DERIVATION OF THE PRIMARY CARE ASSESSMENT TRIAGE TOOL (PCATT) AND VALIDATION AGAINST THE SEPTEMBER 2013 OTTAWA TRAIN – BUS COLLISION

by

Dr. Svetlana Cakarevic CCFP (EM), EBCEM

Thesis Supervisor: Dr. Jeffrey Michael Franc Local Promoter: Dr. Angela Golas

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Author:	**Dr. Svetlana Cakarevic, CCFP (EM), EBCEM**
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Thesis Supervisor:	**Dr. Jeffrey Michael Franc, MD, MSc, FCFP(EM), EMDM. Dip Sport Med, Clinical Professor of Emergency Medicine University of Alberta and Visiting Professor in Disaster Medicine, Universita del Piemonte Orientale**
Local promoter:	**Dr. Angela Golas, FRCPC, Geriatric Psychiatry, University of Toronto**
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ABSTRACT

Background: In the case of a major disaster, there is an increased need to provide care to disaster victims. A key challenge is the lack of resources, or diverting of resources, to manage the most serious cases. However, there is still a need to provide care for other patients with minor injuries, who could be potentially diverted to ambulatory care centres. This study examined how to improve triage process at the scene and thus utilize primary care offices in the management of the casualties. Literature search found limited references to the use of primary care offices in the case of mass casualties or disaster.

Goal: To establish criteria under which casualties of the Mass Casualty Incident (MCI) could be discharged directly from the scene to the care of the primary care physicians. The primary outcome measure of the study was to establish sensitivity of the suitability criteria by having physicians and paramedics apply the tool to a set of known disaster cases. The secondary outcome measure was to analyse if there is a significant difference when this tool is used by paramedics and physicians.

Methodology: In the Derivation Phase, the Primary Care Assessment Triage Tool (PCATT) was developed and reviewed by a focus group of family physicians. These physicians and the authors of this study were blinded to the data set while the PCATT tool was developed. In the Validation Phase, cases were reviewed from the charts of known patients, who were the victims of a mass casualty incident. Eleven casualties that presented to the Queensway Carleton Emergency Department after the Bus versus Train accident that occurred on September 18, 2013 in Ottawa, Ontario, Canada formed the validation set. Cases were considered to have been suitable for primary care if their true outcome did not require admission to hospital or any interventions in the emergency department. Test cases were distributed to paramedics and physicians via an online survey. For each case, participants were asked to

apply the PCATT criteria to decide if the patient was suitable for treatment in a primary care setting. Patients' actual outcome was not known to the participants.

Results: Overall sensitivity of the PCATT tool was 92.1% with 95% confidence interval 90% to 94%. Overall specificity of the PCATT tool was 56.7% with 95% confidence interval of 54% to 59%.

When the PCATT tool was used by physicians, sensitivity was 94.1% and when used by paramedics, sensitivity was 87.9%. The 95% confidence interval for effect size was 0.67% to 11% (p=0.029)

Specificity was 58.5% for physicians and 53.1% for the paramedics. This was also statistically significant (p=0.038) with a 95% confidence interval for effect size of 0.38% to 12%.

Conclusion: In the case of our sample Mass Casualty Incident, the PCATT tool had an acceptable sensitivity when compared to other commonly used tools in the disaster triage. Given the reality of triage needs and priorities during the disaster, when priority of care shifts from 'everything for one' to 'most for many', this tool can be used to divert casualties with minor injuries and psychosocial need to the care of the primary care physicians and thus relieve the burden on already stretched resources in the emergency departments.

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Introduction

On September 18, 2013 just before 9 am, a major incident took place in Ottawa, Canada. A crash between a Via Passenger Train and an OC Transpo transit bus, left six people killed, more than thirty wounded, and a community shaken[2]. On November 13, 2015, a series of coordinated terrorist attacks happened in Paris, France, causing the death of 130 people, and injury to 368 people, out of whom 80-99 were seriously injured requiring intensive care[3].

