cell death in the ACS group. A significant increase in BUN levels in experimental rats was also observed. **Conclusion:** We have successfully developed a model of ACS with documented evidence of renal and respiratory dysfunction. Furthermore, we have microscopy-confirmed evidence of early inflammatory changes and perfusion deficits in the liver, with a concomitant increase in cell death in the ACS group.

Clinical efficacy of routine repeat head computed tomography in pediatric traumatic brain injury. B. Joseph, I. Ibrahim-Zada, V. Pandit, A. Tang, T. O'Keeffe, J. Wynne, L. Gries, R. Friese, P. Rhee. From The University of Arizona, Tucson, Ariz.

Background: Opinion is divided on the role of routine repeat head computed tomography (RHCT) for guiding clinical management in pediatric patients with blunt head trauma. The aim of this study was to identify the clinical efficacy of routine RHCT in pediatric patients. We hypothesize that routine RHCT does not lead to change in management in mild and moderate traumatic brain injury (TBI). **Methods:** We performed a retrospective analysis of all blunt traumatic brain injury patients of age 18 or younger with an intracranial hemorrhage on initial head CT. Indications for RHCT (routine v. neurologic change) and their findings (radiographic progression or improvement) were recorded. Primary outcome was change in management after RHCT. **Results:** A total of 291 pediatric patients was identified, of whom 191 received an RHCT. Of the patients who received a routine RHCT ($n = 184$), radiographic progression was seen in 18% ($n = 34$) patients, with subsequent interventions in 3 patients (craniotomy, $n = 1$; extraventricular drain, $n = 2$). All these 3 patients had a Glasgow Coma Scale (GCS) score less than 8 at the time of admission. In patients who received RHCT due to neurologic decline ($n = 7$), radiographic progression was seen in 85% ($n = 6$) patients, with subsequent neurosurgical interventions in 3 patients (craniotomy, $n = 2$; intracranial pressure monitor, $n = 1$). Two of these patients had a GCS score less than 8 on admission. **Conclusion:** Pediatric trauma patients with blood on initial head CT should undergo RHCT after neurologic deterioration irrespective of the presenting GCS score. In the absence of neurologic deterioration, RHCT does not alter patient

management in pediatric patients with mild or moderate traumatic brain injury.

Early warning scores (EWS) in trauma: assessing the “effectiveness” of interventions by a rural ground transport service in the interior of British Columbia. *L. Takeuchi.* From McMaster University, Hamilton, Ont.

Background: There are limited acute care services and medical personnel in rural communities. Long distances to tertiary hospitals in context of mountainous terrain, severe weather and flight restrictions makes transport extremely challenging in the southern interior of BC. The Interior Health Authority (IHA) has established 4 ground-based High Acuity Response Teams (HARTs). The HARTs consist of a critical care registered nurse, plus a respiratory therapist as required. A transport physician provides medical oversight. The HARTs perform interfacility transport of trauma patients to tertiary care; but does HART make a difference to trauma patient outcome? **Methods:** A “pilot” study was initiated to collect physiologic data elements for calculation of a composite EWS at time of first assessment and serially (every 15 minutes) in response to HART interventions **Results:** Variability of EWS response spans 2 values over a 30-minute time interval following HART interventions, and is similar to variability of other “stressors” associated with the movement of patients in the transport environment. **Conclusion:** The EWS has the potential to quantify the “effectiveness” of interventions in traumatized patients. Further methodologically rigorous research needs to compare EWS in HART trauma patients requiring interfacility transport to first-responder air evacuation trauma patients.

Accuracy of trauma patient transfer documentation in BC. *N. Bradley, M. Hameed, R. Simons, T. Taulu, H. Wong.* From the Vancouver General Hospital, Vancouver, BC

Background: Vancouver General Hospital (VGH) is the only adult level 1 trauma centre in British Columbia. Each year, 200–300 major trauma cases require transfer to VGH for definitive care. Currently, there is no standardized process or documentation required for patient transfers. Lack of standardized handover processes has been linked to adverse events. **Methods:** Accuracy of documentation was quantified using a 2-prong approach. A survey was administered to trauma surgery and emergency medicine physicians, residents and nurses at a level 1 trauma centre to assess subjective perceptions of documentation. A retrospective chart audit was conducted for all trauma patients with an Injury Severity Score of 16 or greater transferred to VGH from April 2012 to March 2011 to objectively determine gaps in transfer documentation. **Results:** Overall, summary documentation for transfer patients within BC was suboptimal. Receiving physicians reported dissatisfaction with ease of access to key information in transfer documents. Chart audit revealed significant gaps in transfer of critical data elements from sending to receiving facilities. **Conclusion:** The current process for transfer of major trauma patients in BC is inefficient, incomplete and may contribute to adverse events. A standardized trauma transfer protocol or checklist may improve patient safety.

Postoperative echocardiogram after penetrating cardiac injuries: a retrospective study. *B. Al Bader, A. Saleem,*

M. Azzam, K. Boulva, T. Razek, K. Khwaja, D. Mulder, D. Deckelbaum, P. Fata. From the McGill University Health Centre, Montréal, Que.

Background: Penetrating cardiac injuries are rare and are associated with significant morbidity and mortality. Currently, there are no guidelines on the use of postoperative echocardiogram to detect occult cardiac injuries in survivors. Our goal was to evaluate the need for routine postoperative echocardiogram following penetrating cardiac trauma. **Methods:** Penetrating cardiac injuries were retrospectively identified using the Montreal General Hospital’s trauma registry from January 2005 to November 2012. Data were collected from the trauma registry, electronic medical records and chart review. **Results:** We identified 34 patients who sustained penetrating cardiac injuries from 25 (74%) stab wounds and 7 (21%) gunshot wounds. Their mean age was 39 (SD 17.43) years, 97% were male and mean Injury Severity Score (ISS) was 39 (SD 24.26). Of these patients, 22 (65%) survived; their mean ISS was 36 (SD 22.85). The right ventricle was most commonly injured (73%), followed by the left ventricle (18%). Postoperatively, 73% of the survivors had an echocardiogram. The time to postoperative echocardiogram was variable, with a mean of 58 (range 1–550) days. Postoperative echocardiogram findings included wall motion abnormalities (50%), pericardial effusions (25%), ventricular septal defects (18%) and septal wall aneurysm (6%). Echocardiogram was repeated in 11 (68.7%) patients, with a follow-up echocardiogram a mean of 1 year after the initial injury. None of these patients underwent further surgical or angiographic intervention for these abnormalities. **Conclusion:** Postoperative echocardiogram detected significant abnormalities after penetrating cardiac trauma. Prospective studies with long-term follow-up are needed to determine their clinical impact on patient outcome.

Loss to follow-up in trauma studies comparing operative methods: a systematic review. *B. Kidane,* M. Plourde,* S. Chadi,* T. Forbes,† N. Parry.†* From the *University of Western Ontario and the †London Health Sciences Centre, London, Ont.

