

ASGBI abstracts 2015

ATMS-Oral Papers

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ATMS Short Paper Session 1

Trauma & Military Surgery (ATMS) 281

Mind the Gap: Surgical Options When Primary Closure is Not Possible Following Damage Control Laparotomy. A Systematic Review

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Aims: A Trauma damage control laparotomy (DCL) entails immediate control of haemorrhage and contamination, laparotomy and physiological stabilisation, then completion of surgery and early primary closure (EPC). Failing early primary closure, temporary abdominal closure (TAC) techniques maintain abdominal integrity until early definitive closure (EDC). The aims were to identify and compare outcomes of early definitive closure methods in these patients.

Methods: NICE, Cochrane, OVID (Medline, AMED, Embase, HMIC) and PubMed databases were accessed using (traum*, damage control, abbreviated laparotomy, component separation, fascial traction, mesh closure, planned ventral hernia (PVH), and topical negative pressure (TNP)). Randomised Controlled Trials, Case Series and Cohort Studies reporting TAC and early definitive closure methods in DCL trauma patients were included. Outcomes were mortality, days to fascial closure, hospital length of stay, abdominal complications and delayed ventral herniation.

Results: 26 studies identified early primary closure (DPC, acute component separation (ACS) and acute mesh repair (AMR)) and TAC methods (Whitman patch (WP), topical negative pressure (TNP), temporary mesh (TM), fascial tension, Bogota bag and skin tension). Estimates for mortality and abdominal complications in AMR and DPC groups were 0.45% and 40.85%, and 6.07%, and 16.74% respectively; AMR ventral hernia / laxity was 51.1% at one year. Days to closure were 6.30, 21.10 and 15.90 in DPC, ACS and AMR groups, whilst hospital LOS in ACS and DPC groups was 17.5 versus 23.3 days.

Conclusions: Acute component separation or mesh repair are alternative early definitive closure techniques to DPC following trauma DCL. Comparing outcomes is hampered by poverty of uniform reporting and bias. Recommendations for standardised reporting nomenclature and methodology are made.

Trauma & Military Surgery (ATMS) 655

Centralisation of Trauma Services within a UK Trauma Network has Shown Changes in Clinical Outcomes at a Major Trauma Centre

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Aims: A major reorganisation of trauma services occurred in the England in 2012. This involved the creation of major trauma networks with a centralized specialist trauma centre, receiving patients from significant geographical distances. This reconfiguration is reviewed with respect to clinical outcomes.

Methods: Data were analysed from a prospectively maintained trauma database from a Major Trauma Centre in Liverpool, UK between November 2011 and June 2014. Primary outcomes included basic demographics, ISS, intervention and mortality rates. Data were compared pre and post centralisation, utilising Fisher's exact test.

Results: The pre-centralised study period was from January 2012 to October 2012 and the post-centralisation period was November 2012 to June 2014. Mean monthly admissions increased significantly 15.7 vs 63.1 (<0.005). There were no significant differences in demographic statistics and GCS levels. There are more patients with an injury severity score > 15 in the pre centralisation group, 58% vs 27% (<0.0001). Less patients required radiological or operative intervention, 28% vs 13% (<0.0001), fewer patients required intensive care, 18% vs 12% (p=0.0569). Similar numbers of patients required neurosurgical transfer, 12% vs 11% (p=0.506). There was a non-significant decrease in mortality rate, 7% vs 5% (p=0.23).

Conclusions: There has been a significant increase in volume of major trauma at our institution since November 2012, with a small decrease in overall mortality. The management has become more refined with fewer patients requiring intervention or higher-level care, with no worsening of morbidity or mortality, demonstrating the effect of this institutional increase in volume.

Trauma & Military Surgery (ATMS) 656

Effects of Distance of Urgent Transfer to a Major Trauma Centre within a UK Trauma Network

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Aims: A major reorganization of trauma services occurred in the England in 2012, with the creation of major trauma networks with a centralized specialist trauma centre receiving patients from significant geographical distances

Methods: Data was analysed from a prospectively maintained database located at a major trauma centre in Liverpool, England, from June 2012 to Jun 2014. Outcomes included basic demographics, ISS, intervention and mortality. Primary outcomes were compared between a group of patients transferred from incidents local to the centre and a second group of patients transferred from geographically greater distances bypassing their local hospital. Data was analysed using Fisher's exact test.

Results: 1261 patients were admitted between June 2012 and June 2014, with 840 in the local cohort and 421 in the bypass group. No significant differences exist between demographic data and injury severity scores. There were more patients with GCS < 8 in the local group, 16% vs 10% (p=0.002). More patients required intervention, 16% vs 11% (p=0.03) and were admitted to intensive care, 16% vs 10% (p=0.006) in the local group. There was no change to patients requiring neurosurgical transfer, 11% vs 11% (p=1.000). There was a slightly higher mortality in the bypass group but not statistically significant: 6% vs 4% (p=0.09).

Conclusions: Mortality between patients transferred geographically longer distances, bypassing their local hospital, was similar to those patients injured locally.

Trauma & Military Surgery (ATMS) 852

Initial electrolyte variability in military trauma patients as a predictor of outcome

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Aims: Aggressive damage control resuscitation and surgery has become the norm within military trauma patients, but little is known about the effects of such aggressive fluid management on a cellular level. A detailed study into the following electrolytes was carried out to see if there were any obvious adverse effects, which could alter our future management of such cases (Sodium, Potassium, Creatinine, Urea, Calcium, Phosphate, Magnesium and Lactate). White Cells and Platelets were also reviewed.

Methods: A retrospective cohort study of a grievously injured group of military trauma patients was carried out. Cases were identified from the UK Joint Theatre Trauma Registry (JTTR) over a 4-year period (2008 to 2012). Information regarding resuscitation products used was examined in detail then further information regarding serial laboratory data was gathered and analysed using statistical methodology (Fisher's Exact and t-test).

Results: Of 231 military trauma patients, 31 died. The analysis of the blood products used showed that significantly more blood products were used

in the fatality group (packed red cells, fresh frozen plasma, platelets and cryoprecipitate), however there was no significant difference for crystalloid or colloid use. On analysis of electrolytes, the mean values of serial sodium and potassium, although within range, did show significant differences between those that survived and those that died. Analysis of white cell count and platelets showed that there were significant differences between initial and subsequent values as well as between those that died and survived.

Conclusions: These results demonstrate that significant biochemical changes do occur in trauma patients, but as the sample is small more needs to be done to investigate what truly happens. A prospective research study is essential as understanding the physiological trauma response can help us guide future resuscitation strategies.

Trauma & Military Surgery (ATMS) 1013

Physiological effects of extracorporeal hemofiltration following bilateral hind limb ischemia-reperfusion injury in *Sus scrofa*

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Aims: Ischemia-reperfusion remains a dilemma with increases in proximal tourniquet usage and survivability of major vascular injuries. The objective of this study was to assess the physiological changes associated with extracorporeal hemofiltration in limb ischemia-reperfusion injury.

Methods: Female Yorkshire-Landrace swine (70–90 kg) were selectively catheterized via right groin to deploy endovascular balloon occlusion of the

distal aorta and inferior vena cava. Hind limbs were rendered ischemic for two hours prior to reperfusion. Venous return was diverted through a novel extracorporeal circuit. Animals underwent non-selective hemofiltration (10–50 kD) or sham filtration (6 and 5 respectively) and were observed for seven days with clinical and laboratory assessments.

Results: Following ischemia, physiologic parameters demonstrated minimal variation between groups. Mean arterial pressure dropped quickly upon reperfusion, requiring fluid and pressor support in both groups. Cardiac output, central venous oxygen saturation, pulmonary arterial and central venous pressure were comparable. Heart rate significantly increased from baseline in the filtration group. Respiratory indicators showed an acute response to acidosis, which subsequently resolved with normalization in pH. Laboratory analysis demonstrated a similar early peak in lactic acidosis that resolved over 6 hours (peak lactate 8.9 mmol/L vs 7.6 control, $p=0.35$). There was observable difference in laboratory analysis of the reperfusate and systemic values; lactate (filter 7.6 vs. 4.32, $p=0.01$, control 8.9 vs 5.3, $p=0.04$) and pH (filter 7.19 vs 7.38, <0.01 , control 7.19 vs 7.39 <0.01). Animals demonstrated hind-limb paralysis throughout the post-operative course. Markers of end-organ injury (creatinine, creatine kinase, liver function enzymes) demonstrated continual evolution of injury through post-operative course, resolving through day 7. Filtration animals trended toward lower postoperative creatinine values (POD7 1.2 vs 0.9, $p=0.13$).

Conclusions: Extracorporeal isolation of venous return allows for hemofiltration, though the tested model demonstrated marginal clinical significance between groups. Differences in reperfusate and systemic circulation suggest robust inherent buffering mechanisms in swine.

ATMS Short Paper Session 2

Trauma & Military Surgery (ATMS) 213

Drug-Eluting Microparticle Immunosuppression in a Porcine Model of Vascularized Composite Allotransplantation (VCA)

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Aims: Consistent advances in body armor and combat casualty care have resulted in soldiers in current conflicts surviving battlefield trauma after sustaining catastrophic extremity and maxillofacial injuries. Reconstructive transplantation, or vascularized composite allotransplantation (VCA), offers a means for superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Using a validated porcine model of VCA with a gracilis myocutaneous flap allotransplant, we evaluated the efficacy of locally applied immunosuppression to delay rejection in the absence of systemic immunosuppression. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for markedly improved safety and expanded applicability of reconstructive transplantation.

Methods: A donor gracilis myocutaneous flap is procured from Yorkshire swine. Prior to transplantation into a recipient, 20 µg of drug-eluting microparticles loaded with IL-2, TGF-β₂, and rapamycin are injected subdermally into donor tissues. Microvascular transfer is then performed to a recipient using the right external carotid artery and internal jugular vein. Animals are survived for 14 days and rejection graded using the Banff rejection scale. Eight treatment animals are compared with 8 control animals which underwent allotransplantation without microparticle injection.

Results: Control animals reached Banff grade 1 and grade 4 rejection on an average of 6.4 days (±0.52) and 10.5 days (±2.6), respectively. All of the controls reached grade 1 rejection by day 7 and grade 4 by day 14. In the experiment group, both grade 1 and 4 rejection were delayed to an average of > 14 days, with earliest grade 1 rejection at day 7 and earliest grade 4 rejection at day 11. Only 50% of the experimental animals reached grade 4 rejection at the limits of our study.

Conclusions: In the absence of systemic immunosuppression, subdermal application of microparticles eluting T-regulatory immunomodulators IL-2, TGF-β₂, and rapamycin significantly delays the time to acute rejection.

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The Role of Free-Tissue Transfer in War-Related Injuries of the Upper and Lower Extremities: A Systematic Review of Current Practice

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Aims: Extremity injuries occurring in combat zones have devastating sequelae. Increasing survival rates following such injuries, combined with rapid advances in microsurgery mean there is an ever-increasing role for free-tissue reconstruction. We aimed to review current trends in microvascular repair of extremity war injuries, focusing on flap types, timing of surgery and post-operative outcomes.

Methods: We conducted a PubMed search of the terms 'Microsurgery' and 'War' and identified articles involving extremity microvascular/free-flap repair in the sub-acute and delayed stage. Single-patient case reports and studies focusing exclusively on craniofacial and thoracoabdominal injuries were excluded. We focused on studies published in the 21st century to accurately reflect the idiosyncrasies of modern warfare.

The relevant articles were reviewed, identifying: geographical location of the injury and site of definitive surgery; anatomical site and number of wounds requiring reconstruction; types of free-flap used; time taken to transfer to a specialist centre and/or perform the reconstruction; flap-related complications; overall free-flap success and limb salvage.

Results: One interventional and ten cohort studies fulfilled our inclusion criteria. In 2 studies reconstruction was performed within combat/austere environments; In 9 studies patients were transferred to a specialist facility for definitive treatment. The number of free-flaps ranged from 6–208. 110 upper and 428 lower limb flaps were described. The most commonly used flap was the Latissimus Dorsi (44.2%). The average time to definitive reconstruction ranged from 9.6 days to 3 years. The average free-flap success rate was 95.3% (range 88.9%–100%).

Conclusions: Extremity injuries in combat zones are characterised by high-injury trauma, extensive tissue loss and gross contamination. Despite the severity of such injuries, challenging locations and delays in surgery, there is great scope for microvascular repair with minimal morbidity and good overall outcomes. Multicentre studies with large numbers are necessary to support these findings, establish definitive management guidelines and determine long-term outcomes.

Trauma & Military Surgery (ATMS) 753

Images of War: Accurate FAST and Abdominal CT Minimizes Negative Laparotomy for Battlefield Abdominal Trauma

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Aims: Focused assessment with sonography for trauma (FAST) and computed tomography (CT) are established contributors to surgical decision making. This study investigates their use in the initial assessment and management of battlefield abdominal injuries in a mature deployed military trauma system.

Methods: Casualties at risk of abdominal injury who were admitted directly to the Camp Bastion Role 3 Medical Treatment Facility, Afghanistan, between July and November 2012 were identified from the UK Joint Theatre Trauma Registry (JTTR), radiology reports and prospectively gathered surgical data. Diagnostic accuracy was determined by comparing radiologically identified injuries with those found at laparotomy. The association between imaging and casualty management was examined.

Results: Of 468 casualties meeting inclusion criteria, 159/468 (34%) had sustained abdominal injuries. 398/468 (85%) were assessed with FAST, 403/468 (86%) with CT. 359/396 (91%) of patients with available FAST reports also underwent CT or laparotomy. 48/468 (12%) of CT patients underwent laparotomy. For detection of intra-abdominal injury FAST sensitivity was 0.556, specificity 0.978, positive predictive value (PPV) 0.865, negative predictive value (NPV) 0.895 and accuracy 0.891. For CT, sensitivity was 0.985, specificity 0.991, PPV 0.956, NPV 0.997 and accuracy 0.990. Forty-six solid organ injuries were identified in 38 patients by CT, of whom 12 were managed non-operatively. Thirty-nine patients had ≥1 hollow viscus injury (HVI); all underwent laparotomy. Six injuries found at laparotomy had not been identified radiologically. In total, CT allowed 78 patients to be managed without laparotomy (15 with selective non-operative management of solid organ injury or haematoma, 61 where penetrating injury was shown not to have penetrated the peritoneum). The negative laparotomy rate was 3/77 (3%).

Conclusions: FAST and CT are integral components of battlefield casualty management. Contrary to traditional military surgical doctrine, accurate imaging allows surgeons to consider non-operative management and is associated with a historically low rate of negative laparotomy.

Trauma & Military Surgery (ATMS) 837

Selective Aortic Arch Perfusion for the reversal of haemorrhage-induced traumatic cardiac arrest in a large swine translational model of non-compressible torso haemorrhageE. B. Barnard^{1*}, J. E. Manning², J. M. Rall³, J. M. Cox³, J. D. Ross³¹59th Medical Wing Office of the Chief Scientist, Institute of Naval Medicine UK,²The University of North Carolina at Chapel Hill, ³59th Medical Wing Office of the Chief Scientist, United States

Aims: Non-compressible torso haemorrhage (NCTH) is the leading cause of potentially survivable combat death, and 90% of deaths occur before hospital arrival. Selective aortic arch perfusion (SAAP) provides the potential to manage hemorrhage-induced traumatic cardiac arrest (HiTCA) with NCTH by controlling aortic torso inflow, increasing cardiac afterload, and delivering oxygenated fluid to the central circulation. Hypothesis: SAAP with oxygenated blood confers a survival advantage over both SAAP with oxygenated Hartmann's solution, and chest compressions with venous blood in HiTCA with NCTH.

Methods: A model of HiTCA in male splenectomised pigs (70-90 kg) was developed - a hybrid of systematic laparoscopic liver injury and arterial haemorrhage. Arrest was defined as a systolic blood pressure (SBP) < 10 mmHg sustained for three minutes. Randomised intervention was: SAAP with oxygenated fresh whole blood (FWB-SAAP), SAAP with oxygenated Hartmann's solution (LR-SAAP), or closed chest compressions with venous FWB (CCC). The SAAP groups received further 250 ml boluses of test fluid if SB < 90 mmHg, up to a maximum of 1750 ml. A 60-minute pre-hospital period was observed. Primary outcome - pre-hospital survival, secondary outcomes - hospital arrival SBP and fluid requirements after 1600 ml SAAP. Results are expressed as means (+/- standard deviation).

