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Research

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Factors Affecting Burnout and Job Satisfaction in Turkish Emergency Medicine Residents

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ABSTRACT

Objective: Despite the increasing concerns on burnout and job satisfaction in health-care professional, very few studies have examined resident physicians in Turkey. This study was aimed to determine the factors affecting burnout and job satisfaction among emergency medicine residents in Turkey.

Method: An number of 410 emergency medicine residents including e-mail addresses registered to Emergency Medicine Associations received questionnaire forms previously prepared on an internet-based questionnaire site. Participants were asked to fill out Maslach Burnout Inventory (MBI), Job Satisfaction Scale (JSS) and socio-demographic data form.

Results: Decrease in depersonalization grades and increase in personal accomplishment grades with the advancing age were found. Residents who had an experience greater than 10 years in the profession showed lower depersonalization grades in comparison with the beginners. Residents who could not reach a consultant for patient evaluation presented higher emotional exhaustion grades. Also residents who felt appreciated in work place and work in concert with the staff had lower burnout grades and higher job satisfaction grades. An increase in the average number of patients seen per day was found out to boost emotional exhaustion grades. Also the visible increase in the time spent for social activities during the week reduced emotional exhaustion and depersonalization grades while increasing personal accomplishment grades. Residents who were exposed to daily violence had lower job satisfaction grades and higher emotional exhaustion and depersonalization grades than those experienced violence on a monthly basis. Increase of job satisfaction was accompanied by a decreased burnout level.

Conclusion: Emergency medicine residents have high burnout levels. For diminished burnout level and enhancement of job satisfaction in emergency medicine, adjustments like social support, workload, workplace stress and prevention of violence would be useful.

KEYWORDS: Burnout; Job satisfaction; Emergency department.

ABBREVIATIONS: MBI: Maslach Burnout Inventory; JSS: Job Satisfaction Scale; PA: Personal Accomplishment; EE: Emotional Exhaustion; JS: Job Satisfaction; DP: Depersonalization.

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INTRODUCTION

The concept of burnout was coined by Freudenberger and later was developed by Maslach. Burnout consists of a three-scale frame of an emotional detachment of individual from his profession; exhaustion (emotional), depersonalization and decrease of personal accomplishment.[1,2] Emotional Exhaustion (EE) describes the exhaustion of individual's emotional resources and eradication of his stamina. Depersonalization (DP) is the negative, unserious attitude and emotional representation shown against those to whom physicians serve without regard to their individual esteem. Inadequacy of Personal Accomplishment (PA) is the tendency of individual to misinterpret in a negative fashion himself. Burnout is oftentimes observed in professions in which the service directly targets people and to which the human factor is determinant in service quality.[2,3] The high point levels in EE and DP with the low points in PA subscales refers burnout.

Job Satisfaction (JS) is defined as "the positive emotional reactions and attitudes that individuals have towards their job".[4] JS is the affective orientation that an employee has towards his or her work. It can be considered as a global feeling about the job or as a related constellation of attitudes about various aspects or facets of the job.[5] Job satisfaction is reported as the most eminent one amongst the factors that display the impact on burnout.[6]

This study was aimed to determine the factors affecting burnout and job satisfaction among emergency medicine residents in Turkey.

METHODS

The written consent was received from Mersin University Faculty of Medicine Ethics Committee. 410 emergency medicine residents including their e-mail addresses were registered to Emergency Medicine Associations received questionnaire forms previously prepared on an internet-based questionnaire. The objective in the study was to reach the entire population.

Scales

Socio-demographic data form: This form includes questions on age, sex, marital status, institution, children, occupational information, working conditions, social activities, making up a total of 33 questions. The form was developed by researchers.

Maslach burnout inventory (MBI): This inventory was developed by Maslach.[7] Its validity study for Turkey was carried out by Ergin.[8] The inventory, consisting of 22 articles, evaluates burnout in three subscales, namely emotional exhaustion (EE), depersonalization (DP) and sense of personal accomplishment (PA). In the scale, 9 items number 1, 2, 3, 6, 8, 13, 14, 16, 20 are used for the calculation of "emotional exhaustion" (EE), 5 items number 5, 10, 11, 15, 22 are for depersonalization (DP) and the remaining 8 items 4, 7, 9, 12, 17, 18, 19, 21 are calculated the grades belonging to the subscales of "personal accomplishment" (PA). Frequency of emotions experienced in relation to all subscales were reported using Likert scaling method, numerating the increase of density of emotional experience as 0 being the least and 4 the most. Articles in the subscales EE and DP were graded using the same method, while the articles in PA subscale were added after reverse grading, thus acquiring a different grade for each subscale. Because that there hasn't been a cut-off value set for the subscale points, a certain discrimination cannot be done whether burnout is present or not. In our study, the cut-off values of the subscales are set as high, medium, low according to statistical levels.

Job satisfaction scale (JSS): Developed by Hackman and Oldham to evaluate job satisfaction (JS), JSS is a self-report scale, consisting of 5 options, 14 items and unfinished positive statements, which is adapted to Turkish and validated by Güler.[9,10] JSS uses a 5-point likert scale for grading. Because all the items are positive the highest grade was 70 and the lowest was 14. The higher the grades the better the job satisfaction. Grades showing job satisfaction were considered low in the grades 14-32, normal in 33-52, and high for 53-70.

Statistical Evaluation

Statistical analysis was performed by using SPSS v. 11.5.0 and MedCalc v. 12.3.0 package programs. Descriptive quantitative data were expressed as mean±SD. Independent sample t test was used in the comparison of two groups for continuous variables which are competent with normal distribution. For comparisons involving more than two groups ANOVA was used, and to determine the location of the difference between the variant groups Tukey-HSD post-hoc statistic was chosen. For variables that are incompetent with normal distribution non-parametric Mann Whitney-U test was used for two-group comparisons and for more than two-group comparisons Kruksal Wallis test was picked and Conniver post-hoc statistics was used to determine the differential group/groups. In addition, Pearson and Spearman correlation coefficients were used in relationship control between continuous variables. Statistically analysis value of $p<0.05$ was accepted to be significant by confidence interval of 95%.

RESULTS

The response rate for this study was 40.7% (n=167). In the examination of distribution of the participants according to age groups, the majority was between the ages of 25 and 29(48.5%), and the second group was between 30-34 ages (30.5). Of the participants, 59.3% were males. While 62.3% of the participants were married, 35.3% were single and 2.4% were divorced. A percent of 54.5% of the residents were occupied in university hospitals and the rest 45.5% were from research and

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training hospital. Review of distribution of participants according to seniority showed that 26.3% were between 3 to 5 years and 22.8% 5 to 10 years. Socio-demographic properties belonging to participants are presented in Table 1.

Socio-demographic Properties	n	%
Age		
< 26	1	0.6
25-29	81	48.5
30-34	51	30.5
>35	34	20.4
Sex		
Male	99	59.3
Female	68	40.7
Marital Status		
Married	104	62.3
Single	59	35.3
Divorced	4	2.4
Institution		
University Hospital	91	54.5
Training and Research Hospital	76	45.5
Spent years in the profession		
0-1 year	21	12.6
1-3 years	33	19.8
3-5 years	44	26.3
5-10 years	38	22.8
>10 years	31	18.6
Total	**167**	**100.0**

Table 1: Socio-demographic properties of emergency medicine residents.

EE, DP, PA and JS Scale mean scores of all participants were found to be 21.3±6.4 (2-36), 10.2±3.9 (2-20), 19.8±3.9 (8-31), 36±9.1 (14-62) respectively.

Our research revealed no statistically significant difference in terms of sex and marital status with burnout subscales and JS grades ($p>0.05$). A statistical significance was acquired between age groups in terms of DP and PA grades ($p<0.05$). DP decreased as the physician aged and PS increased the same way also.

In comparison of beginner physicians between 10 or more years of service experience; experienced ones have lower DP grades ($p<0.05$).

A statistically meaningful difference was found out from the respondents of the question "Is there a nearby consultant available during patient evaluation in the emergency department?" in terms of EE grades ($p<0.05$). Residents who answered "never" had lower EE grades than those that answered "always" ($p<0.05$). Residents who felt appreciated by superiors and co-workers, by the patients and their relatives had significantly lower burnout grades and high JS levels ($p<0.05$). Residents who work in a compliant environment in terms of in-group relations showed significantly lower burnout levels and high JS ($p<0.05$). A statistically significant difference was found in terms of EE, DP and JS grades according to exposure to violence (daily, weekly and monthly) ($p<0.05$). EE and DP grades of those facing violence on a daily basis were much higher than those who are exposed to it once in a month. Those who face daily exposure to violence had lower JS grades than those who experience it once in a month. Table 2 demonstrates EE, DP, PA and JS grades comparison in terms of sex, marital status, age, service life, presence of consultant, appreciation and exposure to violence.

In our study, we found out statistically significant relationship between burnout levels and JS ($p<0.05$). Increase of JS was accompanied by a decrease in EE and DP grades ($p<0.001$), and an augmenting PA ($p<0.05$). A statistically significant relation was found between the number of patients seen per day and EE ($p<0.05$). EE increased as the number of patients seen per day intensified. The increase in the time spent on weekly social activities bolstered a drop in EE grade and increase in JS ($p<0.05$). Variables related to burnout subscales and job satisfaction are given in the Table 3.

DISCUSSION

Burnout syndrome is an important occupational concern affecting all physicians because of the nature of the emergency department; emergency medicine residents who make the first medical contact with patients are greatly under risk. In busy emergency departments, the residents are alone or have only little time attending physicians for counselling. These may be risks for high burnout and low job satisfaction levels by residents in emergency departments in our country. This study have determined that seniority, working with consultants in emergency medicine, and feeling appreciated in work place are factors in resident's satisfaction or burnout status. Also, patients number seen per day was found out to boost EE and social activities were found to be effective in increasing resident's PA. The interval of exposure to violence in work is also effecting the burnout level (except PA) and JS.

According to Maslach, of all the demographic variables studied the most consistent for burnout is age. Young staff members report higher burnout levels than those of 30 or 40 years of age.[11] In this study, emergency residents have higher PA scores and lower DP scores in increasing ages. Different results were revealed in studies examining the relation between age and burnout levels. Studies demonstrating the reduced burnout levels with aging show accordance with our study and are present in literature.[6,12,13] Studies that show no relation between aging and burnout levels also exist.[14-16]

In this study shows no difference between age groups

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	EE Mean±SD	DP Mean±SD	PA Median(Min.-max.)	JS Mean±SD
Sex				
Male	21.1±6.8	10.1±3.9	21(12-31)	36.2±9.2
Female	21.7±5.9	10.5±3.8	20(8-25)	35.6±9.2
p	0.611	0.493	0.129	0.698
Age†				
25-29	22.3±6.4	10.8±3.8	19(8-28)	36.7±8.9
30-34	21±6.8	10.3±3.8	21(12-27)	35.9±9.6
>35	19.2±5.8	8±3.7	22(13-31)	33.7±8.9
p	0.138	**0.01***	**0.007***	0.419
Marital Status				
Married	21.3±6.5	10.2±3.7	21(12-28)	36.4±9.1
Single	21.4±6.5	10.3±4.1	20(8-31)	35.1±9.4
p	0.961	0.869	0.058	0.454
Spent years in the profession				
0-1	24±5.2	11.8±3.2	21(8-23)	35.3±9.4
1-3	21.5±7.1	10.4±3.7	19(13-25)	38.9±9.5
3-5	22±6.5	10.9±3.7	19(12-26)	34.2±7
5-10	21±5.9	9.9±3.2	20(12-28)	35.6±9.8
>10	18.6±6.6	8.2±4.2	22(13-31)	35.8±11.1
p	0.151	**0.042***	**0.015***	0.366
Presence of Consultant				
Never	27.8±6	14.6±4	17(8-23)	31±18.2
Seldom	22±6.5	9.9±4.3	19.5(12-31)	34±8.6
Enough	23.2±5.2	11.2±2.9	20(13-28)	35.3±8.4
Usually	19.8±6.2	10.1±3.8	22(12-27)	38.7±8.4
Always	19.4±6.8	9.5±3.8	21.5(12-26)	37.6±9.1
p	**0.014***	0.055	0.456	0.141
Complaince with Personnel				
Yes	20.4±5.9	9.7±3.6	21(12-31)	37.4±8.6
No	25.5±7.4	12.2±4.5	19(8-28)	30.4±9.3
p	**<0.001***	**0.004***	**0.011***	**0.001***
Appreciation (by patients and relatives)				
Yes	16.5±6.3	7.6±3.4	22(13-28)	42.2±9.7
No	22.7±5.9	10.8±3.7	20(8-31)	34.2±8.3
p	**<0.001***	**<0.001***	**0.022***	**<0.001***
Appreciation (by supervisors and co-workers)				
Yes	19.7±6.4	9.4±3.4	21(12-27)	40.3±7.7
No	22.9±6.1	11±4.1	19(8-31)	31.4±8.3
p	**0.004***	**0.019***	**0.006***	**<0.001***
Exposure to Violence				
Daily	24.3±6.1	12.1±3.9	19.5(8-31)	32.6±8.8
Weekly	20±5.7	9.4±3.2	21(12-26)	36.9±8.8
Monthly	20±6.7	9.8±4	21(12-28)	37.4±9.3
p	**0.004***	**0.003***	0.447	**0.035***

Data are means (SD) and medians (min-max)
Definition of abbreviations: EE: Emotional exhaustion, DP: Depersonalization, PA: Personal Accomplishment, JS: Job Satisfaction
*Statistically significant result
† Those under the age of 25 were excluded due to being 1 person and the divorced were excluded due to being 4 participants.

Table 2: Comparison of EE, DP, PA and JS in terms of sex, age, marital status, spent years in the profession, presence of consulting specialist, compliance with personnel, appreciation and exposure to violence.