Background: The objective of this systematic review was to assess the extent of loss to follow-up (LTFU), reporting of LTFU and methods employed to deal with LTFU in studies of adult trauma patients comparing 2 operative methods as treatment for thoraco-abdominal trauma. **Methods:** We conducted a systematic review of published randomized and nonrandomized studies. **Results:** After screening 4993 eligible papers, 42 studies were included for synthesis (weighted kappa = 0.72). Most studies (78.6%) used a retrospective cohort design and dealt with comparison between endovascular and open repair for blunt thoracic aortic injury (59.5%) or between primary repair/anastomosis and stoma for colon injury (38.1%). Among all studies, the median LTFU at 1 year was 50% and 22.1% for experimental and control groups, respectively. Not having a surgical/interventional specialist as a first or senior author was associated with 24.9% higher LTFU at 1 year ($p < 0.006$). Nearly half (20 of 42) of the included studies only looked at in-hospital outcomes. Only 28.6% of studies explicitly reported on LTFU data. Only 4 studies explicitly described the method of dealing with LTFU; 3 studies employed survival analysis, while 1 study queried a national social

security death index. Sensitivity analyses employing plausible worst-case LTFU scenarios resulted in 12%–54% of studies changing direction of effect (most commonly, changing from null effect to favouring control). **Conclusion:** There is considerable LTFU in trauma studies comparing operative methods. Loss to follow-up is generally poorly reported and handled. Sensitivity analyses suggest that outcomes are very sensitive to differential LTFU. This has serious implications for the evidence-based choice of operative method.

What matters where and to whom: a survey of experts on the Canadian pediatric trauma system. A. Harrington. From York University, Toronto, Ont.

Background: To date, research has suggested that pediatric trauma systems are associated with a reduction in preventable deaths. However, while there are current guidelines and recommendations for pediatric trauma systems, there has been little done in the way of evaluation of the necessary components and the impact the components have on trauma system functioning.

Methods: In order to assess the components of a trauma system, a survey tool was developed. The survey was designed to attain 2 goals, first, is the regional trauma system using the identified best practices, and second, do experts feel that best practice is important or key in the functioning of their regional trauma system? A qualitative literature search was performed to develop thematic topics discussed in the literature as it pertains to key parts of a functioning trauma system. From there, questions regarding transportation of injured children, prehospital care, trauma system organization, trauma centre accreditation and injury surveillance were developed. Snowball sampling is being used to recruit experts to participate in the e-survey. **Results:** The survey is currently collecting data. **Conclusion:** This study will provide the first assessment of identified best practices as they relate to pediatric trauma systems and injury prevention. This will provide policy-makers with the information needed to understand how the components of their pediatric trauma system align with best practices, and what gaps exist. Additionally, it will provide a way to link system components to the outcomes of injured Canadian children.

A quality initiative to enhance pain management for trauma patients: baseline attitudes of practitioners. K. Nixon, G. Martin, K. Gaunt, G. Bandiera, M. Bawazeer, D. MacKinnon, N. Ahmed, J. Spence. From St. Michael's Hospital, Toronto, Ont.

Background: The literature suggests that treatment of pain for traumatic injuries lags behind best practices. However, there are few recommendations to improve patient care and satisfaction.

Methods: An interprofessional team including emergency and trauma physicians, nursing practice leaders, pharmacists and acute pain experts developed a registered nurse (RN)-initiated pain management protocol for an urban, academic, level 1 trauma centre (annual approximate volume 1100). The preimplementation phase assessed MD and RN attitudes through a 42-question survey. **Results:** In all, 124 surveys were received (86% response rate). Respondents estimated only 50% of patients received satisfactory relief, which was attributed to inadequate prescribing (66.1%) rather than inadequate administration (25.8%). Re-

spondents felt that 30% of patients underreported and 23.4% over-reported symptoms. Of respondents, 75.8% stated analgesia was an equal priority with clinical care, 30.9% felt that pain management should sufficiently allow patient function, 25.2% as much as possible and 30.1% to meet patient's pain goal. Respondents rated level of agreement with the following statements regarding barriers to pain management: high workload/acuity 86.3%, awaiting diagnostics/treatment 75%, inadequate pain assessment 67.7%, reluctance to prescribe 64.5%. Only 30% cited patient reluctance. Fear of opioid addiction (11.4%) and avoidance of side effects (24.4%) did not appear to adversely impact attitudes toward pain management. **Conclusion:** Baseline medical staff surveys acknowledge inadequate acute pain management despite it being a clinical priority. Significant barriers identified include inadequate prescribing and pain assessment techniques, high workload and patient acuity. The study identified a need for knowledge translation among practitioners about the goals of pain relief in acute trauma.

Comparison of rotational thromboelastometry (ROTEM) values in massive and nonmassive transfusion patients. P. Veigas, A. Sankarankutty, B. Nascimento, S. Rizoli. From the Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: Identifying which trauma patients are coagulopathic during initial resuscitation may improve survival. Early diagnosis of coagulopathy is difficult due to limitations of conventional coagulation tests (CCT). Viscoelastic analyzers like ROTEM are superior to CCT in diagnosing and managing coagulopathy in trauma. We hypothesized that ROTEM could identify severely injured patients requiring massive transfusion (MT).

Methods: We analyzed all trauma patients admitted to a level 1 trauma centre over a 13-month period (June 2011 to July 2012). ROTEM analyses, EXTEM (extrinsic pathway) and FIBTEM (fibrinogen) were performed immediately upon arrival to hospital. Massive transfusion was the transfusion of 10 or more units of red blood cells within 24 hours of admission. Management of coagulopathy was at the discretion of the attending physicians. **Results:** In all, 1144 patients (73.77% male; mean age 38, SD 18.45 yr) were admitted to Sunnybrook over 13 months. Of these, 24 (2.09%) received MT. Mean Injury Severity Score in the MT group was 40.78 ± 17.10 versus 20.07 ± 13.77 in non-MT group. ROTEM was performed in 12 MT and 628 non-MT patients. We observed prolonged EXTEM clotting time ($99 \text{ s} \pm 50.04 \text{ s}$, $p < 0.0001$), clot formation time ($228.66 \text{ s} \pm 159.6 \text{ s}$, $p < 0.0004$), reduced maximum clot firmness ($40.84 \text{ mm} \pm 14.05 \text{ mm}$, $p < 0.0001$) and clot amplitude at 5, 10, 15 and 25 minutes in the MT group compared with the non-MT group. Similar findings were observed in the FIBTEM test for clot amplitude and maximum clot firmness, indicating a global failure of hemostasis, which was not observed in the non-MT group. **Conclusion:** ROTEM diagnosed a global failure of hemostasis in patients who subsequently required MT, suggesting that ROTEM is able to identify these patients early and is useful for the treating clinician.

Mild traumatic brain injury defined by GCS: Is it really mild? B. Joseph, I. Ibrahim-Zada, H. Aziz, A. Tang, R. Friese, J. Wynne, T. O'keeffe, G. Vercruysse, N. Kulvatunyou, P. Rhee. From the The University of Arizona, Tucson, Ariz.