In Canada, on April 2001, the Commission on the Future of Health Care in Canada[4] was established. Commissioner Roy Romanow was given the mandate to "inquire into and undertake dialogue with Canadians on the future of Canada's public health care system" and "to develop recommendations that will help ensure the long-term sustainability of a high quality, universally accessible, publicly administered health care system, for all Canadians". The Canadian Association of Emergency Physicians (CAEP)[5] saw within this initiative an opportunity to share in this public dialogue, reflect on the current state of emergency medicine, and to identify for the future the necessary components to achieve excellence in patient care. In its statement from April 30, 2002, CAEP stated: “Emergency Department overcrowding has become a national epidemic”. CAEP identified many causes of overcrowding, the most important of these including lack of access to primary care. CAEP had a number of recommendations to improve care in the Canadian Emergency Departments, including the Canadian Triage and Acuity Scale (CTAS) in all Canadian Emergency Departments.

Emergency department overcrowding (EDOC) is defined as a situation where the demand for emergency services exceeds the ability of an emergency department (ED) to provide quality care within appropriate time frames. Overcrowding of the emergency departments is the new reality. The study 'Primary care and Public Emergency Department overcrowding', by Grumbach *et al (1993)* questioned[10] whether referral to primary care settings would be clinically appropriate and acceptable to patients waiting for emergency department care for nonemergency conditions. The authors concluded that it was feasible and tolerable for patients if public ED's referred large numbers of patients to appointments at primary care facilities. The viability of diversion was concluded to be dependent on enhanced availability and coordination of primary care services for low-income populations.

Emergency departments in the United States and Canada annually treat more than 13 million patients with trauma. The National Policy for Emergency Preparedness in the USA calls for hospitals to accommodate surges of 500 new patients per million population in a disaster, however some studies showed lack of preparedness for some of the most vulnerable parts of the population[6].

Commonly used disaster triage tools have been found to have variable sensitivity and specificity. One study (Kahn et al, 2009)[1], examined the sensitivity and specificity of the START triage tool by studying data from a train crash disaster in 2003. The study has found that sensitivity of the START triage tool was 100% (CI 15.8%-100%) when triaged as red, 39.1% (CI 19.7%-61.5%) when triaged as yellow and 45.8% (CI 36.7%-55.2%) when casualties were triaged as green. This study documented a divergence in sensitivity that was dependent on the START tool was only moderately

effective when used by paramedics. All green patients were transported to the local emergency department in two large busses, and thus added additional volume to already busy emergency department.

Goal

To establish criteria under which casualties of the MCI could be discharged directly from the scene to the care of the primary care physicians. The primary objective was to establish the sensitivity of the suitability criteria, in detecting casualties for whom it would be dangerous to be assessed in the primary care office. The secondary objective was to asses if there was a significant difference in sensitivity and specificity when the tool was used by paramedics vs. physicians.

Methodology

The Ethics Committee of the Queensway Carleton Hospital, Ottawa, Ontario reviewed and approved this study.

A Literature was performed using key words ‘disaster’, ‘mass casualty’, ‘triage’, ‘primary care’, ‘family physician’, ‘family doctors’ and ‘surge capacity’, using OVID and PubMed databases. The literature search was done with the help of the librarian at the University of Ottawa School of Medicine Canada. We have found limited references to the use of primary care offices in the case of mass casualties or disaster. We had found no studies that looked into criteria to discharge casualties from the scene to be assessed in the primary care offices.

Study design

In the derivation phase, a focus group of five family physicians, the first author of this study who is residency trained in family medicine with special competency in emergency medicine, two with remote emergency medicine experience, and two with no emergency medicine work experience beyond postgraduate education. The study authors of the study or the physicians did not have any knowledge of the cases of the derivation set during this procedure.. The Primary Care Assessment Triage Tool (PCATT) was established and is displayed in Table One.

Table 1 - Primary Care Assessment Triage Tool

Primary Care Assessment Triage Tool (PCATT)
Age 18-65
Vital signs stable: Blood Pressure systolic > 100 Respiratory Rate < 30 Heart Rate < 100 Oxygen Saturation > 95% Capillary Refill < 2 seconds
Glasgow Coma Scale – 15
Ambulatory patients - No impaired function, Walking Wounded
No head or Neck trauma
No suspected open fractures
Wounds – that do not include head, joints or high risk wounds (eyes, joints, penetrating wounds etc.)
Abrasions, contusions, minor lacerations
Burns - thermal or decontaminated chemical wounds 2nd and 3rd degree affecting < 10 % body surface and not affecting head.