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in terms of job satisfaction. However, some studies reported an increase in job satisfaction as a result of increase of experience gained in the profession and compliance.[6,17-19]

	r	p
EE		
JS	-0.574†	**<0.001***
Number of patients	0.188	**0.03***
Social activities	-0.242	**0.005***
DP		
JS	-0.385†	**<0.001***
Number of patients	0.116	0.174
Social activities	-0.145	0.089
PA		
JS	0.413	**<0.001***
Number of patients	0.061	0.483
Social activities	0.136	0.118
JS		
Number of patients	-0.062	0.483
Social activities	0.268	**0.002***

Definition of abbreviations: EE: Emotional Exhaustion, DP: Depersonalization, PA: Personal Accomplishment, JS: Job Satisfaction
r: Spearman correlation coefficient
†: Pearson correlation coefficient
*Statistically significant result
Table 3: Variables related to burnout and job satisfaction.

Our study revealed no statistically significant difference in terms of sex, burnout subscales and job satisfaction grades. In literature, female physicians showed higher burnout levels.[20-22] Studies also showed no difference between gender in regard to burnout levels.[14,23] Ozyurt reported that male physicians have higher DP score.[6] These discordances can be explained through the weak predicting role of sex itself on burnout levels.

In literature, women have higher job satisfaction.[24-26] But, there are studies in concert with ours showing no difference between gender groups with regarding to job satisfaction.[6,18] On the other hand, some studies found higher job satisfaction in males in Turkey.[27,28]

Our study detected no relationship between marital status and burnout. According to Maslach and Jackson, marital status has a significant relation with emotional exhaustion, one of the burnout subscales. The single and divorced participants have higher burnout levels than those who are married.[29] Ozyurt found in his study that single physicians had higher EE grades than those who are married or divorced.[6] Studies in concert with ours showing no relationship between marital status and burnout also exist.[13-15,22,28] This result can be based on the socio-cultural difference in the society.

Marriage is the factors expected to yield higher job satisfaction by establishing a regular family life and providing a positive impact on work-life. In our study, we found no relationship between marital status and job satisfaction. In the literature on job satisfaction and marital status have been mixed. There are also studies showing that married individuals have higher job satisfaction.[6,19,28,30]

Some studies show no relationship between "spent years in the profession" and burnout levels.[14,31] Our study found lower DP scores in physicians with 10 or more years experience than the beginners. In literature, some studies show relationship between burnout and years in profession.[6,12,13,27,32] Burnout is considered as a high risk factor in the early period of one's career.[11] This result can be explained through professional experience, and increasing authority on patient guidance and management.

Supervision and supporting have effects on EE and DP.[33] Residents who answered as having no consultants during their shifts had higher EE grades compared to those who reported getting more consultants in work. Increase in number of attending physician in emergency departments could provide more bed-side applied education and thus higher self-confidence. In addition, low EE grades can be explained through the available help in patient management, sharing of responsibility and sense of security.

In this study, burnout and job satisfaction levels were examined according to compliance with nurses and other personnel in the working environment. Those working in a compliant environment had significantly lower EE and DP and high PA and job satisfaction grades. This result can be explained through the emergence of socially-related needs (being loved, respected, sense of belonging, approval) and the need to meet those, appearing after physiologic and security needs in Maslow's hierarchy of needs theory. These results are also supportive of the notion that emergency workers must be a team for satisfaction.

According to Maslach, social support decreases the degree of relation between work-place stressors and burnout.[11] Likewise, approving support involves helping one through self-evaluation using approval and appreciation.[34] In our study, residents who felt appreciated by superiors and co-workers had significantly lower EE and DP grades and higher PA and job satisfaction grades. Same result was notified in those who felt appreciated by the patient and his relatives.

One study reported high EE and DP in employees who were exposed or witnessed to violence.[35] Merecz, et al. detected significant relationship between exposure to violence by patients or fellow workers and burnout levels in their study which they carried out on nurses and social service personnel (EE, DP and reduced PA).[36] Winstanley and Whittington, participated by 375 health care professionals, found that those exposed to violence or threatening multiple times had higher EE and DP levels than those who never experienced such exposure.[37] In our study, residents exposed to daily violence had lower JS grades than those

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experienced violence on a monthly basis. Residents exposed to daily violence had higher EE and DP grades than those experienced violence on a weekly or monthly basis. These results support that development of burnout is associated with an increased exposure to violence.

A statistically significant relation was shown between the number of patients seen per day and EE in residents enrolled to our study. There are other studies compliant with our results, demonstrating a direct proportion in increases of emotional exhaustion and number of patients seen per day.[12,38,39] This result can be explained through an increase of physical and mental exhaustion as a result of increasing work-load. Also, the factors such as the number of assisting personnel, availability of other consultants, patient admission rate and time on hospital and work environment related changes could affect the results. However, our study did not involve these.

The relation between the time spent for social activities, JS and burnout state is; an increase in spending time for social actvities resulted with a decrease of EE and increase in JS.

LIMITATIONS

Despite the increasing internet use, the lack of a wide-base database registering emergency medicine residents across Turkey limited our access to all individuals the study targeted. The response rate for our study was 40.7%. Therefore we believe that further extensive studies are needed to determine the factors affecting burnout and job satisfaction among emergency medicine residents in Turkey.

CONCLUSION

Burnout is a syndrome that every physician across the world can experience especially if he/she is an emergency medicine resident. In order to increase job satisfaction and tackle burnout levels, it will be beneficiary to make provisions such as decreasing the number of patients seen per day, increasing the number of emergency department attending physicians and the time spent for social activities, encouraging the appreciation of residents, making adjustments to boost compliance with other personnel, taking measures to prevent violence.

CONFLICTS OF INTEREST

The authors have no commercial associations or sources of support that might pose a conflict of interest.

PARTICIPANT CONSENT STATEMENT

Physicians participated voluntarily; those who consented to participate gave socio-demographic data form, maslach burnout inventory (MBI) and the job satisfaction scale (JSS) *via* internet. Participants who filled in the forms are counted as consent givers automatically.

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All authors contributed to the manuscript; İbrahim Toker and Didem Ovla contributed data acquisition, data analysis; İbrahim Toker, Cüneyt Ayrık, Feriyde Çalışkan Tür, Seyran Bozkurt and Ayşe Devrim Başterzi contributed manuscript preparation, manuscript editing and manuscript review; Serkan Hacar contributed literature search and manuscript editing. All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Mini Review

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Evaluation and Initial Management of Pulmonary Embolism during Pregnancy and the Puerperium

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ABSTRACT

There is an increased risk of venous thromboembolism during pregnancy. The increased risk begins in the first trimester and remains until six weeks postpartum. This paper provides an update on diagnosing and managing pulmonary embolism in pregnancy. Initial workup includes a clinical assessment, baseline blood test, electrocardiogram and a chest radiograph. D-dimer test is not recommended during pregnancy and puerperium. Doppler ultrasound of lower limb is recommended in the presence of a clinical suspicion of deep vein thrombosis. Definitive diagnosis of pulmonary embolism is established with radiological imaging. The preferred imaging modality is isotope perfusion scan with a normal chest radiograph and computed tomographic pulmonary angiography if chest radiograph is abnormal. Therapeutic low molecular weight heparin is the anticoagulant of choice during pregnancy. Warfarin is contraindicated during pregnancy but can be used postpartum. Duration of therapy is at least three months and should continue for six weeks postpartum. An algorithm for diagnosis and management is suggested.

KEYWORDS: Pulmonary embolism; Pregnancy; Puerperium.

INTRODUCTION

The prevalence of Venous thromboembolism (VTE) is 4 to 10 times higher in pregnancy than age matched non-pregnant women.[1] The increased risk of VTE extends from the first trimester until six weeks postpartum.[2]

In developed countries, Pulmonary Embolism (PE) is a leading cause of maternal mortality.[2] Between 2006-2008, 261 women in the UK died directly or indirectly related to pregnancy. The overall maternal mortality rate was 11.39 per 100,000 maternities. Direct deaths decreased from 6.24 per 100,000 maternities in 2003-2005 to 4.67 per 100,000 maternities in 2006-2008 (p=0.02) confidential enquiries into Maternal Death in the UK 'Saving Mothers' Lives', recorded 18 deaths (rate per 100,000 maternities 0.79, 95% Confidence Interval (CI) 0.49-1.25) due to VTE over a 3-year period from 2006 to 2008.[3] Recent review of confidential enquiries into maternal deaths and morbidity 2009-2012 confirmed that VTE remains the leading cause of maternal deaths, with 26 deaths between 2010 and 2012 (rate 1.08, 95% CI 0.71-1.59).[4]

Assessment of a pregnant female with suspected PE is challenging for the front line medical staff. Diagnostic imaging required to confirm or exclude PE is associated with radiation risk to mother and foetus. Missed diagnosis is associated with a high risk of mortality with loss of two lives. A good knowledge of pathophysiological changes in pregnancy, risks and

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benefits of investigations at each stage of assessment, when to seek specialist advice and working in partnership with the patient will help individualise assessment and treatment options.

PATHOPHYSIOLOGY

Pregnancy is a prothrombotic state. Physiological changes occur during pregnancy, notably an increase in plasma coagulation factors, fibrinogen and *Von Willebrand* factor, all of which disrupt the normal homeostatic balance. One retrospective cohort study[5] reported a previous history of thrombosis as being the most significant individual risk factor for VTE. Another recent cohort study showed 17-fold higher risk of VTE during hospital admission not related to delivery, with highest risk in third trimester, remaining significantly higher up to 28 days post-discharge.[6] The risk was highest for women staying three or more days but a fourfold increased risk persisted for hospital stays of less than three days. Risk factors for VTE are summarised in Table 1.

Patient related	Pregnancy related
Previous episode of VTE	Hyperemesis
Obesity (Body mass index >30)	Multiple pregnancy
Age >35 years	Ovarian Hyperstimulation Syndrome
Antiphospholipid syndrome	Surgery / instrumentation
Family history of VTE*	Major postpartum bleed (>1 litre)
Medical co-morbidity**	Parity ≥3

VTE in first-degree relatives (spontaneous or associated with contraceptive use or pregnancy).
**Medical conditions such as diabetes, sickle cell anaemia, nephritic syndrome, acute inflammatory states and heart or lung disease.
Table 1: Patient and pregnancy related risk factors for venous thromboembolism.

CLINICAL PRESENTATION

Signs and symptoms such as breathlessness and leg swelling are associated with late pregnancy and may mimic those of VTE. Other presenting symptoms include chest pain, palpitations, haemoptysis, dizziness or syncope. Tachycardia and tachypnoea may be the only abnormal findings on examination. Hypotension and syncope are seen with massive PE. Pregnancy associated deep vein thrombosis predominantly occurs in the left leg.[7]

INITIAL ASSESSMENT

The initial evaluation aims to assess the risk of PE, exclude alternate diagnoses and develop a patient-centred management plan.

Use of pre-test probability assessment score is not recommended, as it is not evidence based. Reports suggest that a negative D-dimer may be able to rule out PE in many pregnant patients by using pre-test probability score and age-based adjustment threshold of positive D-Dimer level.[8] However, guidelines do not recommend D-dimer since there is a high false positive rate (80-100%) from second trimester onwards and a negative test cannot always exclude VTE.[9]

Baseline blood tests include full blood count, coagulation screen, renal function and liver function. Mild to modest elevation of inflammatory markers (neutrophil count and C-reactive protein) can be seen with venous thromboembolism and not necessarily indicate an infection.

Chest radiograph with appropriate shielding poses negligible risk to the foetus at any stage of pregnancy and should be performed in all cases of suspected PE to exclude alternate diagnoses (e.g. pneumonia, pneumothorax). It is likely to be normal in most patients with acute PE but may show features suggestive of PE (atelectasis, effusion, oligemic lung fields or decreased vascular markings).

ECG usually shows sinus tachycardia. Large PE may lead to right bundle branch block, right axis deviation, p pulmonale (tall P waves in lead II) or S1Q3T3 pattern (may also be seen in normal pregnancy). An urgent bedside echocardiogram showing right ventricular dilatation and dysfunction is suggestive of massive PE.

Arterial blood gas analysis may show low partial pressure of oxygen (PaO_2) with normal or low partial pressure of carbon dioxide ($PaCO_2$). Alveolar arterial (A-a) gradient reflects the difference between alveolar and arterial oxygen concentration and is increased in PE (normal value under 2 kPa or 15 mm Hg for young adults). A-a gradient can be calculated using a simplified formula

$$\text{A-a gradient} = (FiO_2 - [PaCO_2 \times 1.2]) - PaO_2$$

(FiO_2 is fraction of inspired O_2 that is 21% on room air)

Thrombophilia screen and lupus anticoagulant are not recommended before commencing anticoagulant therapy as the information will not influence immediate management and results are affected by both pregnancy and acute thrombosis.

DIAGNOSIS

Baseline investigations cannot confirm the diagnosis of PE. Suspicion of PE should prompt senior review to determine the need and choice of diagnostic imaging and to initiate anticoagulant therapy. Diagnostic imaging should be performed the same day or within 24 hours to determine the need for continued anticoagulant therapy.

Until recently, bilateral Doppler ultrasound of the legs was the recommended initial imaging study for suspected PE as it posed no radiation risk and may detect silent Deep Vein Thrombosis (DVT). It is rarely positive in the absence of clinical signs of DVT and may delay further diagnostic imaging. Recent guidelines recommend Doppler ultrasound only in presence of

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signs and symptoms of DVT.[10,11]

Choice of imaging then varies between isotopes perfusion scan and CT Pulmonary Angiogram (CTPA); opinions and availability vary. Discussion with radiologists is crucial to select the best imaging protocol for each patient.

Isotope perfusion scanning is recommended when the chest radiograph is normal since the likelihood of an underlying lung disease is low in young patients. Isotope perfusion scan is part of the traditional V/Q scan however the ventilation component is omitted and the perfusion scan performed with half the dose of isotope to minimise radiation. Isotope perfusion scan has a high negative predictive value and a negative scan excludes significant PE. Limitations of Isotope perfusion scan include lack of availability out of hours and need for CTPA when indeterminate.