Background: Conventionally, a Glasgow Coma Scale (GCS) score of 13–15 defines mild traumatic brain injury (mTBI). The large spectrum of clinical and radiological findings in these patients, however, leads to poor specificity of this definition. The aim of our study is to identify the high-risk clinical variables that predict neurosurgical intervention (NSI) in patients categorized as mTBI. **Methods:** A retrospective chart review of all patients with mTBI who presented to our level 1 trauma centre was performed. Patients with isolated head injury and intracranial hemorrhage on initial head CT were included. Multiple regression analysis was performed to identify the predictors of NSI in patients with mTBI. **Results:** A total of 1300 patients with blunt TBI were identified, of whom 568 met the inclusion criteria: 66% were male, mean age was 52.5 ± 21.9 years, the median GCS was 15 (14–15), and the median head Abbreviated Injury Scale score was 2 (1–3). Neurosurgical intervention was performed in 32 patients; 46% of these patients had a GCS score of 15 on admission. Neurosurgical intervention was 10 times more likely in patients with displaced skull fracture, 21 times more likely in patients with a base deficit greater than 4, 7 times more likely in patients with progression of the injury on repeat head CT and 3 times more likely in patients with a subdural or epidural hematoma of 10 mm or greater. Abnormal lactate level was not predictive of NSI in mTBI patients ($p = 0.2$). **Conclusion:** The GCS score in mild TBI has limited predictive value for neurosurgical intervention. Base deficit and progression on repeat head CT are the greatest predictors for neurosurgical intervention. A normal GCS score should not be used to gauge injury severity in patients with mTBI.

The CMAC videolaryngoscope is superior to the glidescope for the intubation of trauma patients: a prospective analysis. *T. O’Keeffe, J. Sakles, J. Mosier, J. Wynne, N. Kulvatunyou, A. Tang, B. Joseph, P. Rhee.* From The University of Arizona, Tucson, Ariz.

Background: We have previously shown that videolaryngoscopy (VL) is superior to direct laryngoscopy (DL) in trauma patients. However, there are different types of VL, and it is not known if these are all equal. We hypothesized that the success rate of primary intubation depends on the type of VL used. **Methods:** Data were prospectively collected on trauma patients intubated in an academic level 1 trauma centre over 3 years. We compared the CMAC videolaryngoscope to the GlideScope (GVL), including different versions of the GVL. Primary outcome was successful tracheal intubation on the first attempt. Secondary outcomes included success on subsequent attempts. The χ^2 test or analysis of variance was used to explore differences between groups. **Results:** In all, 580 patients met inclusion criteria: DL was performed in 239 patients (41%) and VL in 341 patients (59%). There were no significant demographic or injury differences between groups. Successful primary intubation was higher for CMAC compared with DL (94.3% v. 84.1%, $p = 0.01$). Secondary success rates were also higher using the CMAC device (86.7% v. 44.7%, $p < 0.01$) and in patients with cervical spine immobilization (95.5% v. 82.6%, $p = 0.02$). The GVL did not outperform DL (87.0% v. 84.1%, $p = 0.4$); however, different GVL devices performed better than others (Standard GVL 86.9% v. Cobalt GVL 46.2%). **Conclusion:** Our data suggest that the CMAC videolaryngoscope is more effective than the GlideScope. Because

it has a Macintosh blade, CMAC can be used as either a direct or video laryngoscope; thus, it offers significant advantages, both from a clinical standpoint and for training.

Injury patterns and outcome of urban versus suburban major trauma. *D. Bracco, K. Khwaja, P. Fata, D. Deckelbaum, T. Razek.* From McGill University, Montréal, Que.

Background: The usual concept of tertiary urban hospital versus rural local hospital is challenged by the presence of numerous local urban hospitals and the expanding urban centres, with suburban local hospitals serving a growing peripheral population. The objective of the present investigation is to compare the pattern of injury, severity and outcome between patients admitted directly to the urban tertiary trauma centre, the urban versus suburban local hospital in a setting without regionalized rotor wing trauma retrieval system. **Methods:** The data from the provincial trauma registry were merged with the internal database. Patients admitted from fiscal year 2008 to 2010 with an Injury Severity Score (ISS) higher than 12 were reviewed. Patients were stratified as primary, secondary urban and secondary suburban, excluding rural hospitals. Multivariate models were constructed to predict mortality and length of stay (LOS), including patient provenance. **Results:** A total of 1051 primary admissions, and 485 transfers from inner city local hospitals and 380 from suburban hospitals were reviewed. Suburban patients were comparable to primary patients in terms of age (50 v. 48), ISS (24 v. 26), New Injury Severity Scores (33 v. 34) and LOS (9.6 v. 9.9 d). Crude mortality was 16% in suburban patients versus 11% in primary admitted patients. After correction for sex, age and ISS, suburban patients had a 48% (95% CI 40%–57%) increased risk of mortality. Suburban patients spend a median 2 hours and 40 minutes in the suburban hospital and an additional 46 minutes on the road. **Conclusion:** The suburban population has a specific injury pattern and is at increased risk of mortality. This requires specific networking and transport channels.

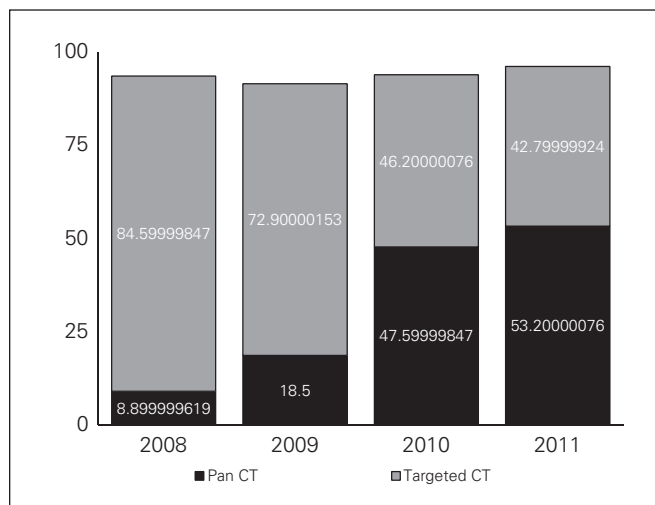
A cost-effective, readily accessible technique for progressive abdominal closure. *J. Rezende-Neto, P. Dias, H. Issa, R. Fortuna, T. Sousa, E. Abreu.* From the Federal University of Minas Gerais, Belo Horizonte, Brazil

Background: High costs and inaccessibility have hampered more widespread use of several commercially available abdominal closure products. We describe a readily accessible and cost-effective technique for abdominal closure. **Methods:** Initially, an open intravenous (IV) bag is inserted between the bowel and the abdominal wall for protection; the skin edges are also protected with hydrocolloid. Next, a series of 12 full-thickness puncture holes are made alongside the abdominal incision (4 cm apart). Three IV tubing (1m long) are inserted through the puncture holes; each tubing is passed through 2 holes on each side of the wound, forming a “U” across the abdominal incision. To protect the skin from pressure sores, the IV tubing is anchored to a latex surgical tubing (1/16” IDx1/32” wall) at each puncture hole site. Two ends of each tubing are passed through the IV roller clamp (1 per tubing), thus securing progressive mobilization of the abdominal wall toward the midline. When the facial edges are approximated to at least 1.5 cm, the IV bag is removed, and closure of the abdominal incision is attempted. The total cost of the

material used is approximately US\$5. **Results:** This method has been used in 3 patients thus far. Total facial closure was obtained in 1 case at 12 days. A 90% facial closure was achieved in the other patients. **Conclusion:** Even though the study cohort is small, facial closure can be effectively achieved at low cost with the technique described herein.