Results: Sixteen animals were included (median weight 83 kg). Left lateral lobe liver resection and arterial bleed was consistent amongst groups - 64.3% (+/- 11.5), $p = 0.99$, and 22.6 ml/kg (+/- 4.7), $p = 0.17$ respectively. The mean SBP during the arrest period was 4 mmHg, with a brady/agonal or asystolic cardiac rhythm. 100% (6/6) FWB-SAAP, 60% (3/5) LR-SAAP, and 40% (2/5) CCC animals survived. Hospital arrival SBP was significantly higher in FWB-SAAP (94.4 mmHg +/- 9.0), compared to both LR-SAAP (26.9 mmHg +/- 27.6) and CCC (26.2 mmHg +/- 36.0), < 0.001 . Mean fluid requirement (after 1600 ml SAAP) was 625 ml (+/- 586) for FWB-SAAP, and 1750 ml (+/- 0) for LR-SAAP, < 0.001 .

Conclusions: FWB-SAAP confers a 100% pre-hospital survival of HiTCA in NCTH even in cardiac asystole.

Trauma & Military Surgery (ATMS) 1064

Hyperbaric Sub-normothermic ex-vivo Perfusion Delays the Onset of Acute Rejection in a Porcine VCA ModelS. D. Lawson^{1*}, L. Wang¹, C. A. Fries², M. Davis¹¹United States Army Institute for Surgical Research, ²USAIRS/The Royal Centre for Defence Medicine, Birmingham, UK, United States

Aims: Vascularized composite allotransplantation (VCA), offers superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Here we evaluate a novel hyperbaric oxygen (HBO) ex-vivo perfusion device to mitigate reperfusion injury and delay the onset of acute rejection in a porcine VCA model. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for reduced toxicity and improved applicability of VCA as a reconstructive technique.

Methods: This experiment utilizes a validated porcine model of gracilis myocutaneous VCA. Eight experimental donor flaps were cannulated intra-arterially and perfused for five hours with hyper-oxygenated WS (mean PaO₂ = 93.3 kPa) at 20°C in a hyperbaric chamber at 3 atm. These flaps were then transplanted heterotopically into recipient animals' necks, genetically controlled to be one HLA mismatch. Eight control flaps were obtained and transplanted without pre-treatment. Animals were evaluated clinically and biochemically. Additionally, flaps were assessed histologically at completion of the experiment (Day 15).

Results: Control flaps experienced Grade 1 rejection at a mean of 6.4 days (SD 0.52) and Grade 4 rejection at a mean of 10.5 days (SD 2.6). The experimental flaps showed a statistically significant delay in the onset of Grade 1 rejection at 13.71 days (SD 0.52, $p = 0.0215$). At the experiment's conclusion (Day 15), 75% of the experimental flaps were without any evidence of Grade 4 rejection.

Conclusions: Hyperbaric subnormothermic perfusion significantly delays the onset of acute rejection. Ischemic injury is mitigated as well as cold preservation-induced injury. This technology has potential utility in the field of solid organ and vascularized composite allotransplantation and could expand the donor pool dramatically. Furthermore, ex-vivo normalization of tissue physiology may reduce antigen presentation and acute rejection phenomena in allotransplantation.

ATMS Short Paper Session 3

Trauma & Military Surgery (ATMS) 166

Gunshot and Blast Injuries: Establishment of an Innovative eLearning Resource for Core Surgical Trainees

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Aims: Gunshot and blast injuries are increasingly seen in civilian practice and their management forms a key curriculum outcome for core surgical trainees. Despite this, inadequate knowledge and exposure among surgical trainees have been identified as possible causes of poor care in the management of these pathologies. To supplement established surgical education methods, eLearning has emerged as a key component of structured, interactive learning for surgical trainees on both civilian and military training pathways.

Methods: This web-based module forms part of a suite of eLearning resources developed by the Royal College of Surgeons of England and hosted on the established eLearning for Healthcare virtual learning environment (VLE). The content is clearly mapped to the Core Surgical Training curriculum. This has resulted in the creation of an accessible, cost-effective, stimulating, relevant, and evidence-based education programme designed to meet the trauma education needs of core trainees.

Results: This study focuses on the conception, formulation and development of this web-based resource. eLearning such as this has clear potential to disseminate education, supplement surgical knowledge and improve the trauma skills of early career trainees, who may be called upon to manage gunshot and blast injuries in civilian and military contexts. A prospective cohort study will evaluate the outcomes of this eLearning against levels one and two of Kirkpatrick's four-level training evaluation model.

Conclusions: The growing need for trauma management skills requires innovative approaches to training planning at all levels. We have developed quality-assured eLearning with clear potential to pedagogically raise core surgical trainees' awareness and knowledge of gunshot and blast injury. This use of information technology supports a trainee-centred educational approach that promotes autonomy, flexibility and time management and helps trainees to assess their competence. These findings can inform further development of online trauma modules aimed at improving surgeons' knowledge and have wider applicability to others developing VLEs.

Trauma & Military Surgery (ATMS) 498

Locally Applied Enzyme Activated Tacrolimus Eluting Hydrogels Significantly Delay the Onset of Acute Rejection of Vascularized Composite Allotransplantation Grafts

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Aims: Vascularized Composite Allotransplantation (VCA), most commonly of the hand or face, can restore form and function in previously unreconstructable injuries. The utility of VCA is restricted by the morbidity and mortality conferred by long term systemic immunosuppression.

Targeted, donor-specific, treatments that delay rejection without systemic effects are a potential solution to this problem. The aim of this study was to evaluate one such treatment.

The investigation needed a previously unavailable animal model that comprised all transplanted tissues, that enabled the study of immune tolerance and healing, and that permitted an assessment of functional recovery.

Methods: We developed the first directly-translatable, orthotopic limb transplantation model in a large animal (swine). This has been used in the first instance to evaluate the efficacy of tacrolimus delivered locally in the transplanted limb by subcutaneous placement of a novel drug eluting hydrogel that releases the drug in the presence of activated macrophages. Six swine served

as donors for six SLA-mismatched recipients. Forelimbs were transplanted at a level corresponding to the mid forearm. Survival was for four weeks.

Limbs were evaluated clinically and histopathologically for signs of rejection, blood and tissue levels of tacrolimus were measured along with other bio-markers.

Results: Control limbs underwent grade 4 acute rejection (complete necrosis of the skin) on post-operative day 6. Intervention limbs had not undergone acute rejection after four weeks. Animals mobilised freely using transplanted limbs, including accessing food, socializing and playing with rubber balls in a normal fashion.

Conclusions: Local delivery of tacrolimus into the grafted limb, using an enzyme responsive hydrogel, significantly delays the onset of acute rejection of grafts in a translatable, orthotopic limb model of VCA.

This novel model is uniquely powerful in that it permits the study of VCA not only in terms of immune rejection or tolerance, but also functional recovery.

Audit and Outcomes Research 553

A Review of Vascular Injuries seen during first two years in a new Major Trauma Centre in the UK

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Aims: The UK saw centralisation of trauma services in 2012 with the development of Level One Major Trauma Centres. Our aim was to review the vascular injuries treated at a major non-urban trauma centre.

Methods: The prospective TARN (Trauma Audit Research Network) database was interrogated for data over a 2-year period from April 2012 to April 2014 for all trauma admissions that had a vascular injury code. Case notes were used to collect demographics, mechanism of injury, Injury Severity Score (ISS), injuries sustained both vascular and non-vascular, management of vascular injuries and outcomes.

Results: Total number of trauma patients received over 2 years = 1697. Of these 69(4%) sustained vascular injuries. Mean age = 44 years, male preponderance (51:18). Mean ISS 24.4 +/- 6.5 with only 13/69 having ISS < 16. The mechanism of injuries recorded - Road Traffic Collision (39), Falls (10), Stabbing (9), Industrial (4), Agricultural (3), Leisure/sport (2), Blows (1) and Shootings (1).

26 patients had vascular injuries that were dealt with by other specialities, 13 general surgery (splenectomy (4), mesenteric bleeds (4)), Orthopaedic (5), Cardiothoracic (4) Neurosurgery (3), and ENT (1) with a mortality of 16% (n = 11).

Nearly half of 48 (n = 21) patients requiring vascular input were treated conservatively, 10 required a combined approach with vascular surgery/radiology, of which 7 were Thoracic-aortic stenting for traumatic dissection. Those requiring surgery were for lacerations of Aorto/iliac (3), Femoral/popliteal (3), Brachial (3) and Radial (2), mesenteric (1), and one retrieval of foreign body impaled in leg.

Conclusions: This review illustrates the range of vascular injuries seen in a new trauma centre in the UK. Unlike urban trauma centres with a large proportion of penetrating injuries, vascular trauma accounts for a small proportion of cases in our centre which deals with a large number of road accidents and falls. We encounter patients with severe multiple injuries and a significant proportion require a combined surgical and radiological approach to management. As such vascular trauma is time and manpower intensive which highlights the need for a multidisciplinary approach to vascular injuries.

Audit and Outcomes Research 987

Abdominal trauma: a regional analysis of management and outcomes:

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Aims: Abdominal trauma poses significant challenges in terms of diagnosis and management. Contemporary prevalence and patterns in the United Kingdom remain largely unknown. The aim of this multicentre study was to examine the characteristics of abdominal trauma in 3 major trauma centres.

Methods: All patients presenting as a 'trauma-call' in the emergency departments of the 3 major trauma centres in the West Midlands with an underlying injury that justified immediate cross-sectional imaging of the abdomen & pelvis were included, over a period of 2 years. Significant blunt abdominal trauma was defined as any blunt abdominal injury requiring immediate exploratory laparotomy or a Computed Tomographic (CT) scan. Delayed laparotomy is defined as major abdominal surgery taking place > 12 hours from admission. Patient records and imaging were reviewed to assess outcomes.

Results: A total of 5,532 patients [3,507 females (63%); mean age: 43±9years (SD)] were included. In 1,658 patients (30%) blunt abdominal trauma was the predominant injury. Initial CT findings of the abdomen and pelvis included: 220 (4%) patients with evidence of free fluid, 195 (3.5%) with a direct mesenteric injury, 41 (0.7%) with a vascular injury, 156 (3%) with a splenic injury, and 104 (2%) with a hepatobiliary injury. A total of 86 (2%) patients underwent a laparotomy, of which 57 (66%) were performed as an emergency (within 12 hours) and 29 (34%) were delayed laparotomies. A total of 120 (2%) patients died within a period of 30 days. Presence of free abdominal or pelvic fluid at baseline was associated with mortality (Odds Ratio: 3.3, $p=0.0003$). There was no difference in mortality for those undergoing delayed or emergency laparotomy ($p=0.14$).

Conclusions: The patterns of injury following significant abdominal trauma vary. Modern management allows the majority of injuries to be treated conservatively following assessment of imaging, when immediate surgical intervention is not mandatory.

Basic and Applied Clinical Science 1018

Is Local Antibiotic Delivery Compatible with Negative Pressure Wound Therapy?

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Aims: Antibiotic loaded Polymethylmethacrylate (PMMA) beads are not an ideal antibiotic vehicle, and negative pressure wound therapy (NPWT) has been shown to reduce their effectiveness. It appears that negative pressure removes the eluted antibiotic from the wound before it can diffuse throughout the wound. We hypothesized that antibiotic impregnated chitosan sponges would effectively reduce bacteria when used with NPWT due to increased contact with the wound surface.

Methods: The effectiveness of PMMA antibiotic beads was compared to antibiotic loaded chitosan sponge, used in both wound pouch and NPWT modalities. A complex tibial open fracture wound was created in goats and inoculated with *S. aureus*. The wounds were debrided at 6 hours, and the bacteria was quantified both pre and post debridement. The animals were assigned to a group, and the bacteria within the wound were re-quantified after 2 days. The four groups were: antibiotic bead pouch, antibiotic beads with NPWT, chitosan sponge pouch, and chitosan sponge with NPWT. Both the beads and sponges contained vancomycin.

Results: There were significantly fewer bacteria within the wounds treated with chitosan sponge compared with antibiotic beads irrespective of use in a pouch or with NPWT. Unlike beads, the effectiveness of chitosan sponges was not reduced by NPWT.

Conclusions: This study demonstrates that a biodegradable chitosan sponge loaded with vancomycin is superior to antibiotic impregnated beads at eradicating *S. aureus* in a complex large animal wound model. It also offers advantages in handling, antibiotic choice, device removal and its effect is not reduced when used with NPWT. PMMA beads act as a depot, eluting antibiotic which must diffuse throughout the wound. When used with NPWT, the antibiotic is removed before it can reach bacteria not in contact with the beads. The increased contact with the wound surface of the chitosan sponge allows improved antimicrobial action, more pronounced with NPWT.

Emergency Surgery including Trauma (ASGBI) 385

Assessment of Sensitivity of Whole Body CT for Major Trauma

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Aims: Whole body Computed Tomography has become standard practice in many centres in the management of severely injured trauma patients, however the evidence for its diagnostic accuracy is limited.

To assess the sensitivity of Whole body CT in Major Trauma.

Methods: Retrospective review of all patients with Injury Severity Score (ISS) > 15 presenting with blunt trauma to a UK Major Trauma Centre between May 2012 and April 2014.

The authors reviewed patient's electronic charts, radiological results, interventional procedure records, discharge letters and outpatient follow up documentation and referenced this with the major trauma database.

Results: 407 patients with ISS > 15 presented to the Trauma centre during May 2012 and April 2014. Of these, 337 (82.8%) had a whole body CT scan. 246 pts were male, 91 were female. 74 (21.9%) were due to a fall from > 2 m, 41 (12.2%) due to a fall from < 2 m, 208 (61.7%) were due to motor vehicle crashes, 1 (0.29%) due to a blast injury, 5 (1.48%) due to blows, and 8 (2.37%) due to crush injuries. Sensitivity for head & neck was 0.98, face 0.98 chest 0.98 and abdomen 0.95. Overall sensitivity was 0.96. 15 injuries (4.5%) were not identified on initial CT (False -ve). These injuries were: Colonic perforation =1, Splenic contusion =1, Pneumothorax =1, Liver laceration =1, intracranial haemorrhage = 1, cerebral contusions = 1, spinal injuries = 7, canal haemorrhage = 1, maxilla fracture = 1.

Conclusions: These results show that whole body CT in trauma has a high sensitivity and a low rate of false negativity (4.5%). However, our study only evaluated a subgroup of patients with ISS > 15 and further work is required to assess the value of CT in trauma patients with less severe injury.

Emergency Surgery including Trauma (ASGBI) 556

Gun-shot Injuries in UK Military Casualties-Features Associated with Wound Severity

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Aims: Surgical treatment of high-energy GSWs to the extremities is challenging. It is recognised that the size of external wounds can belie the extent of deeper tissue damage. GSWs are not homogeneous however and high-energy firearms do not necessarily produce 'high-energy GSWs'. The aim of this study is to firstly characterise the gun shot injuries sustained by UK forces and secondly, test the hypothesis that the likely severity of gun-shot wounds can be predicted by features of the wound.

Methods: The UK Military trauma registry was searched for cases injured by GSW in the five years between 01 Jan 2009 and 31 Dec 2013: only UK personnel were included. Clinical notes and radiographs were then reviewed.

Results: There were 450 cases who met the inclusion criteria. 96 (21%) were fatally injured, with 354 (79%) surviving their injuries. Overall, the chest was the most common region injured (23%). In survivors the limbs were most commonly injured (56%).

Of the 325 survivors with full records, 236 had GSWs to the limbs and pelvis, this cohort was analysed further with respect to which factors were associated with a requirement for repeated debridements. 'Through and through' wounds where the bullet passes through the body without any retention of bullets or fragments thereof, was strongly associated with less requirement for debridement (<0.0001). Fractures were associated with a requirement for a greater number of wound debridements ($p=0.00022$). When comparing wounds with retained, intact bullets with those involving bullet fragmentation, there was no association with the amount of wound debridements required ($p=0.53744$).