CTPA is preferred when the chest radiograph is abnormal or isotope scan is not available. An abnormal CXR should prompt senior review to ascertain an alternate diagnosis. CTPA cannot be performed in patients with renal impairment and contrast allergy. Iodinated contrast used in CTPA can potentially affect neonatal thyroid with a need to check thyroid function in neonates. Another limitation of CTPA is related to the increased cardiac output during pregnancy, which may lead to non-diagnostic examination due to contrast dilution and poor opacification of the pulmonary arteries. CTPA may show an alternate cause of symptoms but in these cases chest radiograph may be sufficient to establish an alternate diagnosis.

There is understandable anxiety among physicians and patients about risk of radiation to mother and foetus. When possible, the patient should be involved in decision-making and informed written consent taken before the procedure. CTPA delivers higher dose of radiation to the mother in particular to the breast tissue. This would be of concern in very young women and those with a strong family history of breast cancer. The lifetime risk of breast cancer in women of reproductive age is 0.5% (1 in 200) and following CTPA has an estimated lifetime risk of 0.6% (1 in 175), an increase in relative risk of 13.6%.[12] Compared to CTPA, Isotope scan delivers higher doses of radiation to the foetus. Following exposure during pregnancy, the risk of cancer to the child up to the age of 15 is estimated at 1 in 280,000 after isotope scan compared to less than 1 in million after CTPA.

MANAGEMENT

Current clinical guidelines agree the need to initiate empiric anticoagulation with Low Molecular Weight Heparin (LMWH) when clinical suspicion of PE is high. Both LMWH and unfractionated heparin do not cross the placenta but LMWH is the preferred choice. LMWH is easier to administer, considered more effective and associated with lower risks of side effects such as heparin induced thrombocytopenia and osteoporosis. There is increased renal clearance and protein binding of LMWH and a higher daily dose in twice daily administration has traditionally been recommended for enoxaparin and dalteparin. Recent studies suggest once daily dose may be adequate (Table 2). Tinzaparin can be given 175 units/kg once daily. Danaparoid is an acceptable alternative to patients who develop adverse reactions to LMWH.[13] Novel oral anticoagulants (NOACs) are not recommended during pregnancy and puerperium.

Booking weight	Enoxaparin	Dalteparin
<50 kg	40 mg twice daily or 60 mg once daily	5,000 iu twice daily or 10,000 iu once daily
50-69 kg	60 mg twice daily or 90 mg once daily	6,000 iu twice daily or 12,000 iu once daily
70-89 kg	80 mg twice daily or 120 mg once daily	8,000 iu twice daily or 16,000 iu once daily
90-109 kg	100 mg twice daily or 150 mg once daily	10,000 iu twice daily or 20,000 iu once daily
110-125 kg	120 mg twice daily or 180 mg once daily	12,000 iu twice daily or 24,000 iu once daily
>125 kg	Discuss with haematologist	Discuss with haematologist

Table 2: Initial daily dose of LMWH during pregnancy.[9]

The need for monitoring heparin therapy with peak anti-Xa activity should be discussed with a haematologist. Monitoring is recommended for under-weight (<50 kg) and overweight (>90 kg) patients, recurrent VTE or other complicating comorbid medical conditions such as impaired renal function.

Warfarin is contraindicated during pregnancy as it crosses the placenta. It is associated with an increased risk of characteristic embryopathy in the first trimester, central nervous system abnormalities during any trimester, maternal and foetal haemorrhage, miscarriage and stillbirth.

Heparin and Warfarin are safe to use in the postpartum period, neither is excreted in breast milk. Patients should be offered a choice between LWMH and Warfarin, as LMWH does not require regular monitoring.

Anticoagulation therapy should be continued for the duration of pregnancy and six weeks post partum with a minimum total duration of 3 months. Longer duration of anticoagulation is required for women suffering from recurrent VTE, antiphospholipid syndrome or thrombophilia. We recommend that anticoagulant therapy during pregnancy and thereafter should be under the supervision of a haematologist (Table 3).

An algorithm for the diagnosis and initial management of PE during pregnancy and puerperium is shown in Figure 1.

RECOMMENDATIONS FOR FURTHER RESEARCH

- Reliable strategies to rule out PE during pregnancy minimising the need for diagnostic imaging.

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Study	Overview	Evaluation
Saving mothers lives[3,4]	• Overall a statistically significant decrease in the maternal death rate between 2006-2008 and 2009-2012 in the UK. • VTE remains a leading cause of direct maternal death.	• Longest running programme of confidential enquiries into maternal deaths worldwide • Each woman's care examined by between ten and fifteen expert reviewers
American thoracic Society/Society of Thoracic Radiology clinical practice guideline[10]	• D-dimer not to be used to exclude PE in pregnancy • Bilateral venous ultrasound if DVT suspected • CXR recommended as the first radiation associated procedure • Lung V/Q scan is the preferred test in the setting of normal CXR • CTPA is advised with abnormal CXR or non-diagnostic V/Q scan	• Multi-disciplinary panel of experts reviewed the available evidence • The majority of the studies used for this guideline, were off a low level of evidence. Much of the studies were conducted on patients from the general population. • However all members of the expert panel agreed with the strong recommendations devised
Royal College of Obstetricians and Gynaecologists guidelines[11]	• D-dimer test not recommended in pregnancy • Doppler ultrasound only if DVT suspected • Ventilation perfusion scan or CTPA to objectively confirm PE • Treat with LMWH until VTE excluded • Neither LMWH nor warfarin contraindicated in breastfeeding.	• Randomized controlled trials, systematic reviews and meta-analyses from 2006–2013 reviewed • Lack of level 1 evidence in pregnant population, most data comes from non-pregnant patients. • Recommendations mostly extrapolated from studies in non-pregnant patients.

DVT= Deep Vein Thrombosis; CTPA= Computed-tomographic pulmonary angiography; LMWH= Low Molecular Weight Heparin; PE= Pulmonary Embolism; V/Q scan= Ventilation/perfusion scan; VTE= Venous thromboembolism.

Table 3: Overview and evaluation of the literature.

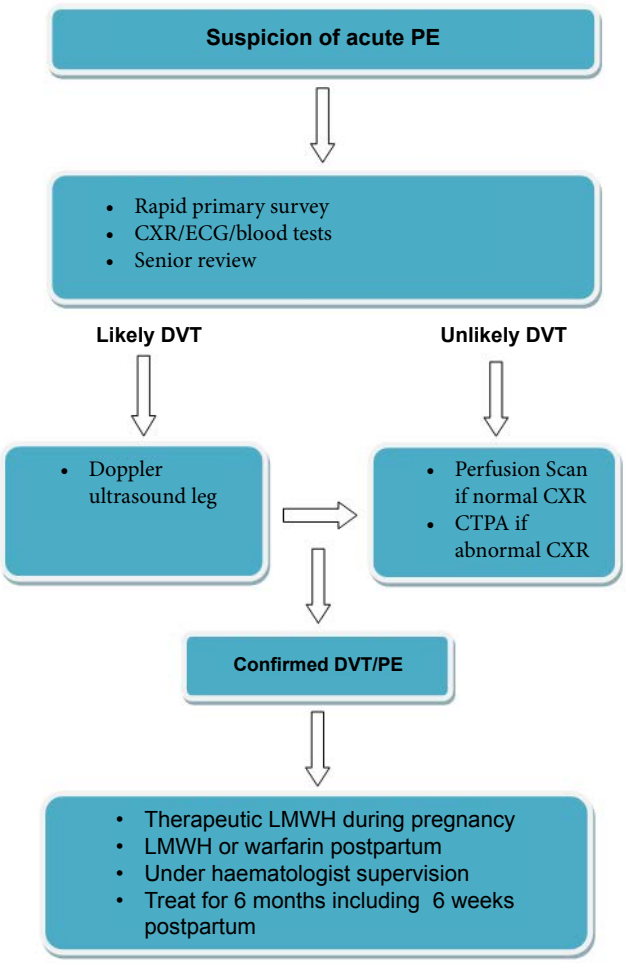

Figure 1: Diagnosis and management of acute pulmonary embolism (PE) during pregnancy and the puerperium.

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- Feasibility and safety of ambulatory care management of suspected PE in pregnancy.
- Effectiveness of newer diagnostic imaging techniques that minimise radiation risk in pregnancy.
- Optimising and monitoring of anticoagulant therapy in pregnancy.
- Longitudinal studies to assess the risk of radiation during pregnancy.

KEY POINTS

- Risk for venous thromboembolism is increased during pregnancy and puerperium.
- Baseline blood tests, ECG and chest radiograph are insufficient to establish a diagnosis of PE.
- Clinical suspicion of PE requires diagnostic imaging with Isotope perfusion scan or CT pulmonary angiogram; both are associated with radiation risk.
- During pregnancy LMWH is the anticoagulant of choice as warfarin is contraindicated.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest with this submission.

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Review

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An Overview of Musculoskeletal Injuries for Emergency Physicians

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ABSTRACT

Musculoskeletal trauma includes injuries affecting the pelvis, upper and lower limbs. These injuries occur in a large number of multiply-injured patients and, as such, are often underestimated, incorrectly treated, and occasionally undiagnosed. This leads to increased morbidity, mortality, and permanent dyes function of the affected limb. Herein, the authors discuss the most common injuries and those that cause life threat or limb loss, intending to schematize the first aid to extremity trauma in the Emergency Room (ER). Although, the definitive treatment of fractures and joint injuries is managed by the orthopedist, the first steps properly taken by the emergency physician are essential for an accurate prognosis and appropriate triage.

KEYWORDS: Physicians; Trauma; Injuries; Fractures; Patient.

ABBREVIATIONS: ER: Emergency Room; TBI: Traumatic Brain Injury.

INTRODUCTION

Trauma is the leading causes of death in people under 44 years of age.[1-2] Musculoskeletal trauma occurs in 85% of those patients experiencing such trauma.[1-2] In the USA, 80,000 people per year sustain traumatic injuries and suffer permanent disability.[1-2] It is estimated that over 36 million emergency room visits are made each year for sustained musculoskeletal trauma, equating to over 442,850 deaths and 2 million hospital admissions.[3] The mechanisms of injury can vary from automotive collisions (head-on crush injuries, lateral impact, ejection, auto *vs*. pedestrian) along with injuries attributed to rapid vertical deceleration (falls) and gunshot wounds (Table 1). These can be a source of confusion and mismanagement when encountered by first responders. Open fracture classification, attributed to Gustilo & Anderson, (Table

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Mechanisms of Trauma	Predictable pattern of injuries
Frontal Automotive Collision	Cervical spine fracture; Sternal and Hip fractures; Posterior hip dislocation and fracture; Knee fractures and dislocation (ligament knee injuries); Ankle fractures and sprain; Long bones fractures;
Lateral Automotive Impact	Cervical spine fracture; Pelvic fracture; Acetabulum fractures; Upper and lower limb fractures;
Rear Lateral Automotive Impact	Cervical spine injuries; Neck soft-tissue injuries;
Ejection from Vehicle	The pattern of injury can be unpredictable as it depends on how the occuapnt lands.High overall mortality rate when comparing to any other mechanism of injury;
Auto *vs.* Pedestrian Collisions	Pelvic fractures; Lower limb fractures;
Rapid Vertical Deceleration (falls)	Pelvic fractures; Lower limb fractures; Acetabulum fractures; Lumbar spine fractures;
Penetrating Trauma by Firearms	The pattern of injury can be unpredictable.

Table 1: Mechanisms of trauma and the predictable pattern of injuries that may result.

Type	Woundsize	Contamination	Soft tissueinjury	Boneinjury
I	<1cm	Clean	Minimum	Simple
II	>1cm	Moderate	Moderate	Moderate
IIIA	<10cm	Extensive	Severepossiblecoverage	Comminutedfracture
IIIB	>10cm	Extensive	Severe, impossiblecoverage	Comminutedfracture
IIIC	>10cm	Extensive	Vascular injury requiring repair reparo	Comminutedfracture

Table 2: Open fracture classification (Gustilo & Anderson).

2) is an essential tool for fracture assessment. Classification is based on wound length, soft tissue injury, contamination, and fracture pattern. Both emergency room physicians and orthopedists should be familiar with this devised schema which dictates surgical intervention and antibiotic coverage. In an effort to streamline care in the ER, certain objectives and assessments should be met.

OBJECTIVES

- Identification of extremity trauma that leads to life-threatening conditions, disability, or limb loss;
- Standardization of care and treatment of trauma patients with extremity injury;
- Requisition of proper radiography according to the affected limb segment;
- Knowledge of the principles and methods of fracture stabilization;
- Identification of any trauma to an extremity that needs immediate surgical intervention;

PRIMARY ASSESSMENT

There are two groups of patients with extremity trauma that physicians will evaluate in emergency situations:

Group 1: Multiple-trauma patients that demonstrate a high level of consciousness and orientation;

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Group 2: Unconscious and disoriented patients with multiple trauma injuries. Etiologies may include Traumatic Brain Injury (TBI), hypovolemic shock, hypoxia, drug intake, immaturity (children) or by seniledementia (elderly).

Easily identifying a patient's group may help emergency physicians to deliver safer care and prevent iaotrogenic injuries. The assistance to trauma victim begins with obtaining a concise history of the accident, which may be provided by the patient themselves or by others and by evaluating the mechanism of trauma – provided by pre-hospital care team (Table 1).[1-3] Regarding patients in Group 1, it is essential to obtain vital information about the accident and the body region injured, which the patient will identify as painful and/or with a functional disability. Patients in Group 2 must be fully unclothed and carefully inspected. Bruises, abrasions, bleeding, and deformities must be identified, providing evidences on possible trauma mechanism. Hypothermia must likewise be assessed and prevented.