Evolution and impact of the use of pan-CT scan in a tertiary urban trauma centre: a 4-year audit. M. Azzam, D. Bracco, K. Khwaja, P. Fata, D. Deckelbaum, T. Razek. From McGill University Health Centre, Montréal, Que.

Background: Pan-CT has emerged as the standard of care in numerous trauma systems, and several studies mostly using a “pre and post” design observed an improvement in outcome. The objective of the present retrospective investigation is to observe the pattern of CT scan use over 4 years in all trauma patients admitted to a level 1 trauma centre. **Methods:** The provincial trauma database and our internal data set were merged, and 4 consecutive years were evaluated. All CT scans performed within 4 hours of admission were considered as done during initial evaluation. Patients were stratified as having no CT scan, having a pan-CT if head, neck/cervical spine, chest and abdomen/pelvis was done and having targeted CT if only components of these scans were done. Primary outcome was hospital mortality. **Results:** A total of 988 out of 2959 patients had pan-CT. The odds of receiving a CT head scan increased by 1.57, the chest by 1.48 and cervical spine by 20.5. The pan-CT rate increased from 8.9% to 53.2% (Figure). The rate of negative CT was highest for



the cervical spine and lowest for head. Increase in incidence of CT was associated with a decrease in catchment rate. When including Injury Severity Score or New Injury Severity Score and age, pan-CT had no impact on outcome. **Conclusion:** The proportion of patients receiving a pan-CT has increased dramatically at our institution, with an associated decrease in rate of positive findings. Pan-CT has no effect on outcome.

Additional and repeated CT scan in interfacilities trauma transfers: room for standardization. Y. Lin, D. Bracco, K. Khwaja, P. Fata, D. Deckelbaum, T. Razek. From the McGill University Health Centre, Montréal, Que.

Background: Despite Advanced Trauma Life Support recommendations, patients often receive advanced imaging modalities in local hospitals before being transferred to a level 1 facility. The problem of repeat CT scanning due to technical and CT scan protocol issues is ongoing. The objective of the present study is to measure the importance of repeat scanning and the incidence of scanning involving other body regions. **Methods:** All secondary transfers to our level 1 facility having a CT scan performed in the local hospital whose images were available in the level 1 trauma centre PACS system over 3 years were reviewed. Patients were considered having a repeat scan if the same body region or an additional scan if another body region was scanned as a part of the initial assessment. **Results:** Over 3 years, 1890 patients were received from local hospitals; 231 (12%) received 337 CT scan examinations in local hospitals. Patients being scanned in local hospitals were sicker (Injury Severity Score 25 v. 14), required intensive care unit admission more frequently (38% v. 29%) and more mechanical ventilation (32% v. 25%). A total of 40% of patients receiving a scan in a local hospital needed the same body part scanned, and 70% of them required another body part to be imaged. **Conclusion:** Repeat and additional images can be improved by standardizing the scanning protocols across a trauma system and changing the approach of local hospital doctors when they send a patient to CT scan from “finding an injury which needs level 1 trauma centre” to “not missing any injuries.”

Pediatric trauma in situ simulation facilitates identification and resolution of system issues. K. Bailey,* D. Norman,* J. Li,† J. Pemberton.† From *McMaster Children’s Hospital and †McMaster University, Hamilton, Ont.

Background: Trauma is one of the leading causes of pediatric disability and death in Canada. Serial pediatric trauma in situ simulations were performed in the McMaster Children’s Hospital emergency department (ED), a low-volume centre with multidisciplinary ad hoc teams, from 2011 to 2012, in attempts to improve the quality of trauma care. The objective of this study is to review the participant evaluations of 10 simulation sessions and the resulting system changes. **Methods:** Evaluation forms were distributed to participants and observers of the simulated trauma, asking for what was learned, liked and what should be changed. The comments on the form were collated and analyzed. Changes to the system made in response to the evaluations were reviewed. **Results:** A total of 119 evaluation forms were completed voluntarily by participants and observers during 10 simulations (mean 12 per session, range 9–16). Feedback was obtained with regards to trauma team dynamics, education needs and system issues. Changes made to the system in response to the feedback included but are not limited to: improved communication processes, documentation processes, defining roles and responsibilities, the relocation and acquisition of equipment in the emergency room, reorganization of the trauma bay, and identifying smocks for team members. **Conclusion:** Pediatric trauma in situ simulations are valuable in helping identify and resolve system issues. They also provide an excellent opportunity for an “ad hoc” multidisciplinary team to rehearse trauma care, which promotes continuous quality improvement.

Hospital code orange plan: there’s an app for that. D. Bracco, J. Al-Oweis, K. Khwaja, P. Fata, D. Deckelbaum, T. Razek. From McGill University, Montréal, Que.

Background: Hospital disaster response plans (code orange plans) are usually rolled out as binders/boxes in the care units. Maintenance, upgrade and distribution of the numerous code orange binders across a hospital is costly and resource-consuming. Most healthcare workers have smartphone or similar devices. **Methods:** The deliverable has to be a complete set of job action sheets for codes green and orange on an entire hospital and be easily accessible, downloadable and upgradable. There must be no deployment fees. Health care givers must be able to access this information while in the hospital or out of the hospital. The information must be available even if power, Internet, hospital web servers and cellular networks are down. **Results:** At the execution level, code orange plans are a set of job action sheets

that include a series of tasks to be done. We designed a vertical application, which can be deployed on Windows, Mac and iOS (iPad, iPhone and iPod touch) platforms, using a single source code. All engine and job action sheets are in a single file. The app (see Figure) allows the user to select the appropriate job action sheet and tick item per item when the tasks are completed.

Conclusion: The iOS application developed allows distribution of code orange and green plans and their job action sheets rapidly, allows access to them anywhere, anytime, and allows follow-up of tasks while running the code.

Diaphragmatic rupture from blunt trauma: an NTDB study. *N. Nash,* O. Albuz,* E. Karamanos,* K. Vogt,* O. Okoye,* P. Talving,* K. Inaba,* D. Demetriades.** From the *University of Southern California and †LA County and USC, Los Angeles, Calif.