In the Validation Phase, test cases were selected from the charts of the casualties that presented to the Queensway Carleton Emergency Department in Ottawa, Canada on September 18 and 19th, 2013. All of the cases that presented to the QCH Emergency Department were included in the study. Patients were considered appropriate for primary care if their true outcome did not require admission, surgery, or specialized treatment that would be unavailable in a primary care setting. Based on these cases, survey questions were created and the survey was distributed to the paramedics and physicians.

Table 2 - Cases Description

Case Number	**Description**	**CTAS**	**Interventions**	**Outcome**
1	82 y/o woman casualty in train versus bus accident.	3	No interventions	Discharged
2	Yes 39 y/o man casualty in train versus bus accident.	3	No interventions	Discharged
3	45 y/o man casualty in train versus bus accident.	3	No interventions	Discharged
4	51 y/o man casualty in train versus bus accident.	1	Multiple Interventions	Admitted
5	21 y/o woman casualty in train versus bus accident.	3	No interventions	Discharged
6	64 y/o man casualty in train versus bus accident.	3	No interventions	Discharged
7	34 y/o woman casualty in train versus bus accident.	3	No interventions	Discharged
8	47 y/o man casualty in train versus bus accident.	1	Multiple interventions	Admitted
9	31 y/o woman casualty in train versus bus accident.	4	No interventions	Discharged

Case Number	Description	CTAS	Interventions	Outcome
10	46 y/o woman casualty in train versus bus accident.	1	Multiple interventions	Admitted
11	26 y/o woman casualty in train versus bus accident.	3	No interventions	Discharged

The survey was distributed to a convenience sample of paramedics and physicians. The target audience was contacted by email, social media and informally. Paramedics were invited through their emails, in cooperation with chief of the paramedics, County of Renfrew. Physicians were contacted by private emails through colleagues and friends and by social media, more specifically Concerned Ontario Doctors Facebook Page and Canadian Physicians Moms Facebook Group.

Participants completed the survey using SurveyMonkey. Each case had a question asking the participant to decide if the patient was suitable to be assessed in a primary care setting by applying the PCATT criteria.

Data was analyzed using R: A Language and Environment for Statistical Computing (R Core Team, Vienna, Austria). Confidence intervals for sensitivity and specificity were calculated using a one sample t-distribution (Devore, p301)[1]. Differences between the physician and paramedic groups was calculated using the Welch two sample t-test.(Devore p336)[1] P-values of less than 0.05 were considered to be significant.

[1] Devore JL. Probability and Statistics for Engineering and the Sciences. 7 ed. 2008. Thomson Brooks / Cole Publishers

Table 3 - Paramedics Characteristics

Paramedics Certification Level	Primary Care Paramedics	41
	Advance Care Paramedics	28
Years of Work Experience	< 1	4
	1-4	9
	5-10	17
	11-15	17
	16-20	3
	> 20	19

Table 4 - Physicians Characteristics

Physician Designation		
	General Practitioner	11
	Family Physician	36
	CCFP	80
	CCFP (EM)	10
	CCFP (Anesthesia)	2
	Other	9
Years of Practice		
	<1	29
	1-4	55
	5-10	18
	>10	33

Results

Two hundred and forty five persons attempted the survey and two hundred and twelve persons completed the survey: 69 paramedics and 148 physicians. Please refer to table 3 for the paramedic's characteristics and to table 4 for physician's characteristics.

Out of 139 physicians who are family doctors that completed survey, 54 had previous emergency medicine experience and 87 had never worked as an Emergency Physician. Table 5 shows triage breakdown per cases.

Table 5 -Triage Breakdown per Cases

Case Number	**True Outcome**	**Triaged to Emergency Department**	**Triaged to Primary Care Office**
1	Suitable for primary care	88	124
2	Suitable for primary care	11	201
3	Suitable for primary care	20	192
4	Required ED	212	0
5	Suitable for primary care	185	27
6	Suitable for primary care	185	27
7	Suitable for primary care	125	87
8	Required ED	179	33
9	Suitable for primary care	40	172

Case Number	True Outcome	Triaged to Emergency Department	Triaged to Primary Care Office
10	Required ED	195	17
11	Suitable for primary care	80	132

Overall sensitivity of the PCATT tool was 92.1% with 95% confidence interval 90% to 94%. Overall specificity of the PCATT tool was 56.7% with 95% confidence interval of 54% to 59%.