During Circulatory assessment (C), after airway maintenance, cervical spine protection, (A) and ventilation (B), it is mandatory to recognize and control hemorrhage from musculoskeletal injuries. Deep lacerations may affect large vessels, causing profuse bleeding and subsequent hypovolemic shock. Direct pressure is the best way to control the bleeding. In 28% to 47% of cases, pelvic fractures are responsible for the cause of shock, requiring early stabilization for adequate control of bleeding.[4-12] Approximately 3% of patients present with a life-threatening hemorrhage due to isolated pelvic injury.[6,10,13] Consequently, the pelvic bleeding must be detected and distinguished from abdominal bleeding within the first few minutes after presentation. Long bone fractures, humerus, femur, and/or tibia, even when not open may provoke massive bleeding and subsequent hypovolemic shock i.e. Grade III (30-40% loss of blood volume). Ultimately, these injuries could result in a compartment syndrome with significant sequelae. In these cases, the correct fracture immobilization can significantly reduce bleeding and provide pain relief. The procedure should be performed during the resuscitation period, often without appropriate radiographic evaluation, due to the risk of imminent death. An important complement to bleeding control measures is intravenous fluid resuscitation including crystalloids and blood products.[14,15]

SECONDARY ASSESSMENT

Once the patient has a patent airway, adequate breathing and cardiovascular stability, a full assessment of the musculoskeletal system (based on the information obtained, physical examination and imaging studies) must be done. The secondary survey should consist of acquiring more information about the patient's past medical history (allergies, past illnesses/pregnancies, last meal, events or environmental conditions related to injury). Along with the repeat head-to-toe physical examination, there must be a reassessment of vitals and ABC's.

PHYSICAL EXAMINATION

The first step on physical examination is to make sure the patient is fully unclothed, but to prevent hypothermia. Where relevant, the immobilization devices used at the crash scene are provisionally withdrawn (except the femoral traction device, when applicable) and put back after the examination when appropriate. The use of radio-transparent splints are recommended.[16] The bandages are removed, the wounds are inspected and new bandages are applied with sterile equipment.[17]

Pertinent to patients of group 1(conscious and oriented)

A) Inspection: Examine from head to toe, searching for swelling, abrasions, injuries, hyperemia, and deformities that may suggest a fracture or dislocation. Make a comparative examination with the other limb when possible.

B) Active Motions: Should be done only if the patient is able to do so. Even when the movements are preserved, joint damage should not be ruled out. Ask the patient to raise their arms, flex and extend the elbows, wrists and fingers. Ask the patient to flex and extend their hips, knees, ankles, and feet. Comparison should be made with contralateral limb. In cases of asymmetry or when the patient cannot perform the movements, carry out palpation, passive motion and always check the pulses.

C) Palpation: This should be performed carefully. Initially palpate suspicious lesion areas, searching for tender points, bony protrusions and crackles. Palpation may be performed in conjunction with passive mobilization.

D) Passive motion: Helps identify occult fractures and joint injuries. Check if there is pain and evaluate stamina and endurance during the movement.

Emergency Room Radiography Request: Cervical (Lateral), Chest (AP), Pelvis (AP) plus affected and suspected musculoskeletal segments.[18]

Pertinent to patients of Group 2 (unconscious and disoriented)

A) Inspection: Observe from head to toe, looking for swelling, abrasions, injuries, hyperemia, and deformities that may suggest a fracture or dislocation.Make comparative examination of the contralateral extremity.

B) Palpation: In this group, palpation should be performed in a systematic way to ensure that no segment is missed. The suggestion is that a top-down palpation should be done in the following order: clavicle, shoulders, arms (humerus), elbow (epicondyles, olecranon and radial head), forearm (radius and ulna), wrists (radial styloid, ulnar and carpal), hands (metacarpal, metacarpophalangeal joints, phalanges, and interphalangeal joints), hip

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(iliac crests, pubis, ischial tuberosity, greater trochanter), thighs (lateral side of the femur), knee (patella, epicondyles, fibular head).

Observe joint effusion, leg (tibia and fibula crest), ankles (lateral and medial malleolus) and foot (calcaneus, tarsal, metatarsal, metatarsal-phalangeal joints, and phalanges). Always perform comparative palpation. Palpate peripheral pulses and test the deep tendon reflexes.

C) Passive motion: Helps identify occult fractures and joint injuries. If there is visible damage/ deformity, passive movement becomes unnecessary.

Emergency Room Radiography Request: Total Column (L + AP), Thorax (AP), pelvis (AP) segments showing signs of bruising, abrasions, bleeding and apparent deformities.

COMPLIMENTARY IMAGE ASSESMENT

Radiography

Table 3 represents the most common segments and incidences encountered in the emergency room.

Important Notes:

- Radiographs should and can be taken with radio-transparent immobilization devices;
- Radiographs must contain the adjacent joints of the affected segment;
- Do not accept poor quality radiographs;

SEGMENT	X –RAY INCIDENCES	PROBABLE DIAGNOSIS
Clavicle	AP Axial 30° cephalad	Fracture: proximal, middle and distal; dislocation of the sternoclavicular or acromioclavicular joint.
Shoulder	AP + L Y-Scapular View Axillary View	Fracture of neck, anatomical, greater or lesser tuberosities and associationed anterior or posterior dislocations.
Arm	AP + L (+ shoulder and elbow)	Humeral fracture of the upper, middle or lower 1/3; diaphyseal simple or complex.
Elbow	AP + L	Fracture of intra or extra-articular condyles; humeral-ulnar dislocation, dislocation of the radial head, fracture of the ulna with dislocation of the radial head, fracture of the radial head
Forearm	AP + L (+ elbow and wrist)	Proximal, middle or distal 1/3 radial diaphysis fracture and / or ulna; associated dislocation of the proximal or distal radio-ulnar joint
Wrist	AP + L (+ elbow)	Fracture of the distal 1/3 of the radius and / or ulna; fracture and / or dislocation of the carpal bones.
Hand	AP + Oblique	Fracture of the metacarpals and phalanges; dislocation of the metacarpophalangeal and interphalangeal.
Pelvis	AP + " in let" + "out let"* (+ Lumbar spine femurs and knee)	Fractures of the ilium, ischium and pubis without amendment of the pelvic ring; fractures with alteration of the pelvic ring: lock (lateral compression); opening (anteroposterior compression) or vertical shear, fracture or dislocation of the acetabulum; fractures the proximal femur, anterior dislocation, central or posterior hip
Thigh	AP + L (Pelvis and knees)	Fractures of the proximal, middle or distal 1/3 femoral shaft.
Knee	AP + L + Oblique Patella (axial)	Fractures of intra-or extra-articular femoral condyles, tibial plateau fractures, fractures of the patella, femur-tibia or femur-patellar dislocations
Leg	AP + L (+ knee and ankle)	Fracture of the proximal, middle or distal 1/3, diaphysis of the tibia and / or fibula.
Ankle	AP + L	Fracture of the tibia, fracture of the lateral, medial malleolus or both. With or without dislocation of the tibio-tarsal joint
Foot	AP + O + (L) (+ ankle)	Fracture of the calcaneus, talus, tarsal bones, metatarsals and phalanges; dislocation articular calcanealtarsal (Chopart), tarsal-metatarsal (Lisfranc) or interphalangeal

Table 3: Radiography by segment and incidences followed by probable diagnosis found in each complimentary exam.

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- In case of children and adolescent with joint trauma, the radiograph of the contralateral limb is mandatory. Otherwise, the cartilaginous structures and epiphyseal growth plates can be misdiagnosed as a fracture.

IMMOBILIZATION

Note: All procedures should be done after the removal of all structures that may cause constriction such as: bandages, jewelry, rings, watches, etc., and the patient should always be placed on the long spine board for transportation. Once in the emergency room, the backboard can be removed when spinal injuries are cleared.[19,20]

Principles of Immobilization

Where relevant, immobilization should be performed at the crash scene before the patient is transported to the hospital. The use of slings, splints, traction, cervical collar, and long spine board is important for the correct treatment of multiple trauma patients. The basic principle of fracture management is always to immobilize the joint above and below the injured bone. Extremities trauma care should be carried out in the secondary assessment, after the treatment of injuries that endanger the patient's life.

A) Upper Extremity

- **Hand and wrist:** These injuries should be immobilized in the anatomical position, with a volar splint for the wrist or volar splint for fingers, discrete wrist dorsiflexion, slight flexion of the fingers, and a sling.
- **Forearm:** Immobilization should contain the elbow (90˚ flexion) and wrist (in neutral position): axillaryhand palmsplint.
- **Elbow:** Immobilize the elbow in a semi-flexed position (30-40°) with axillary-palmar splint. If there is any resistance to move the limb back to its anatomical position, immobilize in the position it was found with an axillary- hand palmsplint.
- **Arm:** Shoulder and elbow should be immobilized, usually by bandaging the arm close to the chest or temporary axillary-hand palmsplints.
- **Shoulder:** The immobilization should be done with the arm close to the chest using bandage or just a sling.
- **Clavicle:** Initial placement of an inter-scapular pad helps to relieve pain and can be maintain edif the patient remains bedridden. The use of a sling may help during transportation. Figure-of-eight bandage (clavicle strap) is employed for middle-third fractures as definitive treatment.[19]

B) Lower Extremity

- **Femur:** Can be carefully immobilized with a traction device applied on the ankle, avoiding application closer to major wounds. Immobilization can be done by bandaging one leg to the other. This type of immobilization is also used for hip fractures.
- **Tibia and fibula:** Should be held in place with a cruropodalic rigid splint or pneumatic splint above the knee and below the ankle.
- **Knee:** Splinting with slight traction or discrete flexion, with a pad under the knee to reduce discomfort.
- **Ankle:** These injuries can be immobilized with pillows or padded splints with 90° of dosiflexion, avoiding pressure on the malleolus and bony prominences.
- **Feet:** Also immobilized with a leg-foot splints.[20]

TRAUMAREQUIRINGIMMEDIATEOPERATIVE INTERVENTION

Unstable Pelvis Fractures

Complex pelvic ring injuries are generally not isolated and are usually observed in patients with multiple trauma, therefore the patient requires critical care. Facing a polytraumapatient with severe fractures involving the pelvic ring, the physician should keep in mind the overall management of the patient including all associated traumatic injuries in addition to management of the pelvic fracture (s).

On physical examination, the emergency physician should look for possible ecchymotic areas, bruising or bleeding near the urethral meatus, vagina, or rectum. If these later two regions are not carefully inspected, an open pelvis fracture may be missed.

Pelvic instability can be simply tested by gently applying lateral and anteroposterior pressure with the thenar region of both hands on the iliac crests, and by holding the hemipelvis with one hand and using the other hand to pull along the vertical plane.[6, 21,22]

Emergency care

Protocol for shock in pelvic fracture

Initial assessment (A,B,C) + IV fluid with poor or transient response:

- If external bleeding → Control
- If internal bleeding, unknown origin → proceed with chest, abdomen and pelvis radiological examination in the ER and perform a Focused Assessment with Sonography for Trauma (FAST) exam. If patient is hemodynamically unstable activate the massive transfusion protocol
- Insert the Resuscitative Endovascular Ballon Occlusion of the Aorta (REBOA) in Zone I (from the origin of the left

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subclavian artery to the celiac artery) if FAST (+), and in Zone III (from the lowest renal artery to the aortic bifurcation) if FAST (-).[23,24]

- If chest bleeding →Thoracotomy may be necessary
- If bleeding origin is in the abdomen or pelvis associated with low risk fracture → Laparotomy may be necessary
- If bleeding origin is in the abdomen or pelvis associated with a high risk pelvic fracture → proceed with pelvic packing and external fixation to stabilize the pelvic fracture and reduce the bleeding

Despite efforts, the mortality rate of unstable pelvic fractures has remained high. It seems that multidisciplinary care is not enough for reducing the mortality of this condition.[23-25] REBOA has emerged as an alternative to control bleeding and stabilizes patients in hemorrhagic shock. A revised algorithm for the management of patients with unstable pelvic fractures and exsanguinating hemorrhage is detailed in Figure 1.[23]

A particularly dangerous situation occurs if the patient is subjected to an emergency laparotomy hastily, wherein an unstable pelvic fracture may be an unknown bleeding source. It is important to stabilize the pelvis and fix an open-book injury with an external fixator before laparotomy is performed. Special attention must be given to "over-resuscitated" patients. Overload crystalloid resuscitation must be avoided and can cause a false positive FAST exam. For pelvic fractures with severe shock and no obvious bleeding source, extraperitoneal packing and/or REBOA before an angio-CT and external fixation are highly recommended. In the case of patient presenting with an acetabulum fracture (not pelvic ring fracture) in severe shock, the ER physician should strongly suspect a vascular injury (iliac artery and/or vein).

OPEN FRACTURES

Open fracture occurs when there is communication between the fracture and the external environment or infected cavities such as mouth, digestive tract, vagina, and anus. The existence of an open wound around a fracture should be considered as an open fracture until proven otherwise. The presence of air in soft tissue in the radiological examination suggests exposure of the injury to the environment.[26]

Initial Approach

At the scene of trauma: The assistance to the patient with an open fracture should begin at the trauma scene. The wound should be isolated from contaminated external environment as soon as possible. At this time, it is ideal to apply gauze or sterile compresses. If not available, clean clothes or clean plastic sheets are acceptable. Improvised immobilization may help prevent further trauma to soft tissues, but an attempt to reducing the open fracture should be avoided due to the risks of bringing debris and microbial contaminants into the wound.