Background: This study was undertaken to identify the incidence of diaphragm injuries in patients incurring blunt trauma, and the effects of mechanism of injury on the risk of diaphragm injury. Further, we wished to assess the incidence and unique risk factors for isolated diaphragm injury. **Methods:** This retrospective cohort study used the National Trauma Databank from 2002 to 2010. The rates of diaphragm injury in patients after blunt injury were identified. Isolated diaphragm injury was considered in patients with a chest and abdomen injury score of less than 3. Regression analyses identified the independent effect of injury mechanism and vehicle position on the risk of diaphragm injury, as well as predictors of isolated diaphragm injury. **Results:** A total of 2 472 699 patients incurring blunt trauma were registered in the National Trauma Databank over the study period, of whom 5551 (0.2%) had a diaphragm injury. The highest rate occurred after motor vehicle collisions (MVCs; 0.4%) and the lowest after falls (0.03%). After an MVC, drivers had a 7 times increased odds of diaphragm injury compared with passengers (OR 7.04, 95% CI 6.21, 7.94). Isolated diaphragm injury occurred in 758 patients (13%), and only increasing age (OR 1.02, 95% CI 1.01–1.03) is an independent risk factor. **Conclusion:** Rupture of the diaphragm is rare after blunt trauma. The highest risk occurs with patients involved in MVCs, particularly if in the driver's seat. Beyond injury severity, no clinically significant predictors were identified for blunt diaphragm injury contributing to its diagnostic difficulty.

Early closure of open abdomen using component separation technique. *M. Alhabboubi, M. Elhusseini, M. Sudarshan, D. Deckelbaum, P. Fata, T. Razek, K. Khwaja.* From McGill University, Montréal, Que.

Background: Achieving primary fascial closure (PFC) in patients with open abdomen (OA) secondary to damage control procedures is challenging, and the optimal management is controversial. Component separation (CS) technique is usually used 6–12 months after discharge to close the fascia. Its use for early closure is not well studied. We present our experience on using CS for early closure. **Methods:** Retrospective chart review included 31 patients with OAs at a level 1 trauma centre between January 2010 and September 2011. Additionally, we identified 18 patients prospectively from September 2011 to July 2012, making a total of 49 patients. Variables collected included: demographics, vital signs

The screenshot shows a mobile application interface for hospital disaster response plans (code orange). The interface is divided into several sections:

- Job sheets:** A search bar contains the word "Orange". Below it, it says "Showing 2" and "Show All My". There are two items listed: "Orange Surgical" with a checked box and "Anesthetist in charge MGH" with a right arrow, and "Orange Surgical" with an unchecked box and "Respiratory therapist in" with a right arrow.
- Job Action Sheet Detail:** A section with a back arrow and the title "Job Action Sheet Detail". It shows "Orange" and "Surgical" in a dropdown menu, and "Anesthetist in charge MGH" in a text field.
- Tasks (6):** A section with a "Show All To do" link. It lists six tasks, each with a checkbox and a right arrow:
 - 1 Report to chief of code Orange operation
 - 2 Organize the operating care of trauma patients
 - 3 Alert OR nurse in charge
 - 4 Alert PACU nurse in charge
 - 5 Alert RT in charge OR
 - 6 Call your second call in
- Report to:** A section with a checkbox and a right arrow.
- Mission:** A section with a checkbox and a right arrow.
- Priority:** A section with a list of tasks numbered 1 to 6, each with a checkbox and a right arrow.

and laboratory values, APACHE II, Injury Severity Scores, fluid balance and complications. Clinic follow-up notes were reviewed to identify CS patients who developed hernia after discharge. **Results:** The PFC rate was 32.6%, CS 36.7% and planned ventral hernia (PVH) 31%. Of the patients who had CS, 2 (11.1%) were reopened and discharged with PVH and 2 died in hospital (11.1%). We were able to achieve partial fascial closure in 2 patients (11.1%). Median duration of follow-up for discharged CS patients who achieved full closure was 88 days (32–372). One patient developed a hernia. Length of intensive care unit and hospital stay and complication rates were similar between the PFC and fully closed CS patients. **Conclusion:** Early use of CS is a safe alternative in cases where PFC is unattainable. Further investigation is needed to determine the long-term results of using this technique.

Surgical fixation versus nonoperative management of flail chest: a meta-analysis. *G. Slobogean,* C. MacPherson,* T. Sun,* M. Pelletier,* M. Hameed.†* From the *University of British Columbia and †Vancouver General Hospital, Vancouver, BC

Background: Flail chest is a life-threatening injury typically treated with supportive ventilation and analgesia. Several small studies have suggested large improvements in critical care outcomes after surgical fixation of multiple rib fractures. The purpose of this study was to compare the results of surgical fixation and nonoperative management of flail chest injuries. **Methods:** A systematic review of previously published studies comparing operative and nonoperative management of flail chest was performed. No language or date restrictions were applied. Quantitative pooling was performed using a random effects model for relevant critical care outcomes. Sensitivity analysis was performed for all outcomes. **Results:** Eleven manuscripts with 753 participants met inclusion criteria. Two studies had randomized control designs. Surgical fixation resulted in better outcomes for all pooled analyses, including substantial decreases in ventilator days (mean 8 d, 95% CI 5–10 d) and the odds of developing pneumonia (OR 0.18, 95% CI 0.11–0.32). Additional benefits included decreased intensive care unit days (mean 5 d, 95% CI 2–8 d), mortality (OR 0.31, 95% CI 0.20–0.48), septicemia (OR 0.36, 95% CI 0.19–0.71), tracheostomy (OR 0.06, 95% CI 0.02–0.20) and chest deformity (OR 0.11, 95% CI 0.02–0.60). All results were stable to basic sensitivity analysis. **Conclusion:** The results of this meta-analysis suggest surgical fixation results in substantial critical care benefits; however, the analyses are based on the pooling of primarily small retrospective studies. Additional prospective randomized trials are still necessary.

Integration of intraoperative angiography as part of damage control surgery in major trauma. *J. Spicer,* M. Abou Khalil,* M. Azzam,† D. Valenti,† P. Fata,* D. Deckelbaum,† T. Razek.** From *McGill University and the †McGill University Health Centre, Montréal, Que.

Background: Early hemorrhage control is necessary to optimize survival in trauma. Multicavitary trauma with simultaneously bleeding sites may require multimodality approaches. This is the first series to report use of intraoperative angiography (IOA) as a strategy to expedite hemorrhage control. **Methods:** A prospect-

ive trauma registry was accessed (July 2011 to present). Cases where IOA was used were selected. A hemorrhage control team was formally structured so that IOA could be performed. Patient data were collected at critical time points during the trauma resuscitation and analyzed. **Results:** Six patients underwent combined surgery and IOA. Five patients had major blunt thoracoabdominal trauma and 1 an intractable upper gastrointestinal bleed with a hostile open abdomen. Among trauma patients, mean age was 26 years, median Injury Severity Score was 43 (range 41–57), time from arrival to the trauma bay to incision in the operating room was 83 minutes (range 41–208) and 210 minutes (range 105–260) to the beginning of angiography. Two patients died in the operating room. Three were transferred to the intensive care unit after a mean total time of 308 minutes (SD 69), 2 of whom went on to discharge from hospital. The patient with upper gastrointestinal bleed had control of hemorrhage by aortic compression with simultaneous angioembolization of a large pseudoaneurysm of the gastroduodenal artery and was discharged 1 month later. **Conclusion:** A multimodality approach to hemorrhage control with IOA is feasible in a basic operating theatre setup in the hands of an experienced hemorrhage control team.