Conclusions: This study has characterised the injuries from firearms sustained by UK Military personnel over 5-years of warfare. More complex wounds as indicated by the requirement for repeated debridements are associated with

injuries where the bullet does not pass straight through the body, or where a bone is fractured.

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Hyper-Acute Rehabilitation at A Major Trauma Centre:

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Aims: Hyper-acute rehabilitation is the implementing of a very early rehabilitation process for patients in parallel with their initial stages of medical treatment and has been used at our trauma centre since June 2012. The identification of a need for and deployment of early rehabilitation can reduce healthcare costs by reducing dependence, nursing care, length of stay (LoS) and prevention of disability. We looked at the trends in hospital episode outcomes in patients going through the hyper-acute rehabilitation service in our major trauma centre.

Methods: A prospective dataset of all patients in the rehabilitation system was interrogated, with primary outcomes measured being LoS and bed occupancy rate (BOR). Secondary outcomes were LoS for patients with an Injury Severity Score (ISS) > 15. Data were analysed for the month of August in three consecutive years (2012, 2013 and 2014).

Results: In August 2012, 27 patients were admitted, with a mean LoS of 8.5 days and BOR of 2.25 patients per bed per month. Mean ISS was 16.3, and mean LoS for patients with ISS > 15 was 14.6 days. In 2013, 76 patients were admitted with a mean ISS of 13.1 for a mean LoS of 7.1 days. The mean LoS for an ISS > 15 was 5.5 days. In August 2014, 47 patients were admitted, with a mean LoS of 6.6 days and BOR of 3.9 patients per bed per month, and mean LoS for patients with ISS > 15 was 9.2 days.

Conclusions: The hyper-acute rehabilitation system has become an established part of post trauma care offered in our centre. Since implementation it has shown substantial short term advantages to the institution by reducing overall LoS, reducing LoS for severely traumatized patients, and increasing bed occupancy rates and improving flow through the trauma ward.

Trauma & Military Surgery (ATMS) 147

The Utility of Surgical Key Performance Indicators in British Military Trauma

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Aims: Performance Indicators (PI) are used extensively in trauma management to compare actual against ideal care. In 2008, authors from the British Military published bespoke Key Performance Indicators (KPIs) which are specific for measuring the performance of end to end care in this unique environment. This paper evaluates the specific surgical KPIs. The primary aim was to review the overall performance of surgical trauma care in war wounded casualties treated at Camp Bastion, Medical Treatment Facility, Afghanistan. Our secondary aims were to assess the utility (clarity and relevance) of the British Military's Surgical KPIs, and make recommendations for future surgical trauma care review

Methods: The original surgical KPIs have been refined based on deployed clinical experience to provide 22 parameters that analyse surgical care. Data on these 22 parameters was prospectively collected for 150 consecutive injured patients who had primary surgery at Camp Bastion between 1 st May 2013 and 20 th August 2013.

Results: Median data recording was 99% (IQR 98-100%). Median relevance was 54% (IQR 10-99%). 80% of KPIs achieved > 60% compliance, of which 50% scored > 80% compliance. (See attached table 1) We propose a new set of surgical KPIs for use in future military trauma surgical care in which 11 KPIs are retained, 9 KPIs are refined and 2 are removed.

Conclusions: This study is the first that we are aware of that measures surgical Performance Indicators in military trauma. We highlight areas for improvement in service delivery and the utility of KPIs themselves. KPIs must constantly evolve in order to maintain relevance and to highlight areas for improvement of the care for war wounded trauma patients. We also provide a list of carefully considered surgical KPIs for future use in the deployed surgical setting.

Trauma & Military Surgery (ATMS) 166

Gunshot and Blast Injuries: Establishment of An Innovative eLearning Resource for Core Surgical Trainees

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Aims: Gunshot and blast injuries are increasingly seen in civilian practice and their management forms a key curriculum outcome for core surgical trainees. Despite this, inadequate knowledge and exposure among surgical trainees have been identified as possible causes of poor care in the management of these pathologies. To supplement established surgical education methods, eLearning has emerged as a key component of structured, interactive learning for surgical trainees on both civilian and military training pathways.

Methods: This web-based module forms part of a suite of eLearning resources developed by the Royal College of Surgeons of England and hosted on the established eLearning for Healthcare virtual learning environment (VLE). The content is clearly mapped to the Core Surgical Training curriculum. This has resulted in the creation of an accessible, cost-effective, stimulating, relevant, and evidence-based education programme designed to meet the trauma education needs of core trainees.

Results: This study focuses on the conception, formulation and development of this web-based resource. eLearning such as this has clear potential to disseminate education, supplement surgical knowledge and improve the trauma skills of early career trainees, who may be called upon to manage gunshot and blast injuries in civilian and military contexts. A prospective cohort study will evaluate the outcomes of this eLearning against levels one and two of Kirkpatrick's four-level training evaluation model.

Conclusions: The growing need for trauma management skills requires innovative approaches to training planning at all levels. We have developed quality-assured eLearning with clear potential to pedagogically raise core surgical trainees' awareness and knowledge of gunshot and blast injury. This use of information technology supports a trainee-centred educational approach that promotes autonomy, flexibility and time management and helps trainees to assess their competence. These findings can inform further development of online trauma modules aimed at improving surgeons' knowledge and have wider applicability to others developing VLEs.

Trauma & Military Surgery (ATMS) 213

Drug-Eluting Microparticle Immunosuppression in a Porcine Model of Vascularized Composite Allotransplantation (VCA)

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Aims: Consistent advances in body armor and combat casualty care have resulted in soldiers in current conflicts surviving battlefield trauma after sustaining catastrophic extremity and maxillofacial injuries. Reconstructive transplantation, or vascularized composite allotransplantation (VCA), offers a means for superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Using a validated porcine model of VCA with a gracilis myocutaneous flap allotransplant, we evaluated the efficacy of locally applied immunosuppression to delay rejection in the absence of systemic immunosuppression. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for markedly improved safety and expanded applicability of reconstructive transplantation.

Methods: A donor gracilis myocutaneous flap is procured from Yorkshire swine. Prior to transplantation into a recipient, 20µm of drug-eluting microparticles loaded with IL-2, TGF-β², and rapamycin are injected subdermally into donor tissues. Microvascular transfer is then performed to a recipient using the right external carotid artery and internal jugular vein. Animals are survived for 14 days and rejection graded using the Banff rejection scale. Eight treatment animals are compared with 8 control animals which underwent allotransplantation without microparticle injection.

Results: Control animals reached Banff grade 1 and grade 4 rejection on an average of 6.4 days (±0.52) and 10.5 days (± 2.6), respectively. All of the controls reached grade 1 rejection by day 7 and grade 4 by day 14. In the experiment group, both grade 1 and 4 rejection were delayed to an average of > 14 days, with earliest grade 1 rejection at day 7 and earliest grade 4 rejection at day 11. Only 50% of the experimental animals reached grade 4 rejection at the limits of our study.

Conclusions: In the absence of systemic immunosuppression, subdermal application of microparticles eluting T-regulatory immunomodulators IL-2, TGF-β², and rapamycin significantly delays the time to acute rejection.

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Mind the Gap: Surgical Options When Primary Closure is not Possible following Damage Control Laparotomy. A Systematic Review

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Aims: A Trauma damage control laparotomy (DCL) entails immediate control of haemorrhage and contamination, laparotomy and physiological stabilisation, then completion of surgery and early primary closure (EPC). Failing early primary closure, temporary abdominal closure (TAC) techniques maintain abdominal integrity until early definitive closure (EDC). The aims were to identify and compare outcomes of early definitive closure methods in these patients.

Methods: NICE, Cochrane, OVID (Medline, AMED, Embase, HMIC) and PubMed databases were accessed using (traum*, damage control, abbreviated laparotomy, component separation, fascial traction, mesh closure, planned ventral hernia (PVH), and topical negative pressure (TNP)). Randomised Controlled Trials, Case Series and Cohort Studies reporting TAC and early definitive closure methods in DCL trauma patients were included. Outcomes were mortality, days to fascial closure, hospital length of stay, abdominal complications and delayed ventral herniation.

Results: 26 studies identified early primary closure (DPC, acute component separation (ACS) and acute mesh repair (AMR)) and TAC methods (Whitman patch (WP), topical negative pressure (TNP), temporary mesh (TM), fascial tension, Bogota bag and skin tension). Estimates for mortality and abdominal complications in AMR and DPC groups were 0.45% and 40.85%, and 6.07%, and 16.74% respectively; AMR ventral hernia / laxity was 51.1% at one year. Days to closure were 6.30, 21.10 and 15.90 in DPC, ACS and AMR groups, whilst hospital LOS in ACS and DPC groups was 17.5 versus 23.3 days.

Conclusions: Acute component separation or mesh repair are alternative early definitive closure techniques to DPC following trauma DCL. Comparing outcomes is hampered by poverty of uniform reporting and bias. Recommendations for standardised reporting nomenclature and methodology are made.

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The Role of Free-Tissue Transfer in War-Related Injuries of the Upper and Lower Extremities: A Systematic Review of Current Practice

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Aims: Extremity injuries occurring in combat zones have devastating sequelae. Increasing survival rates following such injuries, combined with rapid advances in microsurgery mean there is an ever-increasing role for free-tissue reconstruction. We aimed to review current trends in microvascular repair of extremity war injuries, focusing on flap types, timing of surgery and post-operative outcomes.

Methods: We conducted a PubMed search of the terms 'Microsurgery' and 'War' and identified articles involving extremity microvascular/free-flap repair in the sub-acute and delayed stage. Single-patient case reports and studies focusing exclusively on craniofacial and thoracoabdominal injuries were excluded. We focused on studies published in the 21st century to accurately reflect the idiosyncrasies of modern warfare.

The relevant articles were reviewed, identifying: geographical location of the injury and site of definitive surgery; anatomical site and number of wounds requiring reconstruction; types of free-flap used; time taken to transfer to a specialist centre and/or perform the reconstruction; flap-related complications; overall free-flap success and limb salvage.

Results: One interventional and ten cohort studies fulfilled our inclusion criteria. In 2 studies reconstruction was performed within combat/austere environments; In 9 studies patients were transferred to a specialist facility for definitive treatment. The number of free-flaps ranged from 6–208. 110 upper and 428 lower limb flaps were described. The most commonly used flap was the Latissimus Dorsi (44.2%). The average time to definitive reconstruction ranged from 9.6 days to 3 years. The average free-flap success rate was 95.3% (range 88.9%-100%).

Conclusions: Extremity injuries in combat zones are characterised by high-injury trauma, extensive tissue loss and gross contamination. Despite the severity of such injuries, challenging locations and delays in surgery, there is great scope for microvascular repair with minimal morbidity and good overall outcomes. Multicentre studies with large numbers are necessary to support these findings, establish definitive management guidelines and determine long-term outcomes.

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Locally Applied Enzyme Activated Tacrolimus Eluting Hydrogels Significantly Delay the Onset of Acute Rejection of Vascularized Composite Allotransplantation Grafts

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Aims: Vascularized Composite Allotransplantation (VCA), most commonly of the hand or face, can restore form and function in previously unreconstructable injuries. The utility of VCA is restricted by the morbidity and mortality conferred by long term systemic immunosuppression.

Targeted, donor-specific, treatments that delay rejection without systemic effects are a potential solution to this problem. The aim of this study was to evaluate one such treatment.

The investigation needed a previously unavailable animal model that comprised all transplanted tissues, that enabled the study of immune tolerance and healing, and that permitted an assessment of functional recovery.

Methods: We developed the first directly-translatable, orthotopic limb transplantation model in a large animal (swine). This has been used in the first instance to evaluate the efficacy of tacrolimus delivered locally in the transplanted limb by subcutaneous placement of a novel drug eluting hydrogel that releases the drug in the presence of activated macrophages. Six swine served as donors for six SLA-mismatched recipients. Forelimbs were transplanted at a level corresponding to the mid forearm. Survival was for four weeks.

Limbs were evaluated clinically and histopathologically for signs of rejection, blood and tissue levels of tacrolimus were measured along with other bio-markers.

Results: Control limbs underwent grade 4 acute rejection (complete necrosis of the skin) on post-operative day 6. Intervention limbs had not undergone acute rejection after four weeks. Animals mobilised freely using transplanted limbs, including accessing food, socializing and playing with rubber balls in a normal fashion.

Conclusions: Local delivery of tacrolimus into the grafted limb, using an enzyme responsive hydrogel, significantly delays the onset of acute rejection of grafts in a transplantable, orthotopic limb model of VCA.

This novel model is uniquely powerful in that it permits the study of VCA not only in terms of immune rejection or tolerance, but also functional recovery.

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Correlation and Phase Relationship Between Peripheral Muscle Tissue Oxygenation (StO₂) and Arterial Blood Gas Parameters in an Animal Hypovolaemia-Resuscitation Model

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Aims: Near infrared spectroscopy provides a non-invasive, continuous, real-time assessment of tissue oxygenation (StO₂) that can be used to monitor the resuscitation of hypovolaemic patients.

This study aimed to compare the correlation and phase relationship between StO₂ and ABG parameters (principally base excess and lactate), and determine if StO₂ recorded from injured muscles could be used to monitor resuscitation in hypovolaemia.

Methods: Seven splenectomised pigs were subject to a hind limb soft tissue injury followed by a controlled haemorrhage (of approximately 35% blood volume) lasting 10 minutes, and a 30 minute shock phase. The animals then received 60 minutes of hypotensive crystalloid resuscitation to a target systolic blood pressure of 80 mmHg, followed by 150 minutes of normotensive resuscitation with blood products to a target systolic blood pressure of 110 mmHg. StO₂ was recorded from injured and control limbs along with basic physiological and ABG measurements.

Results: Time lag analysis between ABG measurements and physiological parameters assessed by cross-correlation:

Base Excess Lactate Physiological Variable

Correlation Coefficient Lag (minutes) Correlation Coefficient Lag (minutes)

StO₂ Control Limb StO₂ Injured Limb

Heart Rate Mean Arterial Pressure

0.69 0.67 -0.63 0.74 1 32 2423 -0.65 -0.63 0.59 -0.7236 37 27 28

StO₂ values in uninjured limbs were significantly higher than in injured limbs during the haemorrhage and resuscitation phases of the protocol (by 3.4±1%, <0.0001). StO₂ values correlated strongly between limbs ($r = .94$, <0.0001) and accurately tracked the response to haemorrhage and resuscitation.

Conclusions: StO₂ recorded from injured muscle sites can be used to accurately monitor the response to resuscitation in hypovolaemic subjects. StO₂ measurements phase lead changes in base excess and lactate by over 30 minutes and have significant practical advantages over conventional means of assessment of resuscitation.

Trauma & Military Surgery (ATMS) 545

Refining the Trauma and Injury Severity Score (TRISS) to measure the performance of the UK combat casualty care system

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Aims: The TRISS methodology is used in by both the UK and US military trauma registries and relies on dividing casualties according to mechanism: penetrating or blunt, and uses different weighting coefficients accordingly. The UK and US military trauma registries use the original coefficients devised in 1987 and it is not clear how either registry analyses explosive casualties according to the TRISS methodology.

This study aims to use the UK military trauma registry (JTTR) to calculate new TRISS coefficients for contemporary battlefield casualties injured by either gunshot or explosive mechanisms. A secondary aim of this study is to apply the

revised TRISS coefficients to examine the survival trends of UK casualties from recent military conflicts.

Methods: The JTTR was searched for all UK casualties injured or killed in Iraq and Afghanistan by explosive or gun-shot mechanisms between 1 st Jan 2003 and 31 Dec 2014. Details of these casualties including injuries and vital signs were reviewed. A logistic regression analysis was performed to devise new TRISS coefficients, these were then used to examine survival over the 12 years of the study.

Results: Comparing the predictions from the GSW TRISS model to the observed outcomes, it demonstrates a sensitivity of 98.1% and a specificity of 96.8% and an overall accuracy of 97.8%. With respect to the explosive TRISS model, there is a sensitivity of 98.6%, a specificity of 97.4% and an overall accuracy of 98.4%. This improved TRISS methodology was used to measure changes in survival over the study period, the peak performance was in 2009–10.

Conclusions: This study for the first time refines the TRISS methodology with coefficients appropriate for use with combat casualty care systems. This work allows the performance of combat casualty care systems to be accurately measured in future conflicts.