When the PCATT tool was used by physicians, sensitivity was 94.1% and when used by paramedics, sensitivity was 87.9%. This was statistically significant (p=0.029) with a 95% confidence interval for effect size of 0.67% to 11%.

Specificity was 58.5% for physicians and 53.1% for the paramedics. This was also statistically significant (p=0.038) with a 95% confidence interval for effect size of 0.38% to 12%.

Additionally, family physicians were asked if they would be interested to open their offices after hours and at night if there is a large scale MCI. Of 136 that answered the question, 60% would open their offices after hours to help with casualties. Also, although this question was asked just out of interest, the majority of the physicians that agreed to receive casualties, would be able to accommodate about 10 extra patients per physician.

Discussion

In times, when overcrowding in the emergency departments across Canada and USA is a reality, a mass casualty incident might add another dimension to an already stressed system. This study developed a set of criteria to be employed at a disaster scene at the scene of a disaster, to divert patients to primary care offices.

According to the Commander/Special Operations, Ottawa Paramedic Services (direct communication), under the Ambulance Act to date, there is no referral mechanism or method to permit transport or handoff of the patients to a community physician's office or clinic. Patients that refuse transport are welcome to seek medical attention with their own physician if they so wish. Most serious Trauma triaged as 'Reds' as per START criteria, go to the designated Trauma Centre - in the case of Ottawa, Ontario, that is Civic Campus-Ottawa Hospital. Those casualties that are triaged as 'Yellows' to the further Emergency Departments as transport capacity permits to avoid overwhelming the closest Emergency Departments that are receiving 'Red' Casualties. Those casualties that are triaged as 'Green' would go by buses to the furthest Emergency Departments. In the case of the Via Train vs. OC Transpo Bus Crash the 'Green' casualties were sent to the Montfort Hospital in Ottawa by bus with a paramedic on board after all 'Red' and 'Yellow' casualties were transported of the scene of the accident.

According to Commander/Special Operations, Ottawa Paramedic Services, there is no uniform standard triage method used by all ambulance services. The Ministry of

Health and Long-Term Care (MOHLTC) last document on MCI was in 2000. There was a common MOHLTC triage tool but later it was left up to paramedics services to choose which MCI Triage tool to implement. Some paramedics in Ontario use the MOHLTC triage tool, while others use SMART, START, or SALT.

Sensitivity of the PCATT tool appears similar or superior to many other current triage techniques. In the study 'Does START triage work? An outcomes assessment after a disaster' (Kahn at all, 2009)[1], sensitivity and specificity of the START triage tool was assessed by looking into data from train crash disaster 2003. The study has found that sensitivity of the START triage tool was 100% (CI 15.8%-100%) when casualties were triaged as red, 39.1% (CI 19.7%-61.5%) when casualties were triaged as yellow and 45.8% (CI 36.7%-55.2%) when casualties were triaged as green.

IN the study 'Comparative analysis of multiple-casualty incident triage algorithms' (Garner at all, 2003)[11], most commonly used MCI triage tools were assessed for sensitivity, specificity and odds ratio. START (capillary refill) tool was found to have an overall sensitivity of 85 % (CI(95%) of 78%–90%), modified START (radial pulse) tool have a sensitivity of 84 % (CI(95%) of 76%–89%), Triage Sieve (capillary refill) 45% (CI(95%) of 37%–54%), Triage Sieve (heart rate) 45% (CI(95%) of 37–54), CareFlight Triage 82% (CI(95%) of 75–88).

Other commonly used Emergency Department tools appear to have similar sensitivity: for example, Rochester Criteria (92%)[12], Canadian CT spine rule (87-100%)[14,] PECARN Pediatric head injury rule (94-100%)[15], and (PERC) Pulmonary Embolism Rule out Criteria (97%)[17]. Conversely, for reference, sensitivity of computed

tomography for pulmonary embolism was found to be 83%[17], and sensitivity of Doppler ultrasound for deep venous thrombosis was found to be 89 to 96%[18].

During a large-scale disaster, it is often not the sickest that arrive first to the local emergency department but those who are mobile. These 'walking wounded' and their family, may interrupt the emergency departments care of unstable patients and add additional volume to the already strained resources. When the PCATT tool is used by the physicians, it sensitivity is 94%. This could argue for deploying a dedicated physician to the scene of a MCI to help with secondary triage using PCATT tool.