Mass casualty preparedness of regional trauma systems: recommendations for an evaluative framework. *B. Heidary, R. Brown, R. Simons, D. Evans, M. Hameed.* From the Vancouver General Hospital, Vancouver, BC

Background: Numerous natural and human circumstances have left society vulnerable to the overwhelming effects of mass casualty incidents (MCIs). In Canada, there have been 31 MCIs since 1980, making disaster preparedness a public health priority. However, despite the urgency of this problem, an evaluative framework for Canadian trauma systems' disaster preparedness has not been uniformly implemented. A recent study reviewed Canadian MCI events and outlined 6 major priority areas for preparedness. This study makes recommendations for a framework for assessment of Canadian trauma systems' disaster readiness. **Methods:** We conducted a scoping review of literature to identify previous worldwide MCI experiences and available resources for trauma centre MCI response. Key components of MCI response were reviewed, and recommendations were derived from the review. **Results:** Mass casualty incident preparedness priorities were categorized in following areas: leadership, hazard planning, communication, sustainability of peak operations, education and inter-agency cooperation. A total of 100 studies were identified, ranging from expert opinion ($n = 39$), to reviews of specific events ($n = 22$), to collective reviews of multiple MCIs ($n = 15$), to papers studying simulations/models or surveys conducted, to trauma centres ($n = 24$). Although no high-level evidence was identified to make evidence-based recommendations, the literature contains a wealth of experience in each priority area and has the potential to identify gaps in the preparedness of regional trauma systems. **Conclusion:** We suggest that an evidence- and expert-based evaluative framework based on the above literature and integrated into Trauma Association of Canada accreditation guidelines can define MCI standards and ensure the uniformity of mass casualty preparedness in Canadian regional trauma systems.

Diagnostic peritoneal aspirate: An obsolete diagnostic modality? *E. Joos,* K. Inaba,† K. Vogt,* O. Okoye,†*

R. Gelbard,* D. Moe,* D. Grabo,* D. Demetriades.† From *LA County and USC and the †University of Southern California, Los Angeles, Calif.

Background: In the era of focused assessment with sonography for trauma (FAST), the continued role of traditional diagnostic modalities like diagnostic peritoneal aspirate (DPA) for identification of intraperitoneal hemorrhage is unclear. The purpose of this study was to review the impact of DPA in the era of routine FAST use. **Methods:** This retrospective cohort study assessed all patients presenting to the Los Angeles County and University of Southern California level 1 trauma center who underwent DPA between 2007 and 2011. Injury demographics, hemodynamics, FAST and DPA results, as well as outcomes, were abstracted from the trauma registry and medical record review. **Results:** In all, 51 patients underwent a DPA, which represents 0.17% of the overall trauma population. The rate of DPA decreased from 0.34% in 2007 to 0.09% in 2011 ($p < 0.01$). The majority were blunt trauma (88%), and patients had a mean Injury Severity Score of 29 (SD 12) and a median Glasgow Coma Scale score of 8 (IQR 3–14). The overall mortality rate was 57%. All patients had a negative FAST before DPA, except for 4 patients (13%) in whom it was equivocal. Overall, DPA was positive 21% of the time, and in all cases led to a laparotomy that was therapeutic for hemorrhage. **Conclusion:** In severely injured patients who present with hemodynamic instability and a negative or equivocal FAST, DPA was able to identify patients requiring surgical intervention for hemorrhage control.

Blunt hollow viscus injury: the frequency and consequences of delayed diagnosis in the era of selective non-operative management. **R. Berg, K. Inaba, E. Karamanos, O. Okoye, P. Talving, D. Demetriades.** From the University of Southern California, Los Angeles, Calif.

Background: In blunt trauma patients not undergoing immediate surgery, the signs of hollow viscous injury (HVI) are subtle and timeframe of presentation uncertain. Little is known about the incidence and consequences of delayed diagnosis of blunt HVI. **Methods:** All patients experiencing HVI from January 1996 to December 2011 were reviewed. Patients undergoing early operative management (within 24 h of injury) were compared with those undergoing delayed intervention (≥ 24 h). Independent risk factors for delayed intervention were determined. **Results:** Hollow viscous injury occurred in 395 patients (0.07% of all blunt admissions) over the study period. Immediate (≤ 2 h) operative intervention occurred in 43.8%; a further 45.8% underwent surgery within 24 hours. Delayed operative intervention occurred in 10.4%. Multiple regression determined head injury (Abbreviated Injury Scale score ≥ 2 ; OR 2.26, 95% CI 1.92–5.57, $p = 0.037$), male sex (OR 2.20, 95% CI 1.09–4.64, $p = 0.028$) and high injury severity (Injury Severity Score ≥ 25 ; OR 3.04, 95% CI 1.40–6.61, $p = 0.005$) independently associated with delayed HVI repair. Patients undergoing delayed management had a higher incidence of anastomotic leak (adjusted OR 23.24, 95% CI 5.78–93.52, $p < 0.001$), venous-thromboembolic events (adjusted OR 13.88, 95% CI 1.53–126.28, $p = 0.02$), acute renal failure (adjusted OR 12.81, 95% CI 2.55–64.41, $p = 0.02$) and pneumonia (adjusted OR 4.77, 95% CI 1.04–21.98, $p = 0.045$). Stomas were rare (30 of 395, 7.6%) but nearly twice as frequent in the delayed

intervention group (7.1% v. 12.2%). Mortality did not differ between the groups. **Conclusion:** Delayed intervention occurs in 10% of patients with blunt HVI and is associated with increased systemic and local surgical complications. Better determination of factors predictive of blunt HVI in patients without clear need for emergent surgery is required to establish whether observing patients with equivocal signs is a safe strategy.

Ending “double jeopardy:” the diagnostic impact of cardiac ultrasound and chest radiography on operative sequencing in penetrating thoracoabdominal trauma. **R. Berg, K. Inaba, E. Karamanos, J. Pasley, P. Teixeira, P. Talving, D. Demetriades.** From the University of Southern California, Los Angeles, Calif.