Trauma & Military Surgery (ATMS) 582

Tranexamic acid use in trauma: an evaluation over 3 years in a regional major trauma network

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Aims: The aim of the study was to understand if patients presenting to the Major Trauma Centre are being administered Tranexamic Acid (TXA) appropriately, being under utilised or potentially harmful if inappropriately given.

Methods: A retrospective cohort study of patients sustaining trauma injuries over a 3 year period, between January 2012 and December 2014, was undertaken. Quantitative evaluation was made using the hospital's trauma registry and electronic medical records to collect the required data fields. Statistical analysis and evaluation for confounding factors was performed between patient administered TXA (treatment group) and those not administered TXA (control group).

Results: Evaluation of our trauma registry over the 35 month period demonstrated a total of 2266 patients attended our Major Trauma Centre. TXA was administered to 327 patients, the severity of trauma injuries seen in this group was significantly higher than in No TXA group (ISS: 24 Vs 16). Unadjusted comparison demonstrated fatality rates and blood transfusion administration rates were higher in the TXA group, yet the TXA group had much lower survival probability. Furthermore, in sub-group analysis with greater homogeneity, such as penetrating trauma, shocked patients and those requiring blood transfusion, TXA group has lower fatality rates despite poorer survival probabilities.

Conclusions: Trauma care has seen many rapid developments, especially upon waves of higher level scientific studies. However, the implementation of these practices often awaits confirmation prior to universal adoption. Our study demonstrates the incidence of TXA use is lower than expected and further solutions must be sort in order to achieve the expected level. In this unadjusted format, due to the elements of confounding from trauma severity and clinician discretion greater statistical analysis is required to determine the true impact of TXA on trauma survival. Therefore, this study only provides a description of TXA use at this stage and not the clinical influence of TXA in trauma patients.

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Centralisation of Trauma Services within a UK Trauma Network has Shown Changes in Clinical Outcomes at a Major Trauma Centre

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Aims: A major reorganisation of trauma services occurred in the England in 2012. This involved the creation of major trauma networks with a centralized

specialist trauma centre, receiving patients from significant geographical distances. This reconfiguration is reviewed with respect to clinical outcomes.

Methods: Data were analysed from a prospectively maintained trauma database from a Major Trauma Centre in Liverpool, UK between November 2011 and June 2014. Primary outcomes included basic demographics, ISS, intervention and mortality rates. Data were compared pre and post centralisation, utilising Fisher's exact test.

Results: The pre-centralised study period was from January 2012 to October 2012 and the post-centralisation period was November 2012 to June 2014. Mean monthly admissions increased significantly 15.7 vs 63.1 ($p < 0.005$). There were no significant differences in demographic statistics and GCS levels. There are more patients with an injury severity score > 15 in the pre centralisation group, 58% vs 27% ($p < 0.0001$). Less patients required radiological or operative intervention, 28% vs 13% ($p < 0.0001$), fewer patients required intensive care, 18% vs 12% ($p = 0.0569$). Similar numbers of patients required neurosurgical transfer, 12% vs 11% ($p = 0.506$). There was a non-significant decrease in mortality rate, 7% vs 5% ($p = 0.23$).

Conclusions: There has been a significant increase in volume of major trauma at our institution since November 2012, with a small decrease in overall mortality. The management has become more refined with fewer patients requiring intervention or higher-level care, with no worsening of morbidity or mortality, demonstrating the effect of this institutional increase in volume.

Trauma & Military Surgery (ATMS) 656

Effects of Distance of Urgent Transfer to a Major Trauma Centre within a UK Trauma Network

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Aims: A major reorganization of trauma services occurred in the England in 2012, with the creation of major trauma networks with a centralized specialist trauma centre receiving patients from significant geographical distances

Methods: Data was analysed from a prospectively maintained database located at a major trauma centre in Liverpool, England, from June 2012 to Jun 2014. Outcomes included basic demographics, ISS, intervention and mortality. Primary outcomes were compared between a group of patients transferred from incidents local to the centre and a second group of patients transferred from geographically greater distances bypassing their local hospital. Data was analysed using Fisher's exact test.

Results: 1261 patients were admitted between June 2012 and June 2014, with 840 in the local cohort and 421 in the bypass group. No significant differences exist between demographic data and injury severity scores. There were more patients with GCS < 8 in the local group, 16% vs 10% ($p = 0.002$). More patients required intervention, 16% vs 11% ($p = 0.03$) and were admitted to intensive care, 16% vs 10% ($p = 0.006$) in the local group. There was no change to patients requiring neurosurgical transfer, 11% vs 11% ($p = 1.000$). There was a slightly higher mortality in the bypass group but not statistically significant: 6% vs 4% ($p = 0.09$).

Conclusions: Mortality between patients transferred geographically longer distances, bypassing their local hospital, was similar to those patients injured locally.

Trauma & Military Surgery (ATMS) 753

Images of War: Accurate FAST and Abdominal CT Minimizes Negative Laparotomy for Battlefield Abdominal Trauma

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Aims: Focused assessment with sonography for trauma (FAST) and computed tomography (CT) are established contributors to surgical decision making.

This study investigates their use in the initial assessment and management of battlefield abdominal injuries in a mature deployed military trauma system.

Methods: Casualties at risk of abdominal injury who were admitted directly to the Camp Bastion Role 3 Medical Treatment Facility, Afghanistan, between July and November 2012 were identified from the UK Joint Theatre Trauma Registry (JTTR), radiology reports and prospectively gathered surgical data. Diagnostic accuracy was determined by comparing radiologically identified injuries with those found at laparotomy. The association between imaging and casualty management was examined.

Results: Of 468 casualties meeting inclusion criteria, 159/468 (34%) had sustained abdominal injuries. 398/468 (85%) were assessed with FAST, 403/468 (86%) with CT. 359/396 (91%) of patients with available FAST reports also underwent CT or laparotomy. 48/468 (12%) of CT patients underwent laparotomy. For detection of intra-abdominal injury FAST sensitivity was 0.556, specificity 0.978, positive predictive value (PPV) 0.865, negative predictive value (NPV) 0.895 and accuracy 0.891. For CT, sensitivity was 0.985, specificity 0.991, PPV 0.956, NPV 0.997 and accuracy 0.990. Forty-six solid organ injuries were identified in 38 patients by CT, of whom 12 were managed non-operatively. Thirty-nine patients had ≥ 1 hollow viscus injury (HVI); all underwent laparotomy. Six injuries found at laparotomy had not been identified radiologically. In total, CT allowed 78 patients to be managed without laparotomy (15 with selective non-operative management of solid organ injury or haematoma, 61 where penetrating injury was shown not to have penetrated the peritoneum). The negative laparotomy rate was 3/77 (3%).

Conclusions: FAST and CT are integral components of battlefield casualty management. Contrary to traditional military surgical doctrine, accurate imaging allows surgeons to consider non-operative management and is associated with a historically low rate of negative laparotomy.

Trauma & Military Surgery (ATMS) 760

Pre-Hospital Blood Products After Battlefield Trauma: Benefit Unclear

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Aims: Trauma resuscitation with high ratios of plasma to packed red cells has become standard hospital practice. Observational data suggest this may confer a survival benefit, possibly by correction of trauma-induced coagulopathy (TIC). Pre-hospital blood products (PHBPs) are part of a suite of advanced resuscitative interventions associated with increased survival. The contribution of individual components has not been established. This study's aim was to determine whether PHBPs correct TIC or reduce mortality.

Methods: A three-year case-control study of major battlefield trauma casualties (NISS ≥ 16) admitted to a UK military hospital in Afghanistan was performed. Exclusions were surgery at forward facilities, isolated head injuries and unsurvivable injuries (any military AIS = 6). Demographics, wounding mechanism, injuries sustained, trauma burden, pre-hospital vital signs and interventions, PHBP receipt and survival were retrieved from the UK Joint Theatre Trauma Registry. Cases were matched to ROTEM™ records. Coagulopathy was defined as EXTEM-MCF < 40 mm. Multivariate analysis identified factors associated with coagulopathy and mortality.

Results: 1047 cases met eligibility criteria. ROTEM™ data were matched for 687/1047 (65.6%). 272/1047 casualties (26.0%) received PHBP. PHBP recipients were more severely injured than non-recipients (median NISS 41 (29–54) vs. 25 (18–29)), more frequently injured in explosions and had a higher frequency of limb injuries. After multivariate regression, significant independent associations remained between PHBP receipt and both coagulopathy (adjusted OR: 1.543 (95% CI: 1.062–2.241)) and mortality (adjusted OR: 2.038 (95% CI: 1.200–3.461)).

Conclusions: In this large case-control study, pre-hospital blood product resuscitation after major battlefield trauma was not associated with a reduction in the incidence of coagulopathy or in mortality. High quality evidence from prospective trials is needed before widespread adoption of this intervention.

Trauma & Military Surgery (ATMS) 837

Selective Aortic Arch Perfusion for the Reversal of Haemorrhage-Induced Traumatic Cardiac Arrest in a Large Swine Translational Model of Non-Compressible Torso Haemorrhage:E. B. Barnard^{1*}, J. E. Manning², J. M. Rall³, J. M. Cox³, J. D. Ross³¹59th Medical Wing Office of the Chief Scientist, Institute of Naval Medicine UK,²The University of North Carolina at Chapel Hill, ³59th Medical Wing Office of the Chief Scientist, United States

Aims: Non-compressible torso haemorrhage (NCTH) is the leading cause of potentially survivable combat death, and 90% of deaths occur before hospital arrival. Selective aortic arch perfusion (SAAP) provides the potential to manage hemorrhage-induced traumatic cardiac arrest (HiTCA) with NCTH by controlling aortic torso inflow, increasing cardiac afterload, and delivering oxygenated fluid to the central circulation. Hypothesis: SAAP with oxygenated blood confers a survival advantage over both SAAP with oxygenated Hartmann's solution, and chest compressions with venous blood in HiTCA with NCTH.

Methods: A model of HiTCA in male splenectomised pigs (70-90 kg) was developed - a hybrid of systematic laparoscopic liver injury and arterial haemorrhage. Arrest was defined as a systolic blood pressure (SBP) < 10 mmHg sustained for three minutes. Randomised intervention was: SAAP with oxygenated fresh whole blood (FWB-SAAP), SAAP with oxygenated Hartmann's solution (LR-SAAP), or closed chest compressions with venous FWB (CCC). The SAAP groups received further 250 ml boluses of test fluid if SB < 90 mmHg, up to a maximum of 1750 ml. A 60-minute pre-hospital period was observed. Primary outcome - pre-hospital survival, secondary outcomes - hospital arrival SBP and fluid requirements after 1600 ml SAAP. Results are expressed as means (+/- standard deviation).

Results: Sixteen animals were included (median weight 83 kg). Left lateral lobe liver resection and arterial bleed was consistent amongst groups - 64.3% (+/- 11.5), p = 0.99, and 22.6 ml/kg (+/- 4.7), p = 0.17 respectively. The mean SBP during the arrest period was 4 mmHg, with a brady/agonal or asystolic cardiac rhythm. 100% (6/6) FWB-SAAP, 60% (3/5) LR-SAAP, and 40% (2/5) CCC animals survived. Hospital arrival SBP was significantly higher in FWB-SAAP (94.4 mmHg +/- 9.0), compared to both LR-SAAP (26.9 mmHg +/- 27.6) and CCC (26.2 mmHg +/- 36.0), < 0.001. Mean fluid requirement (after 1600 ml SAAP) was 625 ml (+/- 586) for FWB-SAAP, and 1750 ml (+/- 0) for LR-SAAP, < 0.001.

Conclusions: FWB-SAAP confers a 100% pre-hospital survival of HiTCA in NCTH even in cardiac asystole.

Trauma & Military Surgery (ATMS) 852

Initial Electrolyte Variability in Military Trauma Patients as a Predictor of OutcomeS. Mossadegh^{1*}, P. J. Parker²¹Queen Mary University of London, ²Academic Department of Military Surgery and Trauma, United Kingdom

Aims: Aggressive damage control resuscitation and surgery has become the norm within military trauma patients, but little is known about the effects of such aggressive fluid management on a cellular level. A detailed study into the following electrolytes was carried out to see if there were any obvious adverse effects, which could alter our future management of such cases (Sodium, Potassium, Creatinine, Urea, Calcium, Phosphate, Magnesium and Lactate). White Cells and Platelets were also reviewed.

Methods: A retrospective cohort study of a grievously injured group of military trauma patients was carried out. Cases were identified from the UK Joint Theatre Trauma Registry (JTTR) over a 4-year period (2008 to 2012). Information regarding resuscitation products used was examined in detail then further information regarding serial laboratory data was gathered and analysed using statistical methodology (Fisher's Exact and t-test).

Results: Of 231 military trauma patients, 31 died. The analysis of the blood products used showed that significantly more blood products were used in the fatality group (packed red cells, fresh frozen plasma, platelets and cryoprecipitate), however there was no significant difference for crystalloid or colloid use.

On analysis of electrolytes, the mean values of serial sodium and potassium, although within range, did show significant differences between those that survived and those that died. Analysis of white cell count and platelets showed that there were significant differences between initial and subsequent values as well as between those that died and survived.

Conclusions: These results demonstrate that significant biochemical changes do occur in trauma patients, but as the sample is small more needs to be done to investigate what truly happens. A prospective research study is essential as understanding the physiological trauma response can help us guide future resuscitation strategies.

Trauma & Military Surgery (ATMS) 877

Lost in Translation: An Observational Study of the Utilisation and Patient Understanding of Abbreviations on the Consent form for Trauma Surgery in a Busy UK Major Trauma CentreL. Navaratne^{*}, S. Hettiaratchy

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Aims: For consent to be valid, it must be given voluntarily by an appropriately informed person who has the capacity to consent to the intervention in question. Acquiescence where the person does not know what the intervention entails is not 'consent'. It is generally accepted that abbreviations often cause confusion and should be avoided in medical documentation. The aim of this pilot study is to learn about common consenting practices amongst surgeons, the use of abbreviations and if their use contributes to patients not fully understanding their consent form for surgery.

Methods: Over a one week period all adult in-patients pre- and post- emergency or elective procedures on the major trauma step-down ward of a busy UK Major Trauma Centre were included in the study. Data was collected by pre-operative or post-operative interviews conducted by the same investigator (LN). The data recorded included the number and frequency of the abbreviations used by surgeons, patient understanding in general terms of the abbreviations used and whether or not patients fully understood the entire content of their consent form.

Results: From the 50 consent forms a total of 87 abbreviations (with 18 different abbreviations) were used. Nearly one fifth (18%) of consent forms contained 3 or more abbreviations. Patients fully understood their consent form in 86% of cases when no abbreviations (n = 7) were used and in 14% of cases when one or more abbreviations (n = 43) were included in the consent form (Fisher's exact test, p = 0.0004).

Conclusions: If surgeons fail to obtain proper consent and the patient subsequently suffers harm as a result of treatment, this may be a factor in a claim of negligence against the healthcare professional involved. This study demonstrates that abbreviations frequently contribute to patient lack of understanding and it is recommended that their use has no place on the surgical consent form.

Trauma & Military Surgery (ATMS) 1013

Physiological Effects of Extracorporeal Hemofiltration Following Bilateral Hind Limb Ischemia-reperfusion Injury in Sus ScrofaMichael Clemens^{1*}, Mammie Stull², Jason Rall¹, Jennifer Cox¹, James D Ross¹¹59th Medical Wing, Office of the Chief Scientist, ²San Antonio Military Medical Center, United States

Aims: Ischemia-reperfusion remains a dilemma with increases in proximal tourniquet usage and survivability of major vascular injuries. The objective of this study was to assess the physiological changes associated with extracorporeal hemofiltration in limb ischemia-reperfusion injury.

Methods: Female Yorkshire-Landrace swine (70-90 kg) were selectively catheterized via right groin to deploy endovascular balloon occlusion of the distal aorta and inferior vena cava. Hind limbs were rendered ischemic for two hours prior to reperfusion. Venous return was diverted through a novel extracorporeal circuit. Animals underwent non-selective hemofiltration (10-50 kD)

or sham filtration (6 and 5 respectively) and were observed for seven days with clinical and laboratory assessments.