Given that sensitivity of the tool for paramedics was 87.9%, one could argue that the PCATT tool should be refined by creating a joint group that consists of paramedics and physicians.

In this model, patients would not be taken out of the health care system, and would be assessed by the physician for additional injuries. From the primary care office patients might be diverted back to emergency department, local specialist who is available to help such as orthopedic/fracture clinic, or home.

Limitations

Although a major strength of the study design was that the validation cases were based on true patient outcomes, the number of validation cases (11) was small. Clearly, further study and application of the PCATT tool to other patient populations is advisable.

Conclusion

In the case of a Mass Casualty Incident, the PCATT tool has sensitivity comparable or superior to other commonly used tools in the Emergency Department. Keeping in mind that in the case of a disaster, priority shifts from ‘all for one’ to ‘most for many’, this tool could be used to divert casualties’ minor injuries and psychosocial consequences to the care of the primary care physicians and thus relieve the burden on already stretched resources in the emergency departments.

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Addendum

Table 6 - Cases Full Description

Cases	Description		Interventions	Outcome
1	82 y/o woman casualty in train versus bus accident. Ambulatory at the scene. Complains of severe anxiety. No injuries reported. No loss of consciousness, no head injury, no neck pain, no dyspnea, and no chest pain, no vomiting, no other symptoms or injuries reported. Vital signs: HR 90, BP 101/60, RR < 30, BP 101/60, saturation 98% Looks well but anxious. GCS 15, PERRLA, neck supple in all directions, no obvious injuries or lacerations seen, no respiratory distress, very tearful and anxious. Left knee no swelling or bruising, with full range of motion, tender across patella. Ambulatory.	3	None	Discharged

Cases	Description		Interventions	Outcome
2	39 y/o man casualty in train versus bus accident. He complains of left knee injury. Ambulatory at the scene. No loss of consciousness, no head injury, no neck pain, no dyspnea, and no chest pain, no vomiting, no other symptoms or difficulties reported. No other injuries reported. Patient complains of increased stress and anxiety. Vital signs: temperature 37.2, Heart rate 72, respiratory rate < 30 marked as normal, BP 140/89, saturation 99%. GCS 15, PERRLA, neck supple in all directions, no obvious injuries or lacerations seen, no respiratory distress, very anxious.	3	None	Discharged
3	45 y/o man casualty in train versus bus accident. He complains of left thigh abrasion and left knee pain. Ambulatory at the scene. No loss of consciousness, no head injury, no neck pain, no dyspnea, and no chest pain, no vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: temperature 36.2, Heart rate 85, respiratory rate < 30 marked as normal, BP 141/97, saturation 99%. GCS 15, PERRLA, neck supple in all directions, no obvious injuries or lacerations seen, no respiratory distress. Left knee no swelling or bruising, with full range of	3	None	Discharged

Cases	Description		Interventions	Outcome
	motion, tender across patella. Abrasion to left thigh but able to walk and weight bare.			

Cases	Description		Interventions	Outcome
4	51 y/o man casualty in train versus bus accident. Ejected from 2nd storey of double decker bus. Non-ambulatory at the scene. Retrograde amnesia for events. No neck pain, no dyspnea, no chest pain, abdominal pain in the right upper quadrant. Vital signs: temperature 37.1, Heart rate 120, respiratory rate < 30 marked as normal, BP 152/86, saturation 99%. Airway patent, good air entry bilaterally, tachycardia, color normal, GCS 15, PERRLA. Neck supple. Multiple lacerations to face and head. Tender right upper quadrant Right thumb deformity, right forearm pain, right shoulder pain, left lower leg deformity and pain to palpation of tibia and fibula.	1	Multiple interventions Ulnar fracture and fixation Multiple lacerations to head and face Left proximal transverse fibular fracture	Admitted

Cases	Description		Interventions	Outcome
5	21 y/o woman casualty in train versus bus accident. Ambulatory at the scene. Complains of bilateral neck pain and headache but no head injury reported. Pain with turning neck to right. Patient feels paresthesia in bilateral fingers. No loss of consciousness, no dyspnea, and no chest pain, complains of nausea but no vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: temperature 37.0, Heart rate 64, respiratory rate < 30 marked as normal, BP 133/91, saturation 97%. GCS 15, PERRLA, neck supple but pain to left lateral rotation. No signs of head injury. Chest clear, abdomen soft and no other injuries seen. No gross neuro deficits	3	None	Discharged