Background: Mis-sequencing of cavitary exploration occurs in up to 40% of patients with concomitant thoracic and abdominal penetrating trauma who require emergent surgery. Combined use of trauma bay chest radiography (CXR) and cardiac ultrasound should facilitate surgical decision-making, but this investigative approach has not been examined. **Methods:** All patients arriving alive with penetrating chest and abdominal injury requiring immediate surgery without CT imaging between January 2006 and December 2011 were reviewed. The group receiving “complete investigation” (CXR and cardiac ultrasound) was compared with the group in which both investigations were not performed. Outcomes included rates of nontherapeutic exploration, operative mis-sequencing and mortality. **Results:** A total of 164 patients met the inclusion criteria. Two-thirds (110 of 164) underwent “complete” investigation. Patients having “complete” and “incomplete” investigation did not differ significantly in demographics, mechanism, admission hemodynamics, specific injury patterns or severity. Incomplete investigation was associated with increased rates of nontherapeutic laparotomy (13% v. 1.8%, $p = 0.006$) and thoracotomy (7.4% v. 0.9%, $p = 0.041$). Operative mis-sequencing occurred in 27% (6 of 22) of those undergoing dual cavitary intervention and was more than twice as frequent in the “incomplete” group (33.3 v. 14.3%, $p = 0.616$). Examined as a composite measure, negative cavitary exploration or operative mis-sequencing was significantly more frequent in the “incomplete” group (27.8% v. 3.6%, $p < 0.001$). The cohort with these outcomes also experienced greater mortality (58.3% v. 11.4%, $p < 0.001$). **Conclusion:** A third of unstable patients do not undergo both investigations despite similar clinical presentations. Incomplete investigation increases overall risk of negative exploration or mis-sequencing with significant effects on mortality.

Are trauma patients with hyperfibrinolysis diagnosed by rotem salvageable? **A. Sankarankutty, S.Y. Fung, I. Alababtain, E. Bmjac, L. Luz, B. Nascimento, S. Rizoli.** From the Sunnybrook Health Sciences Centre, Toronto, Ont.

Background: Acute coagulopathy of trauma is present in 25% of all severely injured patients on admission. Acute coagulopathy of trauma is complex and poorly understood; its most lethal presentation is hyperfibrinolysis (HF). The scarce evidence on HF suggests it occurs in 2%–20% of trauma patients, with a mortality of 55%–100%. In practice, only viscoelastic tests, such as ROTEM, are capable of diagnosing HF. We studied the outcomes of HF

patients diagnosed by ROTEM on admission to a Canadian level 1 trauma centre. **Methods:** Prospectively collected data from all adult trauma patients admitted to Sunnybrook who had ROTEM done on admission, between August 2011 and July 2012, were analyzed. Demographic, vital signs, laboratory, ROTEM, transfusion and outcome data were collected on these patients. **Results:** Of 608 patients with ROTEM on admission, 17 (2.8%) had HF. Age, sex, injury mechanism, blood pressure, hemoglobin and Abbreviated Injury Scale head score were comparable to patients without HF; while international normalized ratio, platelet count and Injury Severity Score were significantly worse. Mortality was 7 times higher (70.6% v. 9.6% without HF), and one-third of the patients were potentially salvageable. In 2 patients, HF was promptly recognized and aggressively treated; 1 survived. **Conclusion:** Hyperfibrinolysis carries a 7 times higher mortality, but most patients are nonsalvageable. Early diagnosis and treatment may reduce mortality.

The risk of cardiac injury after penetrating thoracic trauma: Which is the better predictor, hemodynamic status or pericardial window? *T. Zakrisson,* P. Parikh,† K. Proctor,† M. Murtha,† C. Schulman,† N. Namias.†* From *St. Michael's Hospital, Toronto, Ont., and the †University of Miami, Coral Gables, Fla.

Background: In patients with penetrating thoracic trauma, pericardial focussed assessment with sonography for trauma (pFAST) is typically performed to detect hemopericardium. We hypothesized that a pericardial window (PCW), but not hemodynamic stability, would discriminate cardiac injury in patients with an equivocal pFAST. **Methods:** With institutional review board approval, charts from all patients with penetrating thoracic trauma and equivocal pFAST scans were retrospectively reviewed over 10 years at a level 1 trauma centre. Hemodynamic stability was defined as a heart rate lower than 100 beats/minute and a systolic blood pressure greater than 90 mm Hg. Equivocal pFAST was confirmed by senior housestaff. Sensitivity, specificity and predictive values (positive and negative) were calculated below (Table). **Results:** There were 42 patients with an equivocal

Table.				
	Sensitivity	Specificity	PPV	NPV
Pericardial window	100%	93%	83%	100%
Hemodynamic instability	80%	40%	15%	94%
NPV = negative predictive value; PPV = positive predictive value.				

pFAST, of whom 20 (48%) received a PCW. Hemopericardium was detected in 6 of 20 (30%), and 5 of 6 (83%) had a cardiac injury requiring repair. In 16 (38%) hemodynamically stable patients, the PCW was positive in 1 of 4 (25%), and this led to a successful cardiac repair. There were 0 deaths among these 16. In the 26 (62%) unstable patients, PCW was positive in 5 (31%), and 4 of 5 (80%) had a cardiac injury requiring repair. There were 3 (11%) deaths among these 26. **Conclusion:** In patients with penetrating thoracic trauma, there is a significant risk of cardiac injury, even when hemodynamically stable with an equivocal pFAST. Pericardial window appears to be a useful confirmatory test in these patients, with a higher predictive value than hemodynamic status.

The online Concussion Awareness Training Toolkit for health practitioners (CATT): a new resource for recognizing, treating, and managing concussion. *S. Babul, R. Goldman, I. Pike, P. Korn.* From the Children's and Women's Hospital of British Columbia, Vancouver, BC

Background: The treatment and management of concussion, particularly in sport, is important nationally and internationally, having received enormous attention in recent years. Concussion continues to be an under-recognized, underdiagnosed and under-treated medical condition, requiring both physical and mental treatment. Short- and long-term effects vary among patients and can greatly affect quality of life. Long-term effects are often not recognized early enough to prevent postconcussion syndrome and permanent brain damage, potentially leading to an impact on social and professional lives. **Methods:** The Concussion Awareness Training Toolkit (CATT) is being developed to standardize practice regarding concussion recognition, diagnosis, treatment and management. Based upon established international principles, this online toolkit includes learner-directed online training in concussion; diagnostic tools; links to clinical resources, patient handouts, journal articles, related websites, concussion videos and study cases; and the Zurich Consensus Statement. **Results:** The CATT is undergoing a 2-pronged evaluation, first, to determine if knowledge, attitudes and practices are significantly improved among physicians and nurses following completion of CATT; and second, to determine if patient care at the British Columbia Children's Hospital, Canada, is improved following physician and nurse completion of CATT. **Conclusion:** Good concussion management will potentially reduce related health problems and may decrease the risk of long-term brain damage, potentially lowering total health care costs among these patients. The CATT is currently being rolled out provincially in British Columbia, Canada, to all doctors and nurses. This work is being accomplished in collaboration with Child Health BC and the BC Medical Association, with the ultimate goal of improving patient care throughout the province.

The prevention of concussion and brain injury in child and youth team sports. *S. Lockhart,* C. Flett,† T. Jackson,† J. Keith.‡* From *Parachute Canada, Toronto, and the †Coaching Association of Canada, ‡Hockey Canada and the §Centre for Ethics in Sport, Ottawa, Ont.