Results: Following ischemia, physiologic parameters demonstrated minimal variation between groups. Mean arterial pressure dropped quickly upon reperfusion, requiring fluid and pressor support in both groups. Cardiac output, central venous oxygen saturation, pulmonary arterial and central venous pressure were comparable. Heart rate significantly increased from baseline in the filtration group. Respiratory indicators showed an acute response to acidosis, which subsequently resolved with normalization in pH. Laboratory analysis demonstrated a similar early peak in lactic acidosis that resolved over 6 hours (peak lactate 8.9 mmol/L vs 7.6 control, $p=0.35$). There was observable difference in laboratory analysis of the reperfusate and systemic values; lactate (filter 7.6 vs. 4.32, $p=0.01$, control 8.9 vs 5.3, $p=0.04$) and pH (filter 7.19 vs 7.38, <0.01 , control 7.19 vs 7.39 <0.01). Animals demonstrated hind-limb paralysis throughout the post-operative course. Markers of end-organ injury (creatinine, creatine kinase, liver function enzymes) demonstrated continual evolution of injury through post-operative course, resolving through day 7. Filtration animals trended toward lower postoperative creatinine values (POD7 1.2 vs 0.9, $p=0.13$).

Conclusions: Extracorporeal isolation of venous return allows for hemofiltration, though the tested model demonstrated marginal clinical significance between groups. Differences in reperfusate and systemic circulation suggest robust inherent buffering mechanisms in swine.

Trauma & Military Surgery (ATMS) 1064

Hyperbaric Sub-normothermic ex-vivo Perfusion Delays the Onset of Acute Rejection in a Porcine VCA Model

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Aims: Vascularized composite allotransplantation (VCA), offers superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Here we evaluate a novel hyperbaric oxygen (HBO) ex-vivo perfusion device to mitigate reperfusion injury and delay the onset of acute rejection in a porcine VCA model. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for reduced toxicity and improved applicability of VCA as a reconstructive technique.

Methods: This experiment utilizes a validated porcine model of gracilis myocutaneous VCA. Eight experimental donor flaps were cannulated intra-arterially and perfused for five hours with hyper-oxygenated WS (mean PaO₂ = 93.3 kPa) at 20°C in a hyperbaric chamber at 3 atm. These flaps were then transplanted heterotopically into recipient animals' necks, genetically controlled to be one HLA mismatch. Eight control flaps were obtained and transplanted without pre-treatment. Animals were evaluated clinically and biochemically. Additionally, flaps were assessed histologically at completion of the experiment (Day 15).

Results: Control flaps experienced Grade 1 rejection at a mean of 6.4 days (SD 0.52) and Grade 4 rejection at a mean of 10.5 days (SD 2.6). The experimental flaps showed a statistically significant delay in the onset of Grade 1 rejection at 13.71 days (SD 0.52, $p=0.0215$). At the experiment's conclusion (Day 15), 75% of the experimental flaps were without any evidence of Grade 4 rejection.

Conclusions: Hyperbaric subnormothermic perfusion significantly delays the onset of acute rejection. Ischemic injury is mitigated as well as cold preservation-induced injury. This technology has potential utility in the field of solid organ and vascularized composite allotransplantation and could expand the donor pool dramatically. Furthermore, ex-vivo normalization of tissue physiology may reduce antigen presentation and acute rejection phenomena in allotransplantation.

Trauma & Military Surgery (ATMS) 582

Tranexamic Acid Use in Trauma: An Evaluation Over 3 years in a Regional Major Trauma Network

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Aims: The aim of the study was to understand if patients presenting to the Major Trauma Centre are being administered Tranexamic Acid (TXA) appropriately, being under utilised or potentially harmful if inappropriately given.

Methods: A retrospective cohort study of patients sustaining trauma injuries over a 3 year period, between January 2012 and December 2014, was undertaken. Quantitative evaluation was made using the hospital's trauma registry and electronic medical records to collect the required data fields. Statistical analysis and evaluation for confounding factors was performed between patient administered TXA (treatment group) and those not administered TXA (control group).

Results: Evaluation of our trauma registry over the 35 month period demonstrated a total of 2266 patients attended our Major Trauma Centre. TXA was administered to 327 patients, the severity of trauma injuries seen in this group was significantly higher than in No TXA group (ISS: 24 Vs 16). Unadjusted comparison demonstrated fatality rates and blood transfusion administration rates were higher in the TXA group, yet the TXA group had much lower survival probability. Furthermore, in sub-group analysis with greater homogeneity, such as penetrating trauma, shocked patients and those requiring blood transfusion, TXA group has lower fatality rates despite poorer survival probabilities.

Conclusions: Trauma care has seen many rapid developments, especially upon waves of higher level scientific studies. However, the implementation of these practices often awaits confirmation prior to universal adoption. Our study demonstrates the incidence of TXA use is lower than expected and further solutions must be sort in order to achieve the expected level. In this unadjusted format, due to the elements of confounding from trauma severity and clinician discretion greater statistical analysis is required to determine the true impact of TXA on trauma survival. Therefore, this study only provides a description of TXA use at this stage and not the clinical influence of TXA in trauma patients.

Trauma & Military Surgery (ATMS) 760

Pre-hospital Blood Pafter Battlefield Trauma: Benefit Unclear

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Aims: Trauma resuscitation with high ratios of plasma to packed red cells has become standard hospital practice. Observational data suggest this may confer a survival benefit, possibly by correction of trauma-induced coagulopathy (TIC). Pre-hospital blood products (PHBPs) are part of a suite of advanced resuscitative interventions associated with increased survival. The contribution of individual components has not been established. This study's aim was to determine whether PHBPs correct TIC or reduce mortality.

Methods: A three-year case-control study of major battlefield trauma casualties (NISS ≥ 16) admitted to a UK military hospital in Afghanistan was performed. Exclusions were surgery at forward facilities, isolated head injuries and unsurvivable injuries (any military AIS = 6). Demographics, wounding mechanism, injuries sustained, trauma burden, pre-hospital vital signs and interventions, PHBP receipt and survival were retrieved from the UK Joint Theatre Trauma Registry. Cases were matched to ROTEM™ records. Coagulopathy was defined as EXTEM-MCF <40 mm. Multivariate analysis identified factors associated with coagulopathy and mortality.

Results: 1047 cases met eligibility criteria. ROTEM™ data were matched for 687/1047 (65.6%). 272/1047 casualties (26.0%) received PHBP. PHBP recipients were more severely injured than non-recipients (median NISS 41 (29–54) vs. 25 (18–29)), more frequently injured in explosions and had a higher frequency of limb injuries. After multivariate regression, significant independent associations remained between PHBP receipt and both coagulopathy (adjusted

OR: 1.543 (95% CI: 1.062-2.241)) and mortality (adjusted OR: 2.038 (95% CI: 1.200-3.461)).

Conclusions: In this large case-control study, pre-hospital blood product resuscitation after major battlefield trauma was not associated with a reduction in the incidence of coagulopathy or in mortality. High quality evidence from prospective trials is needed before widespread adoption of this intervention.

Basic and Applied Clinical Science 1018

Is Local Antibiotic Delivery Compatible With Negative Pressure Wound Therapy?

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Aims: Antibiotic loaded Polymethylmethacrylate (PMMA) beads are not an ideal antibiotic vehicle, and negative pressure wound therapy (NPWT) has been shown to reduce their effectiveness. It appears that negative pressure removes the eluted antibiotic from the wound before it can diffuse throughout the wound. We hypothesized that antibiotic impregnated chitosan sponges would effectively reduce bacteria when used with NPWT due to increased contact with the wound surface.

Methods: The effectiveness of PMMA antibiotic beads was compared to antibiotic loaded chitosan sponge, used in both wound pouch and NPWT modalities. A complex tibial open fracture wound was created in goats and inoculated with *S. aureus*. The wounds were debrided at 6 hours, and the bacteria was quantified both pre and post debridement. The animals were assigned to a group, and the bacteria within the wound were re-quantified after 2 days. The four groups were: antibiotic bead pouch, antibiotic beads with NPWT, chitosan sponge pouch, and chitosan sponge with NPWT. Both the beads and sponges contained vancomycin.

Results: There were significantly fewer bacteria within the wounds treated with chitosan sponge compared with antibiotic beads irrespective of use in a pouch or with NPWT. Unlike beads, the effectiveness of chitosan sponges was not reduced by NPWT.

Conclusions: This study demonstrates that a biodegradable chitosan sponge loaded with vancomycin is superior to antibiotic impregnated beads at eradicating *S. aureus* in a complex large animal wound model. It also offers advantages in handling, antibiotic choice, device removal and its effect is not reduced when used with NPWT. PMMA beads act as a depot, eluting antibiotic which must diffuse throughout the wound. When used with NPWT, the antibiotic is removed before it can reach bacteria not in contact with the beads. The increased contact with the wound surface of the chitosan sponge allows improved antimicrobial action, more pronounced with NPWT.

ATMS Short Paper Session 4

Trauma & Military Surgery (ATMS) 147

The Utility of Surgical Key Performance Indicators in British Military Trauma

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Aims: Performance Indicators (PI) are used extensively in trauma management to compare actual against ideal care. In 2008, authors from the British Military published bespoke Key Performance Indicators (KPIs) which are specific for measuring the performance of end to end care in this unique environment. This paper evaluates the specific surgical KPIs. The primary aim was to review the overall performance of surgical trauma care in war wounded casualties treated at Camp Bastion, Medical Treatment Facility, Afghanistan. Our secondary aims were to assess the utility (clarity and relevance) of the British Military's Surgical KPIs, and make recommendations for future surgical trauma care review

Methods: The original surgical KPIs have been refined based on deployed clinical experience to provide 22 parameters that analyse surgical care. Data on these 22 parameters was prospectively collected for 150 consecutive injured patients who had primary surgery at Camp Bastion between 1 st May 2013 and 20 th August 2013.

Results: Median data recording was 99% (IQR 98-100%). Median relevance was 54% (IQR 10-99%). 80% of KPIs achieved > 60% compliance, of which 50% scored > 80% compliance. (See attached table 1) We propose a new set of surgical KPIs for use in future military trauma surgical care in which 11 KPIs are retained, 9 KPIs are refined and 2 are removed.

Conclusions: This study is the first that we are aware of that measures surgical Performance Indicators in military trauma. We highlight areas for improvement in service delivery and the utility of KPIs themselves. KPIs must constantly evolve in order to maintain relevance and to highlight areas for improvement of the care for war wounded trauma patients. We also provide a list of carefully considered surgical KPIs for future use in the deployed surgical setting.

Emergency Surgery including Trauma (ASGBI) 385

Assessment of Sensitivity of Whole Body CT for Major Trauma

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Aims: Whole body Computed Tomography has become standard practice in many centres in the management of severely injured trauma patients, however the evidence for its diagnostic accuracy is limited.

To assess the sensitivity of Whole body CT in Major Trauma.

Methods: Retrospective review of all patients with Injury Severity Score (ISS) > 15 presenting with blunt trauma to a UK Major Trauma Centre between May 2012 and April 2014.

The authors reviewed patient's electronic charts, radiological results, interventional procedure records, discharge letters and outpatient follow up documentation and referenced this with the major trauma database.

Results: 407 patients with ISS > 15 presented to the Trauma centre during May 2012 and April 2014. Of these, 337 (82.8%) had a whole body CT scan. 246 pts were male, 91 were female. 74 (21.9%) were due to a fall from > 2 m, 41 (12.2%) due to a fall from < 2 m, 208 (61.7%) were due to motor vehicle crashes, 1 (0.29%) due to a blast injury, 5 (1.48%) due to blows, and 8 (2.37%) due to crush injuries. Sensitivity for head & neck was 0.98, face 0.98 chest 0.98 and abdomen 0.95. Overall sensitivity was 0.96. 15 injuries (4.5%) were not identified on initial CT (False -ve). These injuries were: Colonic perforation =1, Splenic contusion =1, Pneumothorax =1, Liver laceration =1,

intracranial haemorrhage = 1, cerebral contusions = 1, spinal injuries = 7, canal haemorrhage = 1, maxilla fracture = 1.

Conclusions: These results show that whole body CT in trauma has a high sensitivity and a low rate of false negativity (4.5%). However, our study only evaluated a subgroup of patients with ISS > 15 and further work is required to assess the value of CT in trauma patients with less severe injury.

Trauma & Military Surgery (ATMS) 545

Refining the Trauma and Injury Severity Score (TRISS) to Measure the Performance of the UK Combat Casualty Care System

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Aims: The TRISS methodology is used in by both the UK and US military trauma registries and relies on dividing casualties according to mechanism: penetrating or blunt, and uses different weighting coefficients accordingly. The UK and US military trauma registries use the original coefficients devised in 1987 and it is not clear how either registry analyses explosive casualties according to the TRISS methodology.

This study aims to use the UK military trauma registry (JTTR) to calculate new TRISS coefficients for contemporary battlefield casualties injured by either gunshot or explosive mechanisms. A secondary aim of this study is to apply the revised TRISS coefficients to examine the survival trends of UK casualties from recent military conflicts.

Methods: The JTTR was searched for all UK casualties injured or killed in Iraq and Afghanistan by explosive or gun-shot mechanisms between 1 st Jan 2003 and 31 Dec 2014. Details of these casualties including injuries and vital signs were reviewed. A logistic regression analysis was performed to devise new TRISS coefficients, these were then used to examine survival over the 12 years of the study.

Results: Comparing the predictions from the GSW TRISS model to the observed outcomes, it demonstrates a sensitivity of 98.1% and a specificity of 96.8% and an overall accuracy of 97.8%. With respect to the explosive TRISS model, there is a sensitivity of 98.6%, a specificity of 97.4% and an overall accuracy of 98.4%. This improved TRISS methodology was used to measure changes in survival over the study period, the peak performance was in 2009–10.

Conclusions: This study for the first time refines the TRISS methodology with coefficients appropriate for use with combat casualty care systems. This work allows the performance of combat casualty case systems to be accurately measured in future conflicts.

Audit and Outcomes Research 553

A Review of Vascular Injuries Seen During First Two Years in a New Major Trauma Centre in the UK

P. Buxton^{*}, L. Meecham, C. Bosanko, C. Day, A. Pherwani

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Aims: The UK saw centralisation of trauma services in 2012 with the development of Level One Major Trauma Centres. Our aim was to review the vascular injuries treated at a major non-urban trauma centre.

Methods: The prospective TARN (Trauma Audit Research Network) database was interrogated for data over a 2-year period from April 2012 to April 2014 for all trauma admissions that had a vascular injury code. Case notes were used to collect demographics, mechanism of injury, Injury Severity Score (ISS), injuries sustained both vascular and non-vascular, management of vascular injuries and outcomes.

Results: Total number of trauma patients received over 2 years = 1697. Of these 69(4%) sustained vascular injuries. Mean age = 44 years, male preponderance(51:18). Mean ISS 24.4+/-6.5 with only 13/69 having ISS < 16. The mechanism of injuries recorded-Road Traffic Collision(39), Falls(10), Stabbing(9), Industrial(4), Agricultural(3), Leisure/sport(2), Blows(1) and Shootings(1). 26 patients had vascular injuries that were dealt with by other specialities, 13 general surgery(splenectomy(4), mesenteric bleeds(4)), Orthopaedic(5), Cardio-thoracic(4) Neurosurgery(3), and ENT(1) with a mortality of 16%(n = 11). Nearly half of 48(n = 21) patients requiring vascular input were treated conservatively, 10 required a combined approach with vascular surgery/radiology, of which 7 were Thoracic-aortic stenting for traumatic dissection. Those requiring surgery were for lacerations of Aorto/iliac(3), Femoral/popliteal(3), Brachial(3) and Radial(2), mesenteric(1), and one retrieval of foreign body impaled in leg.

Conclusions: This review illustrates the range of vascular injuries seen in a new trauma centre in the UK. Unlike urban trauma centres with a large proportion of penetrating injuries, vascular trauma accounts for a small proportion of cases in our centre which deals with a large number of road accidents and falls. We encounter patients with severe multiple injuries and a significant proportion require a combined surgical and radiological approach to management. As such vascular trauma is time and manpower intensive which highlights the need for a multidisciplinary approach to vascular injuries.