At the hospital: It is mandatory to isolate the wound, if not already done. If there is a need to examine the wound, it should be done quickly (minimal time) and in a favourable environment, preferably by the orthopedic surgeon who will treat the fracture. At this time, the emergency physician can classify the fracture exposure level (Table 3), which may help designate the antibiotic therapy (Table 4) and the method of stabilization. Do not forget to give the anti-tetanus immunization according to vaccination history.[27-31]

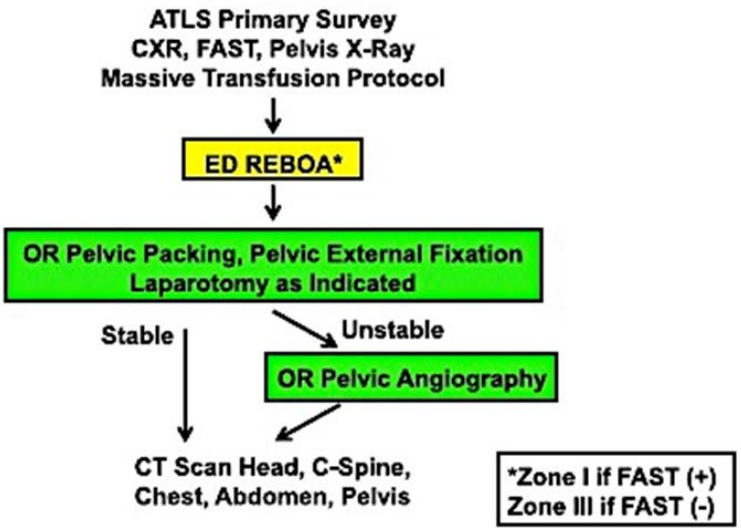

Figure 1: Management of Patient with Unstable Pelvic Fractures and Severe Hemorrhagic Shock (Revised Denver Health Medical Center Algorithm).[23]

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Type	Antibiotic
I and II	Cephalosporin(1st generation)
IIIA, B, C	Cephalosporin(1st generation)+aminoglycosides
In countryside, field or farm	Cephalosporin(1st generation)+aminoglycosides+ Penicillin

Table 4: Antibiotic therapy in open fractures (OF)*.

Antibiotic Therapy in Open Fractures

Important:

1. These fractures should be operated (extensive washing, debridement and stabilization) within 6 hours after trauma, otherwise they are considered infected.
2. These wounds should NOT be initially sutured, regardless of wound size and contamination, even when the patient needs to be transferred to another hospital.

TRAUMATIC AMPUTATION

Traumatic amputation is the most catastrophic extremity injury, which endangers limb viability and patient life. Amputations should be promptly treated, with compression or tourniquet to stop the bleeding. The limb must be properly evaluated and preserved for possible implantation

There are two types of amputation: total, in which the limb is fully separated from the patient; and partial, in which the limb is connected by tissue with little or no vitality.[32]

Treatment:

- Partial Amputation: control bleeding: compression bandage or tourniquet – taking note of the time it was done. Do not clamp vessels; clean the injured extremity; bandages should besterile; and immobilize.
- Total Amputation: The same as discussed in "Partial Amputation". In particular, the limb must be packed in clean dry bandages and always together with the patient to ensure that both arrive at the same time in the hospital. The limb to be implanted should be in hospital at room temperature not greater than 6 hours after trauma, or preserved in a dry plastic bag put on ice-filled box not greater than 18 hours after the accident. Never place the severed limb directly on ice, water, dry ice or in the freezer.[33,34] In severe limb injuries, early fasciotomy may improve limb viability and avoid amputations.[32,35]

FRACTURES ASSOCIATED WITH VASCULAR INJURY

The prognosis of fractures associated with vascular injury depends on the duration and degree of ischemia. The degree of tissue ischemia is aggravated in multiple trauma patients by generalized hypoxia. Prompt diagnosis and direct treatment of vascular injury reduces further damage. The presence of pulse or a Doppler signal does not exclude vascular injury. The arterial injury reconstruction has priority over the bone fixation. If immediate repair is difficult to be executed, a temporary shunt is recommended.[36-39]

FRACTURES WITH COMPARTMENT SYNDROME

Compartment syndrome can lead to subsequent muscular, nervous, and vascular damage. Appreciation of a developing compartment syndrome is extremely important and may contribute to efforts aimed at limb salvage. The classic symptoms, known as the "four Ps" of Griffiths, are: pain, paresthesia, paresis, and pulselessness. The pain may be the first and most important symptom of an impending compartment syndrome. In general, it is described as being much more severe than expected(pain out of proportion to what should be experienced from a physical examination), difficult to control with common analgesics, and the intensity is exacerbated with passive extension of muscle.[40,41]

Since the high pressure in the tissue is the prime condition for the establishment of compartment syndrome, direct measurement of this pressure is the most objective way to make the diagnosis. (Whitesides Method). The most recent evidence suggests that the limits of pressure and time are between (30-40) mm Hg and eight hours. With high pressures extending over eight hours, intracompartmental necrosis will occur. Hence, an immediate fasciotomy should be performed. It is necessary to know the anatomy of the compartments of each limb before fasciotomy, avoiding inadequate fasciotomy which, in and of itself, will result in subsequent tissue necrosis.[42-44]

In multiple trauma patients, irreversible tissue damage may occur at a lower compartment pressure due to generalized hypoxia. High-risk patients, especially those with closed comminuted fractures of the proximal or distal-third tibia or those with complex foot injuries, should be closely monitored. It is important to emphasize that not only fractures can induce compartment syndrome, but contusions involving high-energy trauma and extrinsic factors such as tight bandage or splinting are also related to increase compartment pressure. Delayed presentation of compartment syndrome is uncommon.[45] Attention must be given to fractures near the elbow in children. These fractures (supracondylar) should not be immobilized with circular plaster and flexion greater than 90 degrees due to risk of complications. Contusion or crushing should be observed in the acute phase and an anti-inflammatory therapy should be performed, otherwise it can progress to compartment syndrome.

ASSOCIATED VASCULAR, TENDON AND NERVE INJURIES

Hemorrhage endangers life and must be quickly and effectively controlled. The correct way is applying an occlusive

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bandage with sterile dry gauze. Another option is to stop the bleeding, and placement of vascular clamps and/or tourniquets should be avoided as these procedures may cause more damage to the vessels and the surrounding structures. After hemorrhage control and optimal fluid resuscitation, the treatment of the wound should be initiated. The principles of wound care consist of preventing infection, promoting primary healing, and saving the injured tissues. The ER physician should, through history and physical examination, evaluate what procedures must be urgently performed. The history should contain data about the time between the accident and treatment, contamination of the lesion, the mechanism of trauma, and the procedures performed. Physical examination should be done under sterile conditions in order to calculate the size of the wound, the extent of tissue loss, and viability of the surrounding tissues. Distal limb perfusion must be evaluated in case of suspected arterial lesion associated with a perfusion deficit. Salvage of the limb in a critical trauma patient may be difficult especially in the presence of physiologic derangements (i.e. coagulopathy, hypothermia, and acidosis); however, successful cases have been reported. The vascular exploration should be done in an operating room by a surgeon competent in vascular surgery.[46-48]

The diagnosis of a tendon injury can be done at the first examination by an abnormal digital posture. In patients who can cooperate, separate tests to evaluate the damage of superficial and deep flexor tendons or both can be performed. Before the anesthetic block, the diagnosis of nerve injury is done by performing a sensory examination in the anatomic areas (dermatomes) supplied by the median, radial, and ulnar nerves.

Initial treatment: After quick inspection of the wound and the limb, take the following steps:

- Start a broad-spectrum antibiotic (cephalothin 2g IV or 25 mg/kg);
- Administer an anti-tetanus immunization, according to prior vaccination history;
- Avoid locally anesthetizing the wound if there is possibility of transferring the patient to aorthopedic surgeon.
- If not, block the edges of the wound with Lidocaine 1% and wash the wound with normal saline (at least 1 liter);
- Approximate the wound edges with non-absorbable sutures;
- Occlusive bandage with sterile gauze should be performed to stop the bleeding;
- Maintain temporary immobilization;
- DO NOT tie or clamp bleeding vessels, just apply an occlusive bandage;
- DO NOT suture the fascia, muscles, tendons, or nerves;
- Transfer to the hospital with optimal facility and for anorthopedist evaluation.

OTHER IMPORTANT SITUATIONS

1. Traumatic dislocation of the shoulder (glenohumeral joint): Characterized by acute shoulder dislocation, with severe pain, apparent deformity and functional disability. In anterior dislocations, the arm is abducted and externally rotated, with limitation of internal rotation. In the posterior dislocations (rarer), the shoulder external rotation is limited and the arm is abducted and internally rotated. It should be noted an anterior dislocation occurs in 85-90% of cases and that the axillary nerve is at risk.

Treatment

- Request radiographs AP + Lateral (L) + Axillary of the affected shoulder. Note: If in doubt, compare with the unaffected shoulder; Y-scapular view may be required to identify posterior displacement.
- Put the patient lying on a stretcher;
- Do effective analgesia (i.e.: opioids) and muscle relaxing (Diazepam);
- Make the traction and counter-traction maneuvers;
- Reduction occurs when there is immediate pain relief and return to normal shape of the shoulder;
- Immobilize
- If not reduce, put a sling and refer the patient to an orthopedic surgeon.

2. Dislocations (in general): Dislocations should not be underestimated. The energy required to promote the displacement of a joint, often, is greater than that required to fracture a bone. Thus, it should be faced as an emergency and treated promptly, preferably in the operating room under anesthesia. The reduction of a dislocation gives immediate discomfort and pain relief. Whenever possible, reduction maneuvers must be performed by an orthopedist. These maneuvers should not exceed more than two attempts, because in that case the treatment is surgical, and insisting on maneuvers may worsen the injury. Always assess and document the distal pulses before and after reduction.

3. Fracture of the femoral neck: These fractures, especially in young people, endanger the vascularity of the femoral head and may lead to aseptic necrosis of the femoral head with severe sequelae and disability to the patient. When treated early (within 8 hours post-trauma), the occurrence of necrosis decreases.

If this injury is suspected, AP radiographs of pelvis with 15-20 degrees internal rotation of the lower limbs and L of the affected hip should be requested. The treatment of these fractures is surgical and preference given to techniques of osteosynthesis. In elderly patients, these fractures should also be treated early to prevent necrosis of the femoral head and especially morbidities from the confinement to bed (e.g., pneumonia, urinary

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tract infections, pressure sores, venous thromboembolism, and death).

4. Diaphyseal femur fracture: This fracture is caused by high-energy mechanisms, usually with extensive soft tissue injury, associated injuries and blood loss (even in closed fractures). The provisional immobilization relieves pain, prevents further damage to the soft tissue, reduces bleeding and can decrease the risk of fat embolism syndrome. Increasingly, there is a trend to operate early in these fractures because of associated complications. Intramedullary rodding is currently the treatment of choice in diaphyseal fractures with application of superior and distal locking screws to prevent rotational or shortening deformities.

5. Closed fractures (in general): All diagnosed fractures should be treated, even by a simple immobilization. Thus, all fractures should be considered an emergency.

FINAL CONSIDERATIONS

An attempt has been made to highlight the main extremity injuries which endanger patient's life or the result in loss of the affected limb, commonly seen in emergency departments worldwide. The presented protocols are based on updated literature and accepted in most services. Emergency physicians should consider this content when managing fractures and/or dislocations, paying special attention to those that need emergency treatment. In all cases, after the initial procedure, the patient should be referred for an orthopedic evaluation. An emergency room extremity trauma management flowchart is presented (Figure 2).

CONSENT

No consent is required to this article publication.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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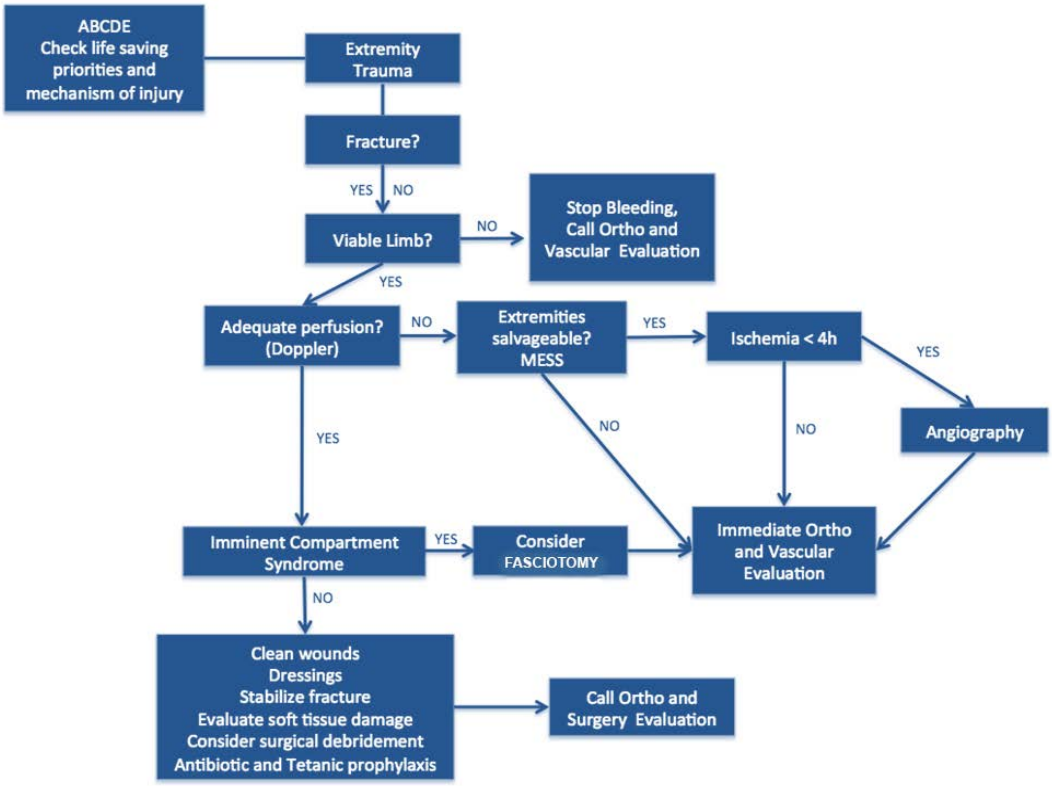

Figure 2: Extremity Trauma algorithm for emergency physicians.