Cases	Description		Interventions	Outcome
6	64 y/o man casualty in train versus bus accident. Complains of nose injury and right knee injury. Ambulatory at the scene. Complains of bilateral neck stiffness but no paresthesia. No loss of consciousness, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: temperature 36.8, Heart rate 118, respiratory rate < 30 marked as normal, BP 223/100, saturation 99%. GCS 15, PERRLA, neck supple no midline tenderness. No signs of head injury. Ambulatory. Abrasion to right knee but good range of motion. Chest clear, abdomen soft and no other injuries seen. No gross neuro deficits.	3	None	Discharged

Cases	Description		Interventions	Outcome
7	34 y/o woman casualty in train versus bus accident. Ambulatory at the scene. Pain in the neck, struck seat. Patient has increased painful sensations to left side of the body. No loss of consciousness, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: temperature 36.8, Heart rate 98, respiratory rate < 30 marked as normal, BP 133/94, saturation 100%. GCS 15, PERRLA, neck supple no midline tenderness. No signs of head injury. Ambulatory. Chest clear, abdomen soft and no other injuries seen. No gross neuro deficits	3	None	Discharged

Cases	Description		Interventions	Outcome
8	47 y/o man casualty in train versus bus accident. Non ambulatory at the scene. Complaining of right forearm pain, right thigh and shin pain. Pain in left thigh. Abrasion to left side of face, laceration to left shin. No neck pain. No loss of consciousness, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting. Vital signs: Heart rate 67, respiratory rate < 30 marked as normal, BP 120/89, saturation 100%. Airway patent, good air entry bilaterally, tachycardia, color normal, GCS 15, PERRLA. Neck supple and no midline tenderness. Abrasion to face. Multiple injuries to all extremities.	1	Multiple interventions Right wrist fracture Non displaced left fibular fracture Open fixation of the left 5^{th} metacarpal bone	Admitted

Cases	Description		Interventions	Outcome
9	31 y/o woman casualty in train versus bus accident. Ambulatory at the scene. Complains of neck pain and shoulder stiffness. No loss of consciousness, no head injury, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: temperature 37.1, Heart rate 83, respiratory rate < 30 marked as normal, BP 129/88, Oxygen saturation 97%. GCS 15, PERRLA, neck supple no midline tenderness. No signs of head injury. Ambulatory. Chest clear, abdomen soft and no other injuries seen. No gross neuro deficits.	4	None	Discharged

Cases	Description		Interventions	Outcome
10	46 y/o woman casualty in train versus bus accident. Non ambulatory at the scene. Complains isolated left upper and lower leg pain. No loss of consciousness, no head injury, no neck pain, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting, no other symptoms or difficulties reported. No other injuries reported. Vital signs: Heart rate 100, respiratory rate 24, Blood pressure 105/70 GCS 15, PERRLA, neck supple no midline tenderness. No signs of head injury. Non ambulatory. Chest clear, abdomen soft and no other injuries seen. No gross neuro deficits. Obvious injury and tenderness to left thigh and tibia.	1	Multiple Interventions Admitted with left femur fracture and left tibia and fibula fracture	Admitted

Cases	Description		Interventions	Outcome
11	26 y/o woman casualty in train versus bus accident. Ambulatory at the scene. Hit face on seat to left side. Pain at left shoulder. No loss of consciousness, no neck pain, no dyspnea, and no chest pain, no abdominal pain, no nausea or vomiting, no other symptoms or difficulties reported. No other injuries reported. Feels in shock. Vital signs: Temperature 36.8, Heart Rate 91, respiratory rate < 30 marked as normal, Blood pressure 114/75, and Oxygen saturation 97%. GCS 15, Oriented in place, time and person, PERRLA, neck supple no midline tenderness. No signs of head injury. Tender and mild swelling at left maxilla. Ambulatory. Chest clear and no tenderness, abdomen soft and no other injuries seen. No gross neuro deficits. Tender left upper humerus but good range of motion and no neurovascular deficits.	3	None	Discharged