Emergency Surgery including Trauma (ASGBI) 556

Gun-Shot Injuries in UK Military Casualties-Features Associated with Wound Severity

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Aims: Surgical treatment of high-energy GSWs to the extremities is challenging. It is recognised that the size of external wounds can belie the extent of deeper tissue damage. GSWs are not homogeneous however and high-energy firearms do not necessarily produce 'high-energy GSWs'. The aim of this study is to firstly characterise the gun shot injuries sustained by UK forces and secondly, test the hypothesis that the likely severity of gun-shot wounds can be predicted by features of the wound.

Methods: The UK Military trauma registry was searched for cases injured by GSW in the five years between 01 Jan 2009 and 31 Dec 2013; only UK personnel were included. Clinical notes and radiographs were then reviewed.

Results: There were 450 cases who met the inclusion criteria. 96 (21%) were fatally injured, with 354 (79%) surviving their injuries. Overall, the chest was the most common region injured (23%). In survivors the limbs were most commonly injured (56%).

Of the 325 survivors with full records, 236 had GSWs to the limbs and pelvis, this cohort was analysed further with respect to which factors were associated with a requirement for repeated debridements. 'Through and through' wounds where the bullet passes through the body without any retention of bullets or fragments thereof, was strongly associated with less requirement for debridement (<0.0001). Fractures were associated with a requirement for a greater number of wound debridements (p = 0.00022). When comparing wounds with retained, intact bullets with those involving bullet fragmentation, there was no association with the amount of wound debridements required (p = 0.53744).

Conclusions: This study has characterised the injuries from firearms sustained by UK Military personnel over 5-years of warfare. More complex wounds as indicated by the requirement for repeated debridements are associated with injuries where the bullet does not pass straight through the body, or where a bone is fractured.

Emergency Surgery including Trauma (ASGBI) 773

Hyper-Acute Rehabilitation at A Major Trauma Centre

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Aims: Hyper-acute rehabilitation is the implementing of a very early rehabilitation process for patients in parallel with their initial stages of medical treatment and has been used at our trauma centre since June 2012. The identification of a need for and deployment of early rehabilitation can reduce healthcare costs by reducing dependence, nursing care, length of stay (LoS) and prevention of disability. We looked at the trends in hospital episode outcomes in patients going through the hyper-acute rehabilitation service in our major trauma centre.

Methods: A prospective dataset of all patients in the rehabilitation system was interrogated, with primary outcomes measured being LoS and bed occupancy rate (BOR). Secondary outcomes were LoS for patients with an Injury Severity Score (ISS) > 15. Data were analysed for the month of August in three consecutive years (2012, 2013 and 2014).

Results: In August 2012, 27 patients were admitted, with a mean LoS of 8.5 days and BOR of 2.25 patients per bed per month. Mean ISS was 16.3, and mean LoS for patients with ISS > 15 was 14.6 days. In 2013, 76 patients were admitted with a mean ISS of 13.1 for a mean LoS of 7.1 days. The mean LoS for an ISS > 15 was 5.5 days. In August 2014, 47 patients were admitted, with a mean LoS of 6.6 days and BOR of 3.9 patients per bed per month, and mean LoS for patients with ISS > 15 was 9.2 days.

Conclusions: The hyper-acute rehabilitation system has become an established part of post trauma care offered in our centre. Since implementation it has shown substantial short term advantages to the institution by reducing overall LoS, reducing LoS for severely traumatized patients, and increasing bed occupancy rates and improving flow through the trauma ward.

Audit and Outcomes Research 553

A Review of Vascular Injuries Seen During First Two Years in a New Major Trauma Centre in the UK

P. Buxton*, L. Meecham, C. Bosanko, C. Day, A. Pherwani

University Hospitals of North Midlands NHS Trust, United Kingdom

Aims: The UK saw centralisation of trauma services in 2012 with the development of Level One Major Trauma Centres. Our aim was to review the vascular injuries treated at a major non-urban trauma centre.

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26 patients had vascular injuries that were dealt with by other specialities, 13 general surgery(splenectomy(4), mesenteric bleeds(4)), Orthopaedic(5), Cardio-thoracic(4) Neurosurgery(3), and ENT(1) with a mortality of 16%(n = 11). Nearly half of 48(n = 21) patients requiring vascular input were treated conservatively, 10 required a combined approach with vascular surgery/radiology, of which 7 were Thoracic-aortic stenting for traumatic dissection. Those requiring surgery were for lacerations of Aorto/iliac(3), Femoral/popliteal(3), Brachial(3) and Radial(2), mesenteric(1), and one retrieval of foreign body impaled in leg.

Conclusions: This review illustrates the range of vascular injuries seen in a new trauma centre in the UK. Unlike urban trauma centres with a large proportion of penetrating injuries, vascular trauma accounts for a small proportion of cases in our centre which deals with a large number of road accidents and falls. We encounter patients with severe multiple injuries and a significant proportion require a combined surgical and radiological approach to management. As such vascular trauma is time and manpower intensive which highlights the need for a multidisciplinary approach to vascular injuries.

Audit and Outcomes Research 987

Abdominal Trauma: a Regional Analysis of Management and Outcomes

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Aims: Abdominal trauma poses significant challenges in terms of diagnosis and management. Contemporary prevalence and patterns in the United Kingdom remain largely unknown. The aim of this multicentre study was to examine the characteristics of abdominal trauma in 3 major trauma centres.

Methods: All patients presenting as a 'trauma-call' in the emergency departments of the 3 major trauma centres in the West Midlands with an underlying injury that justified immediate cross-sectional imaging of the abdomen & pelvis were included, over a period of 2 years. Significant blunt abdominal trauma was defined as any blunt abdominal injury requiring immediate exploratory laparotomy or a Computed Tomographic (CT) scan. Delayed laparotomy is defined as major abdominal surgery taking place > 12 hours from admission. Patient records and imaging were reviewed to assess outcomes.

Results: A total of 5,532 patients [3,507 females (63%); mean age: 43±9 years (SD)] were included. In 1,658 patients (30%) blunt abdominal trauma was the predominant injury. Initial CT findings of the abdomen and pelvis included: 220 (4%) patients with evidence of free fluid, 195 (3.5%) with a direct mesenteric injury, 41 (0.7%) with a vascular injury, 156 (3%) with a splenic injury, and 104 (2%) with a hepatobiliary injury. A total of 86 (2%) patients underwent a laparotomy, of which 57 (66%) were performed as an emergency (within 12 hours) and 29 (34%) were delayed laparotomies. A total of 120 (2%) patients died within a period of 30 days. Presence of free abdominal or pelvic fluid at baseline was associated with mortality (Odds Ratio: 3.3, p=0.0003). There was no difference in mortality for those undergoing delayed or emergency laparotomy (p=0.14).

Conclusions: The patterns of injury following significant abdominal trauma vary. Modern management allows the majority of injuries to be treated conservatively following assessment of imaging, when immediate surgical intervention is not mandatory.

Basic and Applied Clinical Science 1018

Is Local Antibiotic Delivery Compatible with Negative Pressure Wound Therapy?

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Aims: Antibiotic loaded Polymethylmethacrylate (PMMA) beads are not an ideal antibiotic vehicle, and negative pressure wound therapy (NPWT) has been shown to reduce their effectiveness. It appears that negative pressure removes the eluted antibiotic from the wound before it can diffuse throughout the wound. We hypothesized that antibiotic impregnated chitosan sponges would effectively reduce bacteria when used with NPWT due to increased contact with the wound surface.

Methods: The effectiveness of PMMA antibiotic beads was compared to antibiotic loaded chitosan sponge, used in both wound pouch and NPWT modalities. A complex tibial open fracture wound was created in goats and inoculated with *S. aureus*. The wounds were debrided at 6 hours, and the bacteria was quantified both pre and post debridement. The animals were assigned to a group, and the bacteria within the wound were re-quantified after 2 days. The four groups were: antibiotic bead pouch, antibiotic beads with NPWT, chitosan sponge pouch, and chitosan sponge with NPWT. Both the beads and sponges contained vancomycin.

Results: There were significantly fewer bacteria within the wounds treated with chitosan sponge compared with antibiotic beads irrespective of use in a pouch or with NPWT. Unlike beads, the effectiveness of chitosan sponges was not reduced by NPWT.

Conclusions: This study demonstrates that a biodegradable chitosan sponge loaded with vancomycin is superior to antibiotic impregnated beads at eradicating *S. aureus* in a complex large animal wound model. It also offers

advantages in handling, antibiotic choice, device removal and its effect is not reduced when used with NPWT. PMMA beads act as a depot, eluting antibiotic which must diffuse throughout the wound. When used with NPWT, the antibiotic is removed before it can reach bacteria not in contact with the beads. The increased contact with the wound surface of the chitosan sponge allows improved antimicrobial action, more pronounced with NPWT.

Emergency Surgery including Trauma (ASGBI) 385

Assessment of Sensitivity of Whole Body CT for Major Trauma

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Aims: Whole body Computed Tomography has become standard practice in many centres in the management of severely injured trauma patients, however the evidence for its diagnostic accuracy is limited.

To assess the sensitivity of Whole body CT in Major Trauma.

Methods: Retrospective review of all patients with Injury Severity Score (ISS) > 15 presenting with blunt trauma to a UK Major Trauma Centre between May 2012 and April 2014.

The authors reviewed patient's electronic charts, radiological results, interventional procedure records, discharge letters and outpatient follow up documentation and referenced this with the major trauma database.

Results: 407 patients with ISS > 15 presented to the Trauma centre during May 2012 and April 2014. Of these, 337 (82.8%) had a whole body CT scan. 246 pts were male, 91 were female. 74 (21.9%) were due to a fall from > 2 m, 41 (12.2%) due to a fall from < 2 m, 208 (61.7%) were due to motor vehicle crashes, 1 (0.29%) due to a blast injury, 5 (1.48%) due to blows, and 8 (2.37%) due to crush injuries. Sensitivity for head & neck was 0.98, face 0.98 chest 0.98 and abdomen 0.95. Overall sensitivity was 0.96. 15 injuries (4.5%) were not identified on initial CT (False -ve). These injuries were: Colonic perforation =1, Splenic contusion =1, Pneumothorax =1, Liver laceration =1, intracranial haemorrhage = 1, cerebral contusions = 1, spinal injuries = 7, canal haemorrhage = 1, maxilla fracture = 1.

Conclusions: These results show that whole body CT in trauma has a high sensitivity and a low rate of false negativity (4.5%). However, our study only evaluated a subgroup of patients with ISS > 15 and further work is required to assess the value of CT in trauma patients with less severe injury.

Emergency Surgery including Trauma (ASGBI) 556

Gun-Shot Injuries in UK Military Casualties-Features Associated with Wound Severity

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Aims: Surgical treatment of high-energy GSWs to the extremities is challenging. It is recognised that the size of external wounds can belie the extent of deeper tissue damage. GSWs are not homogeneous however and high-energy firearms do not necessarily produce 'high-energy GSWs'. The aim of this study is to firstly characterise the gun shot injuries sustained by UK forces and secondly, test the hypothesis that the likely severity of gun-shot wounds can be predicted by features of the wound.

Methods: The UK Military trauma registry was searched for cases injured by GSW in the five years between 01 Jan 2009 and 31 Dec 2013; only UK personnel were included. Clinical notes and radiographs were then reviewed.

Results: There were 450 cases who met the inclusion criteria. 96 (21%) were fatally injured, with 354 (79%) surviving their injuries. Overall, the chest was the most common region injured (23%). In survivors the limbs were most commonly injured (56%).

Of the 325 survivors with full records, 236 had GSWs to the limbs and pelvis, this cohort was analysed further with respect to which factors were associated with a requirement for repeated debridements. 'Through and through' wounds where the bullet passes through the body without any retention of bullets or fragments thereof, was strongly associated with less requirement for debridement

(<0.0001). Fractures were associated with a requirement for a greater number of wound debridements ($p=0.00022$). When comparing wounds with retained, intact bullets with those involving bullet fragmentation, there was no association with the amount of wound debridements required ($p=0.53744$).

Conclusions: This study has characterised the injuries from firearms sustained by UK Military personnel over 5-years of warfare. More complex wounds as indicated by the requirement for repeated debridements are associated with injuries where the bullet does not pass straight through the body, or where a bone is fractured.

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Hyper-Acute Rehabilitation at A Major Trauma Centre

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Aims: Hyper-acute rehabilitation is the implementing of a very early rehabilitation process for patients in parallel with their initial stages of medical treatment and has been used at our trauma centre since June 2012. The identification of a need for and deployment of early rehabilitation can reduce healthcare costs by reducing dependence, nursing care, length of stay (LoS) and prevention of disability. We looked at the trends in hospital episode outcomes in patients going through the hyper-acute rehabilitation service in our major trauma centre.

Methods: A prospective dataset of all patients in the rehabilitation system was interrogated, with primary outcomes measured being LoS and bed occupancy rate (BOR). Secondary outcomes were LoS for patients with an Injury Severity Score (ISS) > 15. Data were analysed for the month of August in three consecutive years (2012, 2013 and 2014).

Results: In August 2012, 27 patients were admitted, with a mean LoS of 8.5 days and BOR of 2.25 patients per bed per month. Mean ISS was 16.3, and mean LoS for patients with ISS > 15 was 14.6 days. In 2013, 76 patients were admitted with a mean ISS of 13.1 for a mean LoS of 7.1 days. The mean LoS for an ISS > 15 was 5.5 days. In August 2014, 47 patients were admitted, with a mean LoS of 6.6 days and BOR of 3.9 patients per bed per month, and mean LoS for patients with ISS > 15 was 9.2 days.

Conclusions: The hyper-acute rehabilitation system has become an established part of post trauma care offered in our centre. Since implementation it has shown substantial short term advantages to the institution by reducing overall LoS, reducing LoS for severely traumatized patients, and increasing bed occupancy rates and improving flow through the trauma ward.

Trauma & Military Surgery (ATMS) 147

The Utility of Surgical Key Performance Indicators in British Military Trauma

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Aims: Performance Indicators (PI) are used extensively in trauma management to compare actual against ideal care. In 2008, authors from the British Military published bespoke Key Performance Indicators (KPIs) which are specific for measuring the performance of end to end care in this unique environment. This paper evaluates the specific surgical KPIs. The primary aim was to review the overall performance of surgical trauma care in war wounded casualties treated at Camp Bastion, Medical Treatment Facility, Afghanistan. Our secondary aims were to assess the utility (clarity and relevance) of the British Military's Surgical KPIs, and make recommendations for future surgical trauma care review

Methods: The original surgical KPIs have been refined based on deployed clinical experience to provide 22 parameters that analyse surgical care. Data on these 22 parameters was prospectively collected for 150 consecutive injured patients who had primary surgery at Camp Bastion between 1 st May 2013 and 20 th August 2013.

Results: Median data recording was 99% (IQR 98-100%). Median relevance was 54% (IQR 10-99%). 80% of KPIs achieved > 60% compliance, of which 50% scored > 80% compliance. (See attached table 1) We propose a new set of surgical KPIs for use in future military trauma surgical care in which 11 KPIs are retained, 9 KPIs are refined and 2 are removed.

Conclusions: This study is the first that we are aware of that measures surgical Performance Indicators in military trauma. We highlight areas for improvement in service delivery and the utility of KPIs themselves. KPIs must constantly evolve in order to maintain relevance and to highlight areas for improvement of the care for war wounded trauma patients. We also provide a list of carefully considered surgical KPIs for future use in the deployed surgical setting.

Trauma & Military Surgery (ATMS) 166

Gunshot and Blast Injuries: Establishment of An Innovative eLearning Resource for Core Surgical Trainees

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Aims: Gunshot and blast injuries are increasingly seen in civilian practice and their management forms a key curriculum outcome for core surgical trainees. Despite this, inadequate knowledge and exposure among surgical trainees have been identified as possible causes of poor care in the management of these pathologies. To supplement established surgical education methods, eLearning has emerged as a key component of structured, interactive learning for surgical trainees on both civilian and military training pathways.

Methods: This web-based module forms part of a suite of eLearning resources developed by the Royal College of Surgeons of England and hosted on the established eLearning for Healthcare virtual learning environment (VLE). The content is clearly mapped to the Core Surgical Training curriculum. This has resulted in the creation of an accessible, cost-effective, stimulating, relevant, and evidence-based education programme designed to meet the trauma education needs of core trainees.