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Research

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Non-Invasive Characterization of Oxygen Transport in Sickle Cell Disease: A Pilot Study

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ABSTRACT

Introduction: Vaso-occlusive (VOC) crisis is, in part, a result of microvascular ischemic insults to tissue causing pain in Sickle Cell Disease patients, which is a common presentation to the Emergency Department (ED). This study simultaneously measured and compared several global and regional indicators of oxygen transport in normal volunteers and subjects with Sickle Cell Disease (SCD).

Materials and Methods: Healthy African American volunteers were compared to SCD patients, assessed at states of clinical non-distress, referred to herein as "baseline". All subjects underwent 10 minutes of non-invasive monitoring to measure cardiac output, oxygen consumption, arterial oxygen saturation (SpO_2), and Cutaneous tissue saturation of oxygenation ($CtSO_2$).

Results: Twenty one patients (9=healthy & 12=SCD baseline) were chosen. The median superficial $CtSO_2$ (healthy *vs.* SCD baseline) was 72% (IQR=10.94) and 56% (IQR=26.86) with a p-value of 0.0011. Traditional measures of hemodynamic performance (heart rate, blood pressure, cardiac index) were not statistically significant between the two groups.

Conclusion: The study shows Sickle Cell Disease to share similarities with sub-clinical compensated state of shock on a microcirculatory level. The values obtained from the study can hopefully shed light into the intricacies of the baseline biophysiology of Sickle Cell Disease; with a foresight to further understand Vaso-occlusive crises pathological processes and sickled cells interactions with its surrounding environment.

KEYWORDS: Oxygen transportation; Microcirculation; Spectroscopy; Hemoglobin.

ABBREVIATIONS: VOC: Vaso-occlusive Crisis; ED: Emergency Department; SCD: Sickle Cell Disease; $CtSO_2$: Cutaneous Saturation of Oxygen; OER: Oxygen Extraction Ratio; IQR: Interquartile ratios; SD: Standard Deviations; CI: Confidence Intervals.

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INTRODUCTION

Sickle Cell Disease (SCD) is a disease manifestation of a set of genetic abnormalities primarily affecting patients of African and Mediterranean descent. It is caused by a substitution of valine for glutamic acid in the sixth position of the beta globin chain on chromosome 11. This alters the surface charge of the molecule and allows sickle hemoglobin (Hb S) tetramers to polymerize inside the red blood cell. The polymer can alter both the red cell shape and membrane properties leading to abnormal and complex interactions with the vascular endothelium. The combination of these effects produces a hemolytic anemia and suspected microvascular dysfunction, which results in severe pain. The mechanisms by which this occurs have not been well delineated, but are likely due in part to abnormalities in oxygen transport. Current concepts suggest several factors may impact oxygen transport including inflammation,[1-4] neurohumoral responses,[5-8] autonomic nervous system adaptations[9,10] and abnormalities in vascular response. These factors may influence vasculature in SCD patients at baseline and during VOC.

In order to gain a deeper understanding of the pathophysiology of SCD and oxygen transportation, better mechanisms to identify the components of oxygen transport are needed. It is now possible to non-invasively monitor several components of oxygen transport. Some method involve measuring cardiac output by a number of means including impedance cardiography, oxygen consumption through indirect calorimetry, arterial hemoglobin oxygen saturation through pulse oximetry, and tissue hemoglobin oxygen saturation through differential absorption spectroscopy. We used these techniques along with conventional hemodynamic parameters such as heart rate and blood pressure to measure and compare whole body and regional tissue oxygen transport and traditional hemodynamic measures in SCD patients at baseline and patients without SCD.

The purpose of this study to begin to understand the relationship between oxygen transport abnormalities in normal, healthy controls and in patients with SCD. The ability to document such abnormalities may provide important diagnostic and therapeutic endpoints allowing for more objective treatments of SCD and VOC.

MATERIALS AND METHODS

Study Population

The study population consisted of two groups. The first group was composed of nine normal, healthy controls of African-American descent with no history of reported Sickle Cell Disease or trait. The second group consisted of twelve patients with a known history of Sickle Cell Disease classified as homozygous Hb SS or doubly heterozygous Hb SC, that at the time of evaluation, did not report pain. There were no statistical analysis of the control group and SCD group demographics due to the control groups being race and age matched to the SCD patients. The Institutional Review Board has approved this study. All patients signed a consent form prior to enrollment in the study as per IRB regulations.

Non-Invasive Hemodynamic and Oxygen Utilization Measurements

Cutaneous tissue oxygen saturation measurements (CtSO2): Differential absorption spectroscopy was used to measure the aggregate hemoglobin oxygen saturation in a selected volume of tissue. $CtSO_2$ measurements were made with a spectrophotometric[11,12] monitor using a combination of visible and near-infrared light (O_2C: LEA, Inc., Gießen, Germany). A combination of white light and near infrared light was used to detect $CtSO_2$. Oxygen saturation was determined by the differential absorption spectra of oxygenated and deoxygenated hemoglobin to the various light sources as they traverse a certain volume of tissue. The volume of blood in any tissue is approximately 70% venous, 20% capillary, and 10% arterial.[13] The derived $CtSO_2$ is indicative of mainly venous hemoglobin and thus, represents the post-extraction compartment of the tissue. This in turn is indicative of the adequacy of oxygen delivery at the tissue level. Each probe has sensors that can detect superficial as well as deep cutaneous measurements based on optode spacing and the character of light used. Superficial sensors monitor a depth of 2 mm and deep sensors monitor a depth of approximately 7 mm. Two flat probes were secured to the thenar aspect of each individual's palmar surface while recording $CtSO_2$ readings. This was done to minimize pigment interference with the probes while recording data. $CtSO_2$ was measured continuously and values, reported as "percent saturation", were recorded every 5 seconds for averaging over the 10 minute period.

Cardiac index (CI): In order to determine whole body oxygen delivery, cardiac output was measured using an impedance cardiography (Medis Medizinische Meßtechnik, Thueringen, Germany). Eight standard electrodes were placed on each subject; as directed by the manufacturer. Two of these electrodes were placed on each side of the neck and thorax. The electrodes used were standard continuous EKG monitoring electrodes. CI was measured every 5 seconds and these values were used to average CI over the 10 minute period.

Oxygen consumption (VO_2): VO_2 was measured by having patients breathe into a mouthpiece connected to a system that can measure both airflow and the differences between expired and inspired oxygen concentration (BioPac Systems, Gloleta, CA, USA). The patient was instructed to breathe through a disposable mouthpiece and corrugated tubing identical to those used to administer respiratory aerosol treatments. These measurements were made continuously and values taken every 5 seconds were used to average VO_2 over the 10 minute time period.

Arterial hemoglobin oxygen saturation: Arterial hemoglobin

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oxygen saturation (SpO_2) was determined with the use of a pulse oximeter (General Electric Procare Auscultatory 400). SpO_2 was used to substitute for true arterial hemoglobin oxygen saturation. SpO_2 was measured every 5 seconds and averaged over the 10 minute monitoring period.

Oxygen delivery: Oxygen delivery was calculated using the formula $\{DO2=(1.34\times Hgb\times SO_2)+(PO_2\times 0.0031)\}$. Hemoglobin was measured as part of the routine clinic visits or from Emergency Department visits. Control subjects did not have hemoglobin levels drawn. A standard hemoglobin value of 12 mg/dL was used for the control subjects. A Hemoglobin value of 12 mg/dL was chosen for calculating oxygen delivery because this number represents the lower range of normal hemoglobin levels and would therefore underestimate the oxygen extraction ratios when compared to sickle cell patients.

Oxygen extraction ratio (OER): OER can be determined by a number of means. Regional OER was determined by using the $CtSO_2$ and SpO_2 values $(SpO_2-CtSO_2)/SpO_2$.[14]

Vital signs: Standard vital signs, Heart Rate, Blood Pressure, Temperature and Respiratory Rate, were measured by clinically accepted standards.

Statistical Analysis

Data entry and data analysis was performed using JMP 4.0 (SAS Institute, Cary, NC, USA). A non-parametric median Kruskal-Wallis test was performed to determine any significant differences between the study groups. Comparisons of hemodynamic and oxygen transport measures were made utilizing a non-parametric analysis and group medians. Inter-quartile ratios (IQR) ratios were substituted for Standard Deviations (SD) and Confidence Intervals (CI). The level of significance was set at an alpha of 0.05.

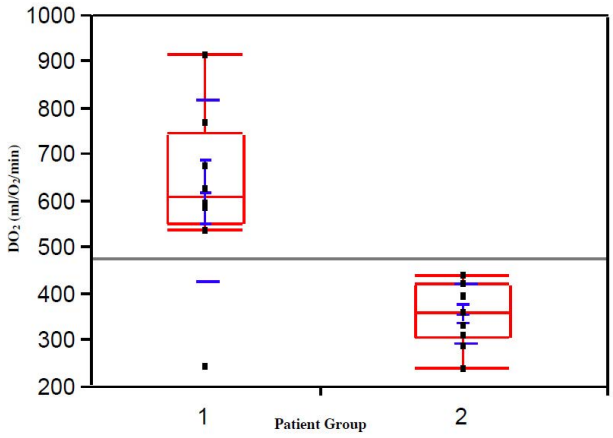
RESULTS

There were 9 self-reported, healthy African-American control subjects, and 21 SCD patients. The median age for the healthy controls was 29±6 years and the median age for the SCD patients was 34±11 years (Table 1). The majority of SCD patients were Hgb SS followed by Hgb SC (Table 1). The majority of the control subjects were male and there was a nearly even gender distribution in the SCD patients (Table 1). DO_2 and VO_2 measurements were measured for healthy control subjects and SCD patients at baseline. The DO_2 for the control subjects was 525.5 ml/O_2/min and 326.8 ml/O_2/min for the SCD group at baseline (Table 2). There were significant differences of DO_2 between the healthy control subjects *vs*. SCD patients at baseline (Figure 1 and Table 2). The VO_2 for the control group was 214.5 ml/min and 202.5 ml/min for the SCD group at baseline which showed no statistically significant differences in VO_2 (Table 2). Superficial and Deep $CtSO_2$ differences between the groups are shown in Figure 2 and Table 2. The median superficial $CtSO_2$ for the Control group and the SCD group was 72% (IQR=10.94) and 56% (IQR=26.86) respectively (p=0.0011). The median deep $CtSO_2$ (control *vs.* SCD baseline) was 73% (IQR=3.74) and 63% (IQR=12.1) respectively and was also significantly different (p=0.0033). Global measures of oxygen delivery (CO, CI, SV, SI and Hgb) were similar with no statistical differences existing between the groups except cardiac output (Table 3). Cardiac index and other global measures of cardiac function were not statistically significant therefore cardiac output was not interpreted to be clinically significant. We found no statistical difference in standard vital sign parameters (Blood Pressure, Heart Rate, Temperature, Respiratory Rate, and SpO_2) between healthy controls and sickle cell patients at baseline. There were significant differences in the OER between the Control group and the SCD group at baseline. The results of Regional Superficial OER were 26% and 42% respectively, with a p-value of 0.0013. The results of the Regional Deep OER were 25% and 34% respectively with a p-value of 0.0037 (Table 2).

Variable	Control Group	SCD Group
Age (years)	29±6	34±11
Hgb SS	Normal Hgb.	16
Hgb SC		4
Hgb Sβ-Thal		2
Gender (M/F)	7/2	11/11

SCD: Sickle Cell Disease; Hgb: Hemoglobin; Thal: Thalassemia.

Table 1: Demographics of control group *vs.* SCD group.



SCD: Sickle Cell Disease; DO_2: Delivery of Oxygen; PT Group: Patient Group.
*Significant at p-value<0.05; DO_2 p=<0.0001.

Figure 1: Oxygen Delivery of control group(1) (n=9) *vs.* SCD(2) (n=12) individuals.

DISCUSSION

The current study demonstrates that non-invasive oxygen transport monitoring is possible in SCD patients. Based on both $CtSO_2$ and VO_2 measurements in the SCD baseline state, it does not appear that SCD patients, despite the chronic nature of the disease, have down regulated their metabolism to compensate for this chronic decrease in DO_2. Due to the anemia that is commonly seen in SCD patients, despite full hemoglobin satura-

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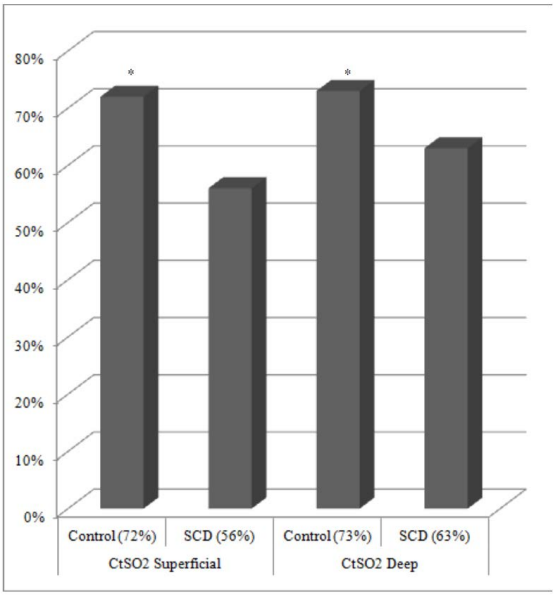
Variable	Control Group-Median (IQR)	SCD Group-Median (IQR)	P-Values
$CtSO_2$ Superficial (%)*	72%(10.94)	56%(26.86)	0.0011
$CtSO_2$ Deep (%)*	73%(3.74)	63%(12.1)	0.0033
VO_2 (ml/min)	214.5(143.3)	202.5(88.75)	0.6742
DO_2 (ml/O2/min)*	525.5(166.6)	326.8(239.3)	<0.0001
Regional Superficial OER (%)*	26%	42%	0.0013
Regional Deep OER (%)*	25%	34%	0.0037

*Significant at p-value<0.05.
SCD: Sickle Cell Disease; $CtSO_2$: Cutaneous Saturation of Oxygen; VO_2: Oxygen Consumption; DO_2: Delivery of Oxygen

Table 2: Comparison of Oxygen Delivery, Oxygen Consumption, Oxygen Extraction Ratio and Cutaneous Saturation of Oxygen.