Background: The Public Health Agency of Canada has funded ThinkFirst Canada (now a program of Parachute), Hockey Canada, the Coaching Association of Canada and the Canadian Centre for Ethics in Sport until Mar. 31, 2013, to reduce severe concussions in child and youth team sports by creating training and resources for coaches and other stakeholders around the identification, management and return-to-play decision-making. **Methods:** A literature review, web scan, stakeholder scan and public survey were conducted to identify current knowledge, awareness and resources around sport-related concussions. Resources were enhanced/developed for coaches, parents, players, schools and health professionals. These included Smartphone apps, online courses for coaches, online resources, face-to-face educational experiences that detailed the most current information around prevention, identification, management and return-to-play guidelines. All resources are being evaluated, and the

public survey, which had over 7000 responses the first time, will be repeated to identify any changes in awareness or knowledge. **Results:** Resources and training were piloted over the fall and winter and finalized by March 31. Training was implemented coast to coast within a variety of sports and settings. Materials were adapted specifically for Aboriginal audiences and piloted tested in rural/remote areas. Examples will be shared during the presentation. **Conclusion:** Funding from the federal government and a strong partnership between sport and injury-prevention organizations has ensured consistent credible information on concussions is available to Canadians. www.parachutecanada.org/activeandsafe is the hub for this material.

Randomized controlled trial of an early rehabilitation intervention to improve return to work Rates following road trauma. S. Faux. From St. Vincent's Hospital, Melbourne, Australia

Background: In Australia's largest state, New South Wales, there are over 22 000 admissions for road trauma per year, and there is a perceived need to offer rehabilitation to many of these patients. **Methods:** Patients were approached for consent in the emergency department once cleared by their treating team at 4 trauma centres. They were assessed for injury severity (Abbreviated Injury Scale), demographics, employment history, past history and role in accident. They were then stratified and randomized into severe and mild or moderate injuries. All were screened at 2 weeks for return-to-work status, pain, anxiety, disability and depression. Those in the intervention group who were "at risk" of chronic symptoms were offered a rehabilitation consultation, and those in the control group who were at risk were sent a letter to see their GP. Outcomes were measured through phone interview at 3 months for mild/moderate injury and at 6 months for severe injury. Primary outcome measure was return to work or usual activities (for the unemployed), and secondary outcome measures were pain, disability, quality of life, anxiety depression and post-traumatic stress disorder. A cost effective analysis was also done. **Results:** In all, 2002 patient were screened in 4 hospitals, and 184 consented: 161 had full data sets to 6 months, and 70.2% returned to work within 3 months. There were no significant differences between groups in return-to-work rates or any secondary outcome measures. Subanalyses showed that older manual workers without compensation benefitted from being in the intervention group. The cost of the 2 interventions was \$298/patient for rehabilitation and \$54/patient for education. **Conclusion:** This is the first study of its kind in Australia and internationally. While a simple education package can assist over 70% of patients to return to work within 3 months, early rehabilitation interventions may need to be targeted to older, manual workers.

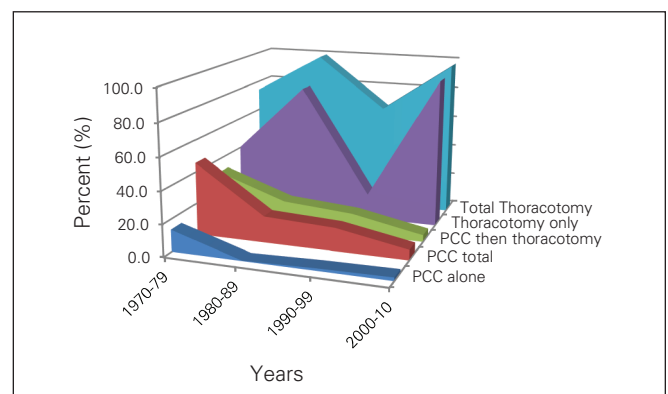
Phone call follow-up. A. Jackson,* T. Joseph,[†] E. Giddins.[‡] From the *Royal North Shore Hospital, the [†]University of Sydney and the [‡]Northern Sydney Central Coast Health, Sydney, Australia

Background: RNSH Sydney, Australia, is a level 1 major trauma service, including burns and spinal statewide services. Multi-trauma patients are admitted under the service bed card. What happens to our trauma patients when they are discharged? Do we

know? Would we like to know their outcomes? **Methods:** To find this information involves a simple telephone follow-up at 72-hour, 1-month and 3-month intervals, with questions and comments at the different times frames, ethics approval obtained, and patients' written consent. **Results:** To date (November 2012), 64 people have been included with similar findings, including ongoing pain issues, fatigue, low moods, anxiety issues and returning to work problematic; 10% showing signs of post-traumatic stress disorder. **Conclusion:** We need to continue this outcome study for another 12–24 months. We need early clinical psychology involvement in the care of trauma patients. We need ongoing psychological follow-up postdischarge from the major trauma service.

Pericardiocentesis in trauma: a systematic review. T. Lee, J.F. Ouellet, M. Cook, M. Schreiber, J. Kortbeek. From the University of Calgary, Calgary, Alta.

Background: Pericardiocentesis (PCC) has been taught in the Advanced Trauma Life Support (ATLS) course as a bridge to definitive surgical therapy for traumatic pericardial tamponade since its inception in 1978. The role of PCC is now described as a temporizing manoeuvre when thoracotomy is not an option. In order to provide the best evidenced-base care to trauma patients, a literature review on the use and effectiveness of PCC in traumatic pericardial tamponade in the modern era is necessary to guide recommendations for future ATLS editions. **Methods:** Scientific publications from 1970 to 2010 involving PCC after trauma were identified using a standardized search strategy. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was employed. Human studies describing acute traumatic tamponade were included. Nontraumatic, subacute and chronic pericardial tamponade publications were excluded. Publications were categorized by level of evidence. **Results:** Of the 135 publications identified, 27 met inclusion criteria, comprising 2094 trauma patients with suspected cardiac tamponade; 29% ($n = 614$) received PCC. Use of PCC decreased from 45.9% of reported cases of traumatic tamponade in 1970–1979 down to 6.4% in 2000–2010 ($p < 0.05$). Between the same periods, use of PCC as a sole intervention decreased from 13.7% to 2.1% ($p < 0.05$; Figure). Survival analysis after PCC was pos-



sible for 380 patients. Overall survival following PCC when used alone or as a bridging intervention was 83.4% ($n = 317$). In patients receiving PCC only, survival was 91.8% ($n = 145$). In patients who received PCC then thoracotomy, survival was 79.5% ($n = 178$).

Conclusion: While studies on the use of pericardiocentesis for trauma are limited, and reports are likely biased toward survivors, the reported survival rate is high, suggesting there exists a specific population of trauma patients who may benefit from PCC. There remains a role for PCC in trauma referral centres, where defini-

tive surgical management is not available and transport times favour temporary decompression. A decision to teach pericardiocentesis should be made based on the frequency of cardiac penetrating trauma occurring in referral hospitals and their distance from the trauma centre.