Results: This study focuses on the conception, formulation and development of this web-based resource. eLearning such as this has clear potential to disseminate education, supplement surgical knowledge and improve the trauma skills of early career trainees, who may be called upon to manage gunshot and blast injuries in civilian and military contexts. A prospective cohort study will evaluate the outcomes of this eLearning against levels one and two of Kirkpatrick's four-level training evaluation model.

Conclusions: The growing need for trauma management skills requires innovative approaches to training planning at all levels. We have developed quality-assured eLearning with clear potential to pedagogically raise core surgical trainees' awareness and knowledge of gunshot and blast injury. This use of information technology supports a trainee-centred educational approach that promotes autonomy, flexibility and time management and helps trainees to assess their competence. These findings can inform further development of online trauma modules aimed at improving surgeons' knowledge and have wider applicability to others developing VLEs.

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Drug-Eluting Microparticle Immunosuppression in a Porcine Model of Vascularized Composite Allotransplantation (VCA)

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Aims: Consistent advances in body armor and combat casualty care have resulted in soldiers in current conflicts surviving battlefield trauma after sustaining catastrophic extremity and maxillofacial injuries. Reconstructive transplantation, or vascularized composite allotransplantation (VCA), offers a means for superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Using a validated porcine model of VCA with a gracilis myocutaneous flap allotransplant, we

evaluated the efficacy of locally applied immunosuppression to delay rejection in the absence of systemic immunosuppression. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for markedly improved safety and expanded applicability of reconstructive transplantation.

Methods: A donor gracilis myocutaneous flap is procured from Yorkshire swine. Prior to transplantation into a recipient, 20µm of drug-eluting microparticles loaded with IL-2, TGF-β², and rapamycin are injected subdermally into donor tissues. Microvascular transfer is then performed to a recipient using the right external carotid artery and internal jugular vein. Animals are survived for 14 days and rejection graded using the Banff rejection scale. Eight treatment animals are compared with 8 control animals which underwent allotransplantation without microparticle injection.

Results: Control animals reached Banff grade 1 and grade 4 rejection on an average of 6.4 days (±0.52) and 10.5 days (± 2.6), respectively. All of the controls reached grade 1 rejection by day 7 and grade 4 by day 14. In the experiment group, both grade 1 and 4 rejection were delayed to an average of > 14 days, with earliest grade 1 rejection at day 7 and earliest grade 4 rejection at day 11. Only 50% of the experimental animals reached grade 4 rejection at the limits of our study.

Conclusions: In the absence of systemic immunosuppression, subdermal application of microparticles eluting T-regulatory immunomodulators IL-2, TGF-β², and rapamycin significantly delays the time to acute rejection.

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Mind the Gap: Surgical Options when Primary Closure is not Possible Following Damage Control Laparotomy. A Systematic Review

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Aims: A Trauma damage control laparotomy (DCL) entails immediate control of haemorrhage and contamination, laparotomy and physiological stabilisation, then completion of surgery and early primary closure (EPC). Failing early primary closure, temporary abdominal closure (TAC) techniques maintain abdominal integrity until early definitive closure (EDC). The aims were to identify and compare outcomes of early definitive closure methods in these patients.

Methods: NICE, Cochrane, OVID (Medline, AMED, Embase, HMIC) and PubMed databases were accessed using (traum*, damage control, abbreviated laparotomy, component separation, fascial traction, mesh closure, planned ventral hernia (PVH), and topical negative pressure (TNP)). Randomised Controlled Trials, Case Series and Cohort Studies reporting TAC and early definitive closure methods in DCL trauma patients were included. Outcomes were mortality, days to fascial closure, hospital length of stay, abdominal complications and delayed ventral herniation.

Results: 26 studies identified early primary closure (DPC, acute component separation (ACS) and acute mesh repair (AMR)) and TAC methods (Whitman patch (WP), topical negative pressure (TNP), temporary mesh (TM), fascial tension, Bogota bag and skin tension). Estimates for mortality and abdominal complications in AMR and DPC groups were 0.45% and 40.85%, and 6.07%, and 16.74% respectively; AMR ventral hernia / laxity was 51.1% at one year. Days to closure were 6.30, 21.10 and 15.90 in DPC, ACS and AMR groups, whilst hospital LOS in ACS and DPC groups was 17.5 versus 23.3 days.

Conclusions: Acute component separation or mesh repair are alternative early definitive closure techniques to DPC following trauma DCL. Comparing outcomes is hampered by poverty of uniform reporting and bias. Recommendations for standardised reporting nomenclature and methodology are made.

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The Role of Free-Tissue Transfer in War-Related injuries of the Upper and Lower Extremities: A Systematic Review of Current Practice

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Aims: Extremity injuries occurring in combat zones have devastating sequelae. Increasing survival rates following such injuries, combined with rapid advances in microsurgery mean there is an ever-increasing role for free-tissue reconstruction. We aimed to review current trends in microvascular repair of extremity war injuries, focusing on flap types, timing of surgery and post-operative outcomes.

Methods: We conducted a PubMed search of the terms 'Microsurgery' and 'War' and identified articles involving extremity microvascular/free-flap repair in the sub-acute and delayed stage. Single-patient case reports and studies focusing exclusively on craniofacial and thoracoabdominal injuries were excluded. We focused on studies published in the 21st century to accurately reflect the idiosyncrasies of modern warfare.

The relevant articles were reviewed, identifying: geographical location of the injury and site of definitive surgery; anatomical site and number of wounds requiring reconstruction; types of free-flap used; time taken to transfer to a specialist centre and/or perform the reconstruction; flap-related complications; overall free-flap success and limb salvage.

Results: One interventional and ten cohort studies fulfilled our inclusion criteria. In 2 studies reconstruction was performed within combat/austere environments; In 9 studies patients were transferred to a specialist facility for definitive treatment. The number of free-flaps ranged from 6–208. 110 upper and 428 lower limb flaps were described. The most commonly used flap was the Latissimus Dorsi (44.2%). The average time to definitive reconstruction ranged from 9.6 days to 3 years. The average free-flap success rate was 95.3% (range 88.9%-100%).

Conclusions: Extremity injuries in combat zones are characterised by high-injury trauma, extensive tissue loss and gross contamination. Despite the severity of such injuries, challenging locations and delays in surgery, there is great scope for microvascular repair with minimal morbidity and good overall outcomes. Multicentre studies with large numbers are necessary to support these findings, establish definitive management guidelines and determine long-term outcomes.

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Locally applied enzyme activated tacrolimus eluting hydrogels significantly delay the onset of acute rejection of Vascularized Composite Allotransplantation grafts

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Aims: Vascularized Composite Allotransplantation (VCA), most commonly of the hand or face, can restore form and function in previously unreconstructable injuries. The utility of VCA is restricted by the morbidity and mortality conferred by long term systemic immunosuppression.

Targeted, donor-specific, treatments that delay rejection without systemic effects are a potential solution to this problem. The aim of this study was to evaluate one such treatment.

The investigation needed a previously unavailable animal model that comprised all transplanted tissues, that enabled the study of immune tolerance and healing, and that permitted an assessment of functional recovery.

Methods: We developed the first directly-translatable, orthotopic limb transplantation model in a large animal (swine). This has been used in the first instance to evaluate the efficacy of tacrolimus delivered locally in the transplanted limb by subcutaneous placement of a novel drug eluting hydrogel that releases the drug in the presence of activated macrophages. Six swine served

as donors for six SLA-mismatched recipients. Forelimbs were transplanted at a level corresponding to the mid forearm. Survival was for four weeks. Limbs were evaluated clinically and histopathologically for signs of rejection, blood and tissue levels of tacrolimus were measured along with other bio-markers.

Results: Control limbs underwent grade 4 acute rejection (complete necrosis of the skin) on post-operative day 6. Intervention limbs had not undergone acute rejection after four weeks. Animals mobilised freely using transplanted limbs, including accessing food, socializing and playing with rubber balls in a normal fashion.

Conclusions: Local delivery of tacrolimus into the grafted limb, using an enzyme responsive hydrogel, significantly delays the onset of acute rejection of grafts in a translatable, orthotopic limb model of VCA.

This novel model is uniquely powerful in that it permits the study of VCA not only in terms of immune rejection or tolerance, but also functional recovery.

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Correlation and Phase Relationship Between Peripheral Muscle Tissue Oxygenation (StO₂) and Arterial Blood Gas Parameters in an Animal Hypovolaemia-Resuscitation Model

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Aims: Near infrared spectroscopy provides a non-invasive, continuous, real-time assessment of tissue oxygenation (StO₂) that can be used to monitor the resuscitation of hypovolaemic patients.

This study aimed to compare the correlation and phase relationship between StO₂ and ABG parameters (principally base excess and lactate), and determine if StO₂ recorded from injured muscles could be used to monitor resuscitation in hypovolaemia.

Methods: Seven splenectomised pigs were subject to a hind limb soft tissue injury followed by a controlled haemorrhage (of approximately 35% blood volume) lasting 10 minutes, and a 30 minute shock phase. The animals then received 60 minutes of hypotensive crystalloid resuscitation to a target systolic blood pressure of 80 mmHg, followed by 150 minutes of normotensive resuscitation with blood products to a target systolic blood pressure of 110 mmHg. StO₂ was recorded from injured and control limbs along with basic physiological and ABG measurements.

Results: Time lag analysis between ABG measurements and physiological parameters assessed by cross-correlation:

Base Excess Lactate Physiological Variable

Correlation Coefficient Lag (minutes) Correlation Coefficient Lag (minutes)

StO₂ Control Limb StO₂ Injured Limb

Heart Rate Mean Arterial Pressure

0.69 0.67 -0.63 0.7431 32 24 23 -0.65 -0.63 0.59 -0.72 36 37 27 28

StO₂ values in uninjured limbs were significantly higher than in injured limbs during the haemorrhage and resuscitation phases of the protocol (by 3.4±1%, <0.0001). StO₂ values correlated strongly between limbs ($r = .94$, <0.0001) and accurately tracked the response to haemorrhage and resuscitation.

Conclusions: StO₂ recorded from injured muscle sites can be used to accurately monitor the response to resuscitation in hypovolaemic subjects. StO₂ measurements phase lead changes in base excess and lactate by over 30 minutes and have significant practical advantages over conventional means of assessment of resuscitation.

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Refining the Trauma and Injury Severity Score (TRISS) to Measure the Performance of the UK Combat Casualty Care System

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Aims: The TRISS methodology is used in by both the UK and US military trauma registries and relies on dividing casualties according to mechanism: penetrating or blunt, and uses different weighting coefficients accordingly. The UK and US military trauma registries use the original coefficients devised in 1987 and it is not clear how either registry analyses explosive casualties according to the TRISS methodology.

This study aims to use the UK military trauma registry (JTTR) to calculate new TRISS coefficients for contemporary battlefield casualties injured by either gunshot or explosive mechanisms. A secondary aim of this study is to apply the revised TRISS coefficients to examine the survival trends of UK casualties from recent military conflicts.

Methods: The JTTR was searched for all UK casualties injured or killed in Iraq and Afghanistan by explosive or gun-shot mechanisms between 1 st Jan 2003 and 31 Dec 2014. Details of these casualties including injuries and vital signs were reviewed. A logistic regression analysis was performed to devise new TRISS coefficients, these were then used to examine survival over the 12 years of the study.

Results: Comparing the predictions from the GSW TRISS model to the observed outcomes, it demonstrates a sensitivity of 98.1% and a specificity of 96.8% and an overall accuracy of 97.8%. With respect to the explosive TRISS model, there is a sensitivity of 98.6%, a specificity of 97.4% and an overall accuracy of 98.4%. This improved TRISS methodology was used to measure changes in survival over the study period, the peak performance was in 2009–10.

Conclusions: This study for the first time refines the TRISS methodology with coefficients appropriate for use with combat casualty care systems. This work allows the performance of combat casualty case systems to be accurately measured in future conflicts.

Trauma & Military Surgery (ATMS) 582

Tranexamic Acid Use in Trauma: An Evaluation Over 3 Years in a Regional Major Trauma Network

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Aims: The aim of the study was to understand if patients presenting to the Major Trauma Centre are being administered Tranexamic Acid (TXA) appropriately, being under utilised or potentially harmful if inappropriately given.

Methods: A retrospective cohort study of patients sustaining trauma injuries over a 3 year period, between January 2012 and December 2014, was undertaken. Quantitative evaluation was made using the hospital's trauma registry and electronic medical records to collect the required data fields. Statistical analysis and evaluation for confounding factors was performed between patient administered TXA (treatment group) and those not administered TXA (control group).

Results: Evaluation of our trauma registry over the 35 month period demonstrated a total of 2266 patients attended our Major Trauma Centre. TXA was administered to 327 patients, the severity of trauma injuries seen in this group was significantly higher than in No TXA group (ISS: 24 Vs 16). Unadjusted comparison demonstrated fatality rates and blood transfusion administration rates were higher in the TXA group, yet the TXA group had much lower survival probability. Furthermore, in sub-group analysis with greater homogeneity, such as penetrating trauma, shocked patients and those requiring blood transfusion, TXA group has lower fatality rates despite poorer survival probabilities.

Conclusions: Trauma care has seen many rapid developments, especially upon waves of higher level scientific studies. However, the implementation of these practices often awaits confirmation prior to universal adoption. Our study demonstrates the incidence of TXA use is lower than expected and further solutions must be sort in order to achieve the expected level. In this unadjusted format, due to the elements of confounding from trauma severity and clinician discretion greater statistical analysis is required to determine the true impact of TXA on trauma survival. Therefore, this study only provides a description of TXA use at this stage and not the clinical influence of TXA in trauma patients.

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Centralisation of Trauma Services Within a UK Trauma Network Has Shown Changes in Clinical Outcomes at a Major Trauma Centre

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Aims: A major reorganisation of trauma services occurred in the England in 2012. This involved the creation of major trauma networks with a centralized specialist trauma centre, receiving patients from significant geographical distances. This reconfiguration is reviewed with respect to clinical outcomes.

Methods: Data were analysed from a prospectively maintained trauma database from a Major Trauma Centre in Liverpool, UK between November 2011 and June 2014. Primary outcomes included basic demographics, ISS, intervention and mortality rates. Data were compared pre and post centralisation, utilising Fisher's exact test.

Results: The pre-centralised study period was from January 2012 to October 2012 and the post-centralisation period was November 2012 to June 2014. Mean monthly admissions increased significantly 15.7 vs 63.1 ($p < 0.005$). There were no significant differences in demographic statistics and GCS levels. There are more patients with an injury severity score > 15 in the pre centralisation group, 58% vs 27% ($p < 0.0001$). Less patients required radiological or operative intervention, 28% vs 13% ($p < 0.0001$), fewer patients required intensive care, 18% vs 12% ($p = 0.0569$). Similar numbers of patients required neurosurgical transfer, 12% vs 11% ($p = 0.506$). There was a non-significant decrease in mortality rate, 7% vs 5% ($p = 0.23$).

Conclusions: There has been a significant increase in volume of major trauma at our institution since November 2012, with a small decrease in overall mortality. The management has become more refined with fewer patients requiring intervention or higher-level care, with no worsening of morbidity or mortality, demonstrating the effect of this institutional increase in volume.

Trauma & Military Surgery (ATMS) 656

Effects of Distance of Urgent Transfer to a Major Trauma Centre within a UK Trauma Network

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Aims: A major reorganization of trauma services occurred in the England in 2012, with the creation of major trauma networks with a centralized specialist trauma centre receiving patients from significant geographical distances

Methods: Data was analysed from a prospectively maintained database located at a major trauma centre in Liverpool, England, from June 2012 to Jun 2014. Outcomes included basic demographics, ISS, intervention and mortality. Primary outcomes were compared between a group of patients transferred from incidents local to the centre and a second group of patients transferred from geographically greater distances bypassing their local hospital. Data was analysed using Fisher's exact test.

Results: 1261 patients were admitted between June 2012 and June 2014, with 840 in the local cohort and 421 in the bypass group. No significant differences exist between demographic data and injury severity scores. There were more patients with GCS < 8 in the local group, 16% vs 10% ($p = 0.002$). More patients required intervention, 16% vs 11% ($p = 0.03$) and were admitted to intensive care, 16% vs 10% ($p = 0.006$) in the local group. There was no change to patients requiring neurosurgical transfer, 11% vs 11% ($p = 1.000$). There was a slightly higher mortality in the bypass group but not statistically significant: 6% vs 4% ($p = 0.09$).