*Significant at p-value<0.05; Superficial $CtSO_2$ p=0.0011; Deep $CtSO_2$ p=0.0033.
$CtSO_2$: Cutaneous Saturation of Oxygen; SCD: Sickle Cell Disease.

Figure 2: Superficial and deep $CtSO_2$: Control group (n=9) *vs.* SCD group (n=12).

Variable	Control Group-Median (IQR)	SCD Group-Median (IQR)	P-Values
CO (L/min)	7.20(3.21)	5.39(2.22)	0.0430
CI (L/min/mm)	3.34(1.06)	2.96(0.97)	0.0611
SV (ml/min)	97.49(28.23)	77.32(30.45)	0.7250
SI (ml/min/mm)	49.62(17.03)	41.87(19.30)	0.6560
Hgb	12(N/A)	9.4(2.8)	-

SCD: Sickle Cell Disease; CO: Cardiac Output; CI: Cardiac Index, SV: Stroke Volume; SI: Stroke Index; Hgb: Hemoglobin

Table 3: Comparison of global measures of oxygen delivery between control group and SCD group. *Significant at p-value<0.05. CI, SV and SI were not statistically significant, therefore CO was not interpreted to be clinically significant.

tion with oxygen, it is not surprising that their DO_2 is significantly lower than patients without SCD. What may not be as obvious is that there does not appear to be any significant increase in cardiac output to compensate for this reduction in hemoglobin content.

As discussed in the *Methodology* section of this paper, the values of $CtSO_2$ by differential absorption spectroscopy are representative of the venous hemoglobin oxygen saturation values, since venous blood dominates the majority of blood volume of the analyzed tissue. Thus, a measure of tissue hemoglobin oxygen saturation reflects the post-extraction compartment of tissue in terms of oxygen delivery and utilization. In our study, SCD patients compared to non-SCD controls exhibit evidence of increased regional oxygen extraction, even when not reporting a VOC. Patients in this cohort revealed that they have high extrac-

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tion ratios at baseline. This decrease in microvascular delivery may in turn be caused by a combination of further rheologic and/or microvascular problems. Whether or not this can be termed "dysfunction" at the microvascular level is unclear, as this may represent appropriate compensation at this level. Given our data, sickle cell disease might be viewed as a sub-clinical compensated state of shock as defined by decreases in tissue oxygen delivery on a microcirculatory level.[15-18] Similar to other states of shock, regional oxygen transport changes are possible without changes in global oxygen transport or vital signs.

Although it is unlikely that the subcutaneous tissues were dysoxic or ischemic, changes in $CtSO_2$ measured at this level are consistent with homeostatic changes seen in organ systems that are at risk of damage by states of shock, such as the splanchnic bed.[19,20] Previous studies by Cheung, et al.[21,22] have demonstrated the ability to use surrogate sites, such as conjunctival vessels, as a marker of active VOC. The study however, did not look at global measurements of oxygen transport and compare them to regional measurements of oxygenation. The study instead focused on the use of intravital microscopy to objectively quantify conjunctival vessels in SCD patients at baseline, during crisis, and post crisis.

Diverting blood flow from cutaneous tissue beds to more essential organ systems, to maintain oxygen delivery, is a known event in hemorrhagic, cardiogenic and at several stages of septic shock.[23-25] With further investigative studies, the paradigm of SCD physiology may be shown to more closely resemble shock syndromes. The introduction of regional measurement techniques has highlighted the inadequacy of the information being garnered by global measurements of hemodynamic oxygenation such as DO_2, VO_2, and arterial hemoglobin oxygen saturation as well as traditional physical examination findings such as blood pressure and heart rate. Therefore, consideration should be given to emphasizing the underlying microcirculation,[26,27] as reflected in tissue oxygenation as both a diagnostic and therapeutic endpoint.

The pathophysiology of sickle cell is complex and involves many organ systems as a result of episodic microcirculatory insults which are believed to result in end-organ ischemic damage and pain.[28-30] Currently approved clinical tools are limited in their ability to detect localized changes in oxygen transport. The use of non-invasive tools will allow for increased understanding of microcirculatory oxygen delivery and utilization of SCD along with the many factors that are likely to impact it at this level in a clinical environment.[31,32] For example, one could envision using this type of monitoring to explore the impact of such interventions as vasodilators or blood substitutes on their ability to improve regional oxygen delivery and to correlate this with the outward manifestation of pain. The effects of treatment on these parameters were not measured; however, future studies should incorporate these in a temporal fashion.

CONCLUSION

SCD patients have decreased levels of $CtSO_2$ at baseline when compared to healthy controls suggesting an increased rate of oxygen extraction, which may be secondary to decreases in tissue oxygen delivery, as represented by the DO_2 values of both study populations. SCD may share microvasular similarities to compensated shock and can be measured. Novel non invasive techniques should be evaluated and may allow for further understanding of SCD microvasculature.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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AUTHOR'S CONTRIBUTIONS

Dr. Imoigele P. Aisiku had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Study Concept and Design: Imoigele P. Aisiku, Wally R. Smith, Lynn T. Penberthy and Kevin R. Ward.

Acquisition of Data: Imoigele P. Aisiku, Wally R. Smith and Kevin R. Ward.

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Study Supervision: Imoigele P. Aisiku, Wally R. Smith and Kevin R. Ward.

CONSENT

No consent for publication is required as all patients signed a consent form to be part of the study and no identifying data is presented in the manuscript.

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Research

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Remembering the Health Outcomes of Hurricane Katrina A Decade Later: A Report on Katrina Evacuees Discharged Post 'Emergent' Care in a Houston-based Emergency Department

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ABSTRACT

Introduction: Existing literature is missing a description of a displaced population in the aftermath of Hurricane Katrina, who were seen and discharged from emergency departments of a Houston hospital system 10 years ago.
Hypothesis/Problem: Health effects of Hurricane Katrina are an important public health topic that is not sufficiently discussed in the existing literature. Failure to provide this information is largely due to the lack of appropriate, representative data and absence of a systematic data capture process.
Methods: A retrospective Electronic Health Record review of 'Katrina evacuees', obtained from Houston Fire Department run call data, was used to identify: visit type, top three ICD-9-coded diagnoses, medical insurance, number of visits and emergency medical service utilization.
Results: The majority of patient visits were by Black, female gender and adults between 19 and 44 years. The leading diagnosis was hypertension. Circulatory system related diagnoses were nearly three times higher among Katrina evacuees than national data from 2005 and 2007. Most patients used emergency medical service services [815(60%)], had one emergency department visit [570(70%)], and reported Medicaid [577(40%)] or self-pay [425(30%)] as the insurance source.
Conclusion: Disaster planning for the aftermath of natural disasters would benefit from knowledge pertaining to known chronic and non-chronic care needs of populations in pre-specified areas. Variance in primary diagnoses suggests the need for published data reporting annual primary diagnoses in local EDs by region. Access to this information *via* the internet contributes to estimating the likelihood of ED volume of chronic and non-chronic visit demand,[1] providing foundational information for disaster preparedness plans nationwide.

KEYWORDS: Emergency medicine; Hurricane; Disaster preparedness; Natural disasters.

ABBREVIATIONS: HFD: Houston Fire Department; ED: Emergency Department; EMS: Emergency Medical Services; KE: Katrina evacuees; HER: electronic health record; FEMA: Federal Emergency Management Agency; MHH: Memorial Hermann Health System; TMC: Texas Medical Center; MRN: Medical Record Number.

INTRODUCTION

A decade ago, US history was made in the aftermath of Hurricane Katrina to the Gulf Coast region. Hurricane related disasters occurred over the previous decade.[2,3] However, none resulted in a forced, long-term evacuation of over one million Gulf Coast residents, with ap-

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proximately 200,000 New Orleans residents arriving to a neighbouring metropolitan city (Houston, Texas, USA) by planes and busloads.[4-7] Published data on Emergency Department (ED) visits in Houston described the increase in visits by Katrina Evacuees (KE).[6] Houston, TX is the fourth largest city in the US and local EDs are considered the public health safety net system that meets the need of merely one-third of service demands among a largely, uninsured population.[8] Overcrowded EDs do not have the capacity to adequately provide care to a surge of thousands of patients.[9] The forced, long-term evacuation immobilized the entire metropolitan health care system.[10] Limited data substantiating the impact of Hurricane Katrina on the health care system has been published.[6,11]

A quantified analysis detailing the increased demands on EDs due to the translocation of a population post Hurricane Katrina has not been published. Statistics of the patient population injured or whose chronic medical conditions worsened after being displaced remains unknown to the medical and public health community.[11] Trauma patients presenting to Mississippi hospitals were triaged and provided medical care in a relatively short time frame immediately after the storm.[11] Interestingly, operations were at normal levels directly before landfall of the storm as well. Following Hurricane Katrina, two waves of patients presented to the ED. The initial wave of patients were local trauma patients. The second were patients with chronic medical conditions who ran out of medication and/or access to specialty services such as dialysis, methadone, or oxygen supply.[11] Mobile field hospitals treated approximately 8,000 patients following the storm.[11,12] In Houston, Texas, more than 11,000 patients were treated at Katrina Clinic, a temporary clinical establishment designed to meet the medical needs of the dislocated population,[13] and over 10,000 received medical care at the convention center.[6,14] Dissimilar to the Mississippi study,[11] this Houston based study described Katrina evacuees (KE) with a system initiated by the local fire department, and refined by the study team.

Several publications discuss mass evacuations post Hurricane Katrina, however, the focus of the discussion or study varied widely. An assessment of Chicago's public health response evaluated key systemic changes created to deliver healthcare to the displaced population.[15] Surveillance done in Arkansas, Louisiana, Mississippi, Texas, and Indiana over a three-week period after Hurricane Katrina discovered primary health care services and medication refills were the top reported needs of disaster survivors.[16,17] A needs assessment verified that most non-injury-related health care visits were for medication refills, oral health problems, or chronic conditions.[18,19] Additionally, a survey of KE reported that 41% had a history of one chronic disease.[20]

New Orleans residents reported significant health declines after Hurricane Katrina,[21-24] substantiating evidence of health declines after natural disasters.[24] Published findings confirm that a substantial number of people with preexisting health conditions will need medical care after a disaster.[25] A comparative analysis, pre and post Hurricane Katrina, revealed a significant decrease in health among the adult population in New Orleans, LA a year post the storm, measured by a rising disability rate from 20.6% to 24.6%.[24] Demographic disparities after the storm were assessed based on age, race, and gender.[26-28] Published findings support the notion that Hurricane Katrina evacuees experienced adverse health outcomes, poorer access to health care, and had disproportionately more disability after the storm.[24] Data captured confirm health disparities among this disaster's survivors, as chronic illness are commonly worsened by disaster conditions.[19] As a result, the influx of KE patients will likely result in increased visits to the ED for chronic conditions and other health declines related to the storm.

The study described here was an in-depth analysis of a passive data collection method by a community based health care service provider's attempt to systematically describe a population displaced after a natural disaster. This is the first study to provide a description of a displaced population after Hurricane Katrina, who were evaluated and discharged from the EDs of a large health system.

MATERIAL AND METHODS

Study design and Selection of participants

The cohort of patients for this retrospective chart review was obtained from the Houston Fire Department's (HFD) KErun calls to a Memorial Hermann Hospital (MHH) System ED. HFD, the third largest fire department in the United States, is responsible for providing Emergency Medical Services (EMS) to a population of more than 2 million in an area totalling 654 square miles.[29] Run calls were designated as KEs by HFD if they had: (1) HFD electronic tablet records designating subject(s) as FEMA, flood evacuee, New Orleans, refugee or Katrina, (2) run calls made to temporary housing shelters housing Hurricane Katrina evacuees (i.e. Houston Reliant Center), or (3) run calls made to a zip code where FEMA maps indicated a high concentration of Hurricane Katrina evacuees. MHH is the largest not-for-profit health system in Southeast Texas and largest health system in Houston with 12 satellite hospitals, one of the nation's busiest Level 1 trauma centers and a total of 3781 beds. Thus, run calls to MHH following Hurricane Katrina serves as an indicator of resource utilization required post the translocation of a population following a natural disaster. The study was reviewed and approved by the Institutional Review Board of the University of Texas – Health Science Center at Houston and MHH (HSC-MS-07-0519).

Data Collections and Processing

The cohort utilized in this study were designated as KE if they had a: (1) Gulf coast state address, (2) Gulf coast state phone number, (3) notation on their medical record describing them as a KE or hurricane evacuee, and (4) Out-of-State insur-

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ance. Patient-visits from the cohort of HFD run calls between August 2005 and August 2006 (landfall of Hurricane Katrina to one year post -storm), were cross-referenced with the MHH Electronic Health Record (EHR). Data were collected on standardized electronic abstraction forms created in Microsoft Excel® spreadsheet Version 14.0.7116.5000 (Microsoft Corporation, 2010, Redmond, Washington, USA).

Ten data abstractors received a tutorial from the PI, which included collection a mock data abstraction session. Training was supplemented with a PowerPoint tutorial (made available for review). Routine meetings took place between abstractors and investigators to ensure productive and consistent rates of data abstraction. The PI implemented quality assurance methods and reviewed the first five patient-visit-data abstractions of each abstractor. This strategy ensured achievement of performance goals. Retraining took place when errors were identified.