Conclusions: Mortality between patients transferred geographically longer distances, bypassing their local hospital, was similar to those patients injured locally.

Trauma & Military Surgery (ATMS) 753

Images of War: Accurate FAST and Abdominal CT Minimizes Negative Laparotomy for Battlefield Abdominal Trauma

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Aims: Focused assessment with sonography for trauma (FAST) and computed tomography (CT) are established contributors to surgical decision making. This study investigates their use in the initial assessment and management of battlefield abdominal injuries in a mature deployed military trauma system.

Methods: Casualties at risk of abdominal injury who were admitted directly to the Camp Bastion Role 3 Medical Treatment Facility, Afghanistan, between July and November 2012 were identified from the UK Joint Theatre Trauma Registry (JTTR), radiology reports and prospectively gathered surgical data. Diagnostic accuracy was determined by comparing radiologically identified injuries with those found at laparotomy. The association between imaging and casualty management was examined.

Results: Of 468 casualties meeting inclusion criteria, 159/468 (34%) had sustained abdominal injuries. 398/468 (85%) were assessed with FAST, 403/468 (86%) with CT. 359/396 (91%) of patients with available FAST reports also underwent CT or laparotomy. 48/468 (12%) of CT patients underwent laparotomy. For detection of intra-abdominal injury FAST sensitivity was 0.556, specificity 0.978, positive predictive value (PPV) 0.865, negative predictive value (NPV) 0.895 and accuracy 0.891. For CT, sensitivity was 0.985, specificity 0.991, PPV 0.956, NPV 0.997 and accuracy 0.990. Forty-six solid organ injuries were identified in 38 patients by CT, of whom 12 were managed non-operatively. Thirty-nine patients had ≥ 1 hollow viscus injury (HVI); all underwent laparotomy. Six injuries found at laparotomy had not been identified radiologically. In total, CT allowed 78 patients to be managed without laparotomy (15 with selective non-operative management of solid organ injury or haematoma, 61 where penetrating injury was shown not to have penetrated the peritoneum). The negative laparotomy rate was 3/77 (3%).

Conclusions: FAST and CT are integral components of battlefield casualty management. Contrary to traditional military surgical doctrine, accurate imaging allows surgeons to consider non-operative management and is associated with a historically low rate of negative laparotomy.

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Pre-hospital Blood Products After Battlefield Trauma: Benefit Unclear

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Aims: Trauma resuscitation with high ratios of plasma to packed red cells has become standard hospital practice. Observational data suggest this may confer a survival benefit, possibly by correction of trauma-induced coagulopathy (TIC). Pre-hospital blood products (PHBPs) are part of a suite of advanced resuscitative interventions associated with increased survival. The contribution of individual components has not been established. This study's aim was to determine whether PHBPs correct TIC or reduce mortality.

Methods: A three-year case-control study of major battlefield trauma casualties (NISS ≥ 16) admitted to a UK military hospital in Afghanistan was performed. Exclusions were surgery at forward facilities, isolated head injuries and unsurvivable injuries (any military AIS = 6). Demographics, wounding mechanism, injuries sustained, trauma burden, pre-hospital vital signs and interventions, PHBP receipt and survival were retrieved from the UK Joint Theatre Trauma Registry. Cases were matched to ROTEM™ records. Coagulopathy was defined as EXTEM-MCF < 40 mm. Multivariate analysis identified factors associated with coagulopathy and mortality.

Results: 1047 cases met eligibility criteria. ROTEM™ data were matched for 687/1047 (65.6%). 272/1047 casualties (26.0%) received PHBP. PHBP recipients were more severely injured than non-recipients (median NISS 41 (29–54) vs. 25 (18–29)), more frequently injured in explosions and had a higher

frequency of limb injuries. After multivariate regression, significant independent associations remained between PHBP receipt and both coagulopathy (adjusted OR: 1.543 (95% CI: 1.062-2.241)) and mortality (adjusted OR: 2.038 (95% CI: 1.200-3.461)).

Conclusions: In this large case-control study, pre-hospital blood product resuscitation after major battlefield trauma was not associated with a reduction in the incidence of coagulopathy or in mortality. High quality evidence from prospective trials is needed before widespread adoption of this intervention.

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Selective Aortic Arch Perfusion for the reversal of haemorrhage-induced traumatic cardiac arrest in a large swine translational model of non-compressible torso haemorrhage

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Aims: Non-compressible torso haemorrhage (NCTH) is the leading cause of potentially survivable combat death, and 90% of deaths occur before hospital arrival. Selective aortic arch perfusion (SAAP) provides the potential to manage hemorrhage-induced traumatic cardiac arrest (HiTCA) with NCTH by controlling aortic torso inflow, increasing cardiac afterload, and delivering oxygenated fluid to the central circulation. Hypothesis: SAAP with oxygenated blood confers a survival advantage over both SAAP with oxygenated Hartmann's solution, and chest compressions with venous blood in HiTCA with NCTH.

Methods: A model of HiTCA in male splenectomised pigs (70-90 kg) was developed - a hybrid of systematic laparoscopic liver injury and arterial haemorrhage. Arrest was defined as a systolic blood pressure (SBP) < 10 mmHg sustained for three minutes. Randomised intervention was: SAAP with oxygenated fresh whole blood (FWB-SAAP), SAAP with oxygenated Hartmann's solution (LR-SAAP), or closed chest compressions with venous FWB (CCC). The SAAP groups received further 250 ml boluses of test fluid if SB < 90 mmHg, up to a maximum of 1750 ml. A 60-minute pre-hospital period was observed. Primary outcome - pre-hospital survival, secondary outcomes - hospital arrival SBP and fluid requirements after 1600 ml SAAP. Results are expressed as means (+/- standard deviation).

Results: Sixteen animals were included (median weight 83 kg). Left lateral lobe liver resection and arterial bleed was consistent amongst groups - 64.3% (+/- 11.5), $p = 0.99$, and 22.6 ml/kg (+/- 4.7), $p = 0.17$ respectively. The mean SBP during the arrest period was 4 mmHg, with a brady/agonal or asystolic cardiac rhythm. 100% (6/6) FWB-SAAP, 60% (3/5) LR-SAAP, and 40% (2/5) CCC animals survived. Hospital arrival SBP was significantly higher in FWB-SAAP (94.4 mmHg +/- 9.0), compared to both LR-SAAP (26.9 mmHg +/- 27.6) and CCC (26.2 mmHg +/- 36.0), < 0.001 . Mean fluid requirement (after 1600 ml SAAP) was 625 ml (+/- 586) for FWB-SAAP, and 1750 ml (+/- 0) for LR-SAAP, < 0.001 .

Conclusions: FWB-SAAP confers a 100% pre-hospital survival of HiTCA in NCTH even in cardiac asystole.

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Initial Electrolyte Variability in Military Trauma Patients as a Predictor of Outcome

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Aims: Aggressive damage control resuscitation and surgery has become the norm within military trauma patients, but little is known about the effects of such aggressive fluid management on a cellular level. A detailed study into the following electrolytes was carried out to see if there were any obvious adverse effects, which could alter our future management of such cases (Sodium, Potassium, Creatinine, Urea, Calcium, Phosphate, Magnesium and Lactate). White Cells and Platelets were also reviewed.

Methods: A retrospective cohort study of a grievously injured group of military trauma patients was carried out. Cases were identified from the UK Joint Theatre Trauma Registry (JTTR) over a 4-year period (2008 to 2012). Information regarding resuscitation products used was examined in detail then further information regarding serial laboratory data was gathered and analysed using statistical methodology (Fisher's Exact and t-test).

Results: Of 231 military trauma patients, 31 died. The analysis of the blood products used showed that significantly more blood products were used in the fatality group (packed red cells, fresh frozen plasma, platelets and cryoprecipitate), however there was no significant difference for crystalloid or colloid use. On analysis of electrolytes, the mean values of serial sodium and potassium, although within range, did show significant differences between those that survived and those that died. Analysis of white cell count and platelets showed that there were significant differences between initial and subsequent values as well as between those that died and survived.

Conclusions: These results demonstrate that significant biochemical changes do occur in trauma patients, but as the sample is small more needs to be done to investigate what truly happens. A prospective research study is essential as understanding the physiological trauma response can help us guide future resuscitation strategies.

Trauma & Military Surgery (ATMS) 877

Lost in Translation: An Observational Study of the Utilisation and Patient Understanding of Abbreviations on the Consent form for Trauma Surgery in a Busy UK Major Trauma Centre

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Aims: For consent to be valid, it must be given voluntarily by an appropriately informed person who has the capacity to consent to the intervention in question. Acquiescence where the person does not know what the intervention entails is not 'consent'. It is generally accepted that abbreviations often cause confusion and should be avoided in medical documentation. The aim of this pilot study is to learn about common consenting practices amongst surgeons, the use of abbreviations and if their use contributes to patients not fully understanding their consent form for surgery.

Methods: Over a one week period all adult in-patients pre- and post- emergency or elective procedures on the major trauma step-down ward of a busy UK Major Trauma Centre were included in the study. Data was collected by pre-operative or post-operative interviews conducted by the same investigator (LN). The data recorded included the number and frequency of the abbreviations used by surgeons, patient understanding in general terms of the abbreviations used and whether or not patients fully understood the entire content of their consent form.

Results: From the 50 consent forms a total of 87 abbreviations (with 18 different abbreviations) were used. Nearly one fifth (18%) of consent forms contained 3 or more abbreviations. Patients fully understood their consent form in 86% of cases when no abbreviations ($n = 7$) were used and in 14% of cases when one or more abbreviations ($n = 43$) were included in the consent form (Fisher's exact test, $p = 0.0004$).

Conclusions: If surgeons fail to obtain proper consent and the patient subsequently suffers harm as a result of treatment, this may be a factor in a claim of negligence against the healthcare professional involved. This study demonstrates that abbreviations frequently contribute to patient lack of understanding and it is recommended that their use has no place on the surgical consent form.

Trauma & Military Surgery (ATMS) 1013

Physiological Effects of Extracorporeal Hemofiltration Following Bilateral hind limb ischemia-reperfusion injury in *Sus scrofa*

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Aims: Ischemia-reperfusion remains a dilemma with increases in proximal tourniquet usage and survivability of major vascular injuries. The objective of this study was to assess the physiological changes associated with extracorporeal hemofiltration in limb ischemia-reperfusion injury.

Methods: Female Yorkshire-Landrace swine (70-90 kg) were selectively catheterized via right groin to deploy endovascular balloon occlusion of the distal aorta and inferior vena cava. Hind limbs were rendered ischemic for two hours prior to reperfusion. Venous return was diverted through a novel extracorporeal circuit. Animals underwent non-selective hemofiltration (10-50kD) or sham filtration (6 and 5 respectively) and were observed for seven days with clinical and laboratory assessments.

Results: Following ischemia, physiologic parameters demonstrated minimal variation between groups. Mean arterial pressure dropped quickly upon reperfusion, requiring fluid and pressor support in both groups. Cardiac output, central venous oxygen saturation, pulmonary arterial and central venous pressure were comparable. Heart rate significant increased from baseline in the filtration group. Respiratory indicators showed an acute response to acidosis, which subsequently resolved with normalization in pH. Laboratory analysis demonstrated a similar early peak in lactic acidosis that resolved over 6 hours (peak lactate 8.9 mmol/L vs 7.6 control, $p=0.35$). There was observable difference in laboratory analysis of the reperfusate and systemic values; lactate (filter 7.6 vs. 4.32, $p=0.01$, control 8.9 vs 5.3, $p=0.04$) and pH (filter 7.19 vs 7.38, <0.01 , control 7.19 vs 7.39 <0.01). Animals demonstrated hind-limb paralysis throughout the post-operative course. Markers of end-organ injury (creatinine, creatine kinase, liver function enzymes) demonstrated continual evolution of injury through post-operative course, resolving through day 7. Filtration animals trended toward lower postoperative creatinine values (POD7 1.2 vs 0.9, $p=0.13$).

Conclusions: Extracorporeal isolation of venous return allows for hemofiltration, though the tested model demonstrated marginal clinical significance between groups. Differences in reperfusate and systemic circulation suggest robust inherent buffering mechanisms in swine.

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Hyperbaric Sub-Normothermic ex-vivo Perfusion Delays the Onset of Acute Rejection in a Porcine VCA Model

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Aims: Vascularized composite allotransplantation (VCA), offers superior functional recovery following devastating maxillofacial and upper limb injuries compared to traditional reconstructive techniques. Here we evaluate a novel hyperbaric oxygen (HBO) ex-vivo perfusion device to mitigate reperfusion injury and delay the onset of acute rejection in a porcine VCA model. Translating these results may reduce dosing requirements for systemic immunosuppression, allowing for reduced toxicity and improved applicability of VCA as a reconstructive technique.

Methods: This experiment utilizes a validated porcine model of gracilis myocutaneous VCA. Eight experimental donor flaps were cannulated intra-arterially and perfused for five hours with hyper-oxygenated WS (mean $PaO_2 = 93.3$ kPa) at 20% O_2 in a hyperbaric chamber at 3 atm. These flaps

were then transplanted heterotopically into recipient animals' necks, genetically controlled to be one HLA mismatch. Eight control flaps were obtained and transplanted without pre-treatment. Animals were evaluated clinically and biochemically. Additionally, flaps were assessed histologically at completion of the experiment (Day 15).

Results: Control flaps experienced Grade 1 rejection at a mean of 6.4 days (SD 0.52) and Grade 4 rejection at a mean of 10.5 days (SD 2.6). The experimental flaps showed a statistically significant delay in the onset of Grade 1 rejection at 13.71 days (SD 0.52, $p=0.0215$). At the experiment's conclusion (Day 15), 75% of the experimental flaps were without any evidence of Grade 4 rejection.

Conclusions: Hyperbaric subnormothermic perfusion significantly delays the onset of acute rejection. Ischemic injury is mitigated as well as cold preservation-induced injury. This technology has potential utility in the field of solid organ and vascularized composite allotransplantation and could expand the donor pool dramatically. Furthermore, ex-vivo normalization of tissue physiology may reduce antigen presentation and acute rejection phenomena in allotransplantation.

Audit and Outcomes Research 987

Abdominal Trauma: A Regional Analysis of Management and Outcomes

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Aims: Abdominal trauma poses significant challenges in terms of diagnosis and management. Contemporary prevalence and patterns in the United Kingdom remain largely unknown. The aim of this multicentre study was to examine the characteristics of abdominal trauma in 3 major trauma centres.

Methods: All patients presenting as a 'trauma-call' in the emergency departments of the 3 major trauma centres in the West Midlands with an underlying injury that justified immediate cross-sectional imaging of the abdomen & pelvis were included, over a period of 2 years. Significant blunt abdominal trauma was defined as any blunt abdominal injury requiring immediate exploratory laparotomy or a Computed Tomographic (CT) scan. Delayed laparotomy is defined as major abdominal surgery taking place >12 hours from admission. Patient records and imaging were reviewed to assess outcomes.

Results: A total of 5,532 patients [3,507 females (63%); mean age: 43±9 years (SD)] were included. In 1,658 patients (30%) blunt abdominal trauma was the predominant injury. Initial CT findings of the abdomen and pelvis included: 220 (4%) patients with evidence of free fluid, 195 (3.5%) with a direct mesenteric injury, 41 (0.7%) with a vascular injury, 156 (3%) with a splenic injury, and 104 (2%) with a hepatobiliary injury. A total of 86 (2%) patients underwent a laparotomy, of which 57 (66%) were performed as an emergency (within 12 hours) and 29 (34%) were delayed laparotomies. A total of 120 (2%) patients died within a period of 30 days. Presence of free abdominal or pelvic fluid at baseline was associated with mortality (Odds Ratio: 3.3, $p=0.0003$). There was no difference in mortality for those undergoing delayed or emergency laparotomy ($p=0.14$).

Conclusions: The patterns of injury following significant abdominal trauma vary. Modern management allows the majority of injuries to be treated conservatively following assessment of imaging, when immediate surgical intervention is not mandatory.