Abstractors included patient visits found in the MHH EHR between August 2005 and August 2006. Additional visits absent from the HFD dataset were also included. For example, if the HFD dataset shows two visits between August 2004 and August 2006 for a patient and the MHH EHR listed even visits for that same patient during that time interval, then all seven patient-visits were recorded in the study dataset. Missing, conflicting, or ambiguous data were marked as unknown by the abstractors and later reviewed by senior members of the research team for quality control/assurance purposes.

Measures: Data was collected on the following variables: name, Medical Record Number (MRN), Date of Birth (DOB), race, arrival date, discharge date, visit type, chief complaint, and top three diagnoses, along with ICD 9 codes, medical insurance, and listed address were recorded for each patient visit. Patient visit data was collected from each patient's face sheet in the EHR. Highest hospital location and EMS usage data were obtained by a review of discharge summaries or ED physician and nurse documentation.

Primary data analysis

An inter-rater reliability assessment was done on 20 patient visits from each of the 74 datasets. Patient visits were randomly selected and abstracted again by a single abstractor. Data from the abstractors were compared and the inter-rater reliability was assessed using Cohen's Kappa co-efficient with Microsoft Excel® spreadsheet Version 14.0.7116.5000 (Microsoft Corporation, 2010, Redmond, Washington, USA) (See Table 1). Abstractor agreement for each variable (number of agreements divided by the agreements plus disagreements) was illustrated. Only patient visits that concluded in the Emergency Department were utilized for data analysis, all inpatient, observation and outpatient visits to MHH were excluded.

Variables	Observer Agreement	
	Agreement, %	(95%, CI)
Gender	100	1.00(1.00-1.00)
Race	99.8	0.99(0.99-1.00)
Medical Insurance	99.1	0.99(0.98-0.99)
Visit Type	91.9	0.87(0.85-0.89)
EMS Used	88.8	0.81(0.79-0.84)
Highest Hospital Acuity	85.4	0.78(0.75-0.81)

'CI' refers to Confidence Interval

Table 1: Summary of study statistics and inter-rater reliability agreement.

RESULTS

The abstraction process flow is mapped in Figure 1. HFD cohort data contained 11,305 entries and dates of transport ranged from August 2005 to January 2007. 'Entries' are line items by HFD personnel and confirm an ambulatory phone call was made. Missing patient identification data, such as date of birth or social security number [4(.04%)] and duplicate entries [1,023(9%)] were removed. 'Patient visits' reflect patient-encounters to the ED. In some cases, a single patient had multiple patient visits. 'Patients' are the individual person present at a patient visit. 'MHH destination' refers to MHH. Frequency data reported in Figure 1 reflect the variable described as the numerator and the preceding cell as the denominator.

Abstractor agreements in Table 1 were highest in categories with well-defined, objective criteria such as gender and race (99% to 100% agreement; 0.99-1.00). However, fair abstractor agreements were noted in subjective categories such as visit type, highest hospital acuity (85% to 91% agreement; 0.78-0.91).

Descriptive Results

The study population, 815 KE, accounted for 1354 patient visits. Most patient visits were by those of Black race, female gender, and adults 19-44 years (Table 2). Approximately, one-third of ED visits did not utilize EMS services. Fifty-one percent (N=735) of the KE had Medicare/Medicaid. Eighteen percent (N=146) had private insurance. Seventy percent (N=570) had a single ED visit. Thirteen percent (N=106) had more than two visits. Only ~7 % (N=57) had greater than three visits. Merely 0.7% (N=6) utilized the ED more than ten times.

Chronic conditions, including hypertension (ranked 1st) and diabetes mellitus (ranked 3rd), were leading diagnoses among KE visits (Table 3). Non-chronic conditions, including headaches, back pain, chest pain, and abdominal pain were in the top six individual diagnoses. The percent distribution of ICD-9-CM diagnostic code categories when compared to those found in the published National Hospital Ambulatory Medical Care Survies[30,31] (Table 4) showed an increase in 3 categories: Musculoskeletal system & connective tissue (709.3-739.9),

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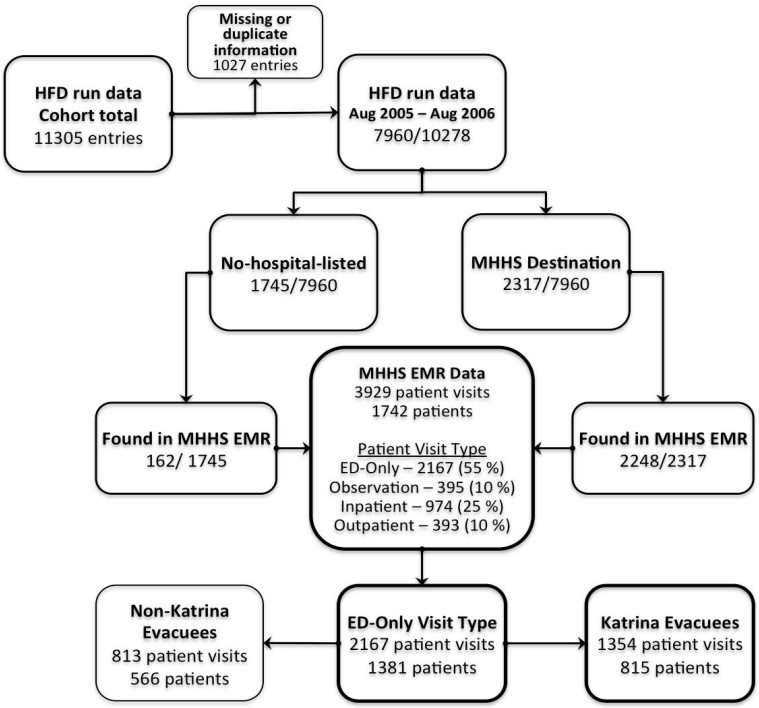

Figure 1: Data abstraction from HFD run data cohort.

Demographics	KE(N)	%
Age		
0 to 15	99	7%
15 to 24	389	29%
25 to 44	495	37%
45 to 64	268	20%
65 to 74	51	4%
75 and over	52	4%
Gender		
Male	470	35%
Female	884	65%
Ethnicity		
Black	1147	85%
White	147	11%
Asian/South Pacific	19	1%
Latino	3	0%
Other	38	3%
Healthcare Utilization	**KE**	**%**
EMS Use		
Yes	815	60%
No	519	38%
Unknown	20	1%
Insurance		
Medicare Only	69	5%
Medicaid Only	577	40%
Medicare & Medicaid	89	6%
Self-Pay	425	30%
Private	268	18%
Worker's Compensation	6	<1%

Table 2: Descriptive analysis of Katrina evacuees.

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Endocrine, nutritional & metabolic, immunity (204-279.9) and Circulatory system (388.7-459.19) with a decrease in the Injury & Poisoning category (800-999.9). Compared to the leading primary diagnosis in US Emergency department in 2005 and 2007 (Table 5), spinal disorders (720-724), arthropathies and related disorders (710-719), contusions with intact skin surface (920-924) and Headache (784) were the leading ICD-9 diagnoses.

DISCUSSION

Notable public health and medical challenges resulted from Hurricane Katrina, rendering several large hospitals immobilized and KEs with chronic and non-chronic health conditions without access to usual sources of health care.[19] This is one of few studies to 1) analyze summary data captured by community-based, emergency medical services (EMS) healthcare providers and 2) assess disaster survivors' healthcare needs in comparison to a national population. Study findings provide, for the first time, the prevalence of EMS and ED utilization of a displaced population as well as the common discharge diagnoses among a displaced population seeking emergent care in a urban large health system post landfall of one of the worst natural disasters in US history, Hurricane Katrina.[32] Though different, our findings add to the body of work noted from those that sought treatment in New Orleans.[19] Our outcomes support findings from Chicago[15] indicating health care providers need to prepare to manage chronic conditions. These conditions may worsen in the absence of healthcare access, full insurance coverage, and sufficient income.[33-35] Attention to spinal conditions/injuries is also important, as presentation would be different from the typical

	Diagnosis	ICD-9	N	%
1	Hypertension	401.9	207	6.4
2	Headache	784	88	2.7
3	Diabetes Mellitus	250	73	2.3
4	Back pain unspecified	724.5	72	2.2
5	Chest pain	786.5	66	2.0
6	Abdominal pain	789	62	1.9
7	Convulsions	780.39	59	1.8
8	Fever	780.6	53	1.6
9	Injuring passenger in MVC other than motorcycle	E812.1	52	1.6
10	Shortness of breath	786.05	51	1.6

Table 3: Top 10 diagnoses among Katrina evacuees.

System	ICD-9-Code Range		KE	%	2005 (%)	2007 (%)
Infectious & Parasitic Diseases	1	136.9	45	1.4	3.0	2.8
Neoplasms	137	239.9	3	0.1	0.2	0.2
Endocrine, Nutritional & Metabolic, Immunity	240	279.9	148	4.6	1.5	1.8
Blood & Blood-Forming disorders	280	289.9	50	1.5	--	--
Mental Disorders	290	315.9	150	4.6	3.5	3.5
Nervous System and Sense Organs	316	388.69	51	1.6	5.1	5.2
Circulatory System	388.7	459.19	296	9.2	3.5	3.6
Respiratory System	459.2	519.9	178	5.5	11.0	9.8
Digestive System	520	578.9	75	2.3	6.0	6.1
Genitourinary System	579	628.1	139	4.3	4.6	5.4
Complications of Pregnancy, Childbirth, & the Puerperium	628.2	674.8	108	3.3	--	--
Skin & Subcutaneous Tissue	674.9	709.02	52	1.6	4.0	4.2
Musculoskeletal System & Connective Tissue	709.3	739.9	346	10.7	5.5	6.3
Congenital Anomalies	740	759.9	1	0.0	--	--
Certain Conditions Originating in the Perinatal Period	760	779.3	0	0.0	--	--
Symptoms, Signs & Ill-Defined Conditions	779.4	799.9	835	25.9	19.3	21.6
Injury & Poisoning	800	999.9	356	11.0	24.9	22.5
V Codes	V01	V86.1	109	3.4	2.6	2.7
E Codes	E800	E999.1	284	8.8	--	--

-- notes that the value was not listed.

Table 4: Katrina evacuee diagnoses by system and ICD-9 code compared to national data (reference).

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	Diagnoses	ICD9-Codes	KE	%	2005 (%)	2007 (%)
1	Abdominal pain	789.0	62	1.9	4.0	4.9
2	Chest pain	786.5	66	2.0	3.8	4.1
3	Contusion with intact skin surface	920–924	93	2.9	4.2	3.7
4	Acute upper respiratory infection, excluding pharyngitis	460–461,463–466	45	1.4	3.7	3.2
5	Spinal disorders	720–724	174	5.4	2.5	3.0
6	Open wound, excluding head	874–897	42	1.3	3.5	2.7
7	Cellulitis and abscess	681–682	38	1.2	2.3	2.6
8	Fractures, excluding lower limb	800–819	22	0.7	2.0	2.1
9	Urinary tract infection, site not specified	599.0	43	1.3	1.6	1.9
10	Sprains and strains, excluding ankle and back	840–844, 845.1,848	10	0.3	2.2	1.8
11	Sprains and strains of neck and back	846,847	50	1.5	2.2	1.8
12	Otitis media and Eustachian tube disorders	381–382	13	0.4	1.9	1.8
13	Open wound of head	870–873	28	0.9	1.9	1.7
14	Rheumatism, excluding back	725–729	71	2.2	1.6	1.7
15	Diseases of the teeth and supporting structures	520-525	10	0.3	--	1.5
16	Headache	784.0	88	2.7	--	1.5
17	Arthopathies and related disorders	710-719	100	3.1	--	1.5
18	Pyrexia of unknown origin	780.6	53	1.6	--	1.4
19	Acute pharyngitis	462	16	0.5	1.4	1.4
20	Asthma	493	0	0.0	1.5	1.4
	All Other reasons		2202	68.3	--	54.2

-- notes that the value was not listed

Table 5: The 20 leading primary diagnosis in the ED: United States, 2007.

reasons patients visit the ED.

Findings suggest the majority of the displaced population had a single ED visit, half had government insurance, and two of the top three diagnoses, hypertension and diabetes, were chronic conditions left unmanaged in the wake of the storm. Comparatively, non-chronic issues, body aches/pains and headaches, were likely related to environmental and/or social stressors post disaster.

Study findings contribute to the existing body of literature by providing additional information, aiding in overall understanding of disaster-displaced populations, which is described as critical for a society to prepare and respond effectively.[8] The data is representative of a larger displaced population that utilized EMS services prior to presentation to a health system. Primary diagnoses of KE in this study (Table 3) are vastly different from the primary diagnoses reported on a national scale (Table 5).[30,31] Variance in primary diagnoses suggests the need for published data reporting annual primary diagnoses in local EDs by region. Access to this information *via* the internet contributes to estimating the likelihood of ED volume of chronic and non-chronic visit demand,[1] providing foundational information for disaster preparedness plans nationwide.

System level (i.e. region, county, or parish) diagnoses information should be made publicly available to facilitate preparation in disaster recovery efforts. The MedCon:PreEvent tool was developed and published to assist disaster response planning and estimate displaced persons requiring special medical care during a disaster.[25] This tool can assist disaster planners with preparing medical needs of disaster evacuees. It provides data needed to re-evaluate the medical approach to use and enhance healthcare servicesprovided.[25] Importance of a clear, comprehensive, and well communicated emergency response plan, with capabilities to be tailored to varied types, sizes, and proximities of disaster is supported.[15] By having access to local primary ED diagnoses, disaster preparedness planners can prepare to provide survivors with access to preventive care needs for chronic conditions such as hypertension and diabetes. This information is pertinent to cost effective strategies because a population with preventable illness largely addressed by preventive care measures will likely avert use of the ED for non-emergent conditions. It is imperative that provisions for creation and dissemination of services and resources for survivors be prioritized by disaster preparedness groups.

LIMITATIONS

Although, this study offers insight on healthcare utilization of KE, the authors hesitate to make generalizations to healthcare use of KE overall. Study findings were subject to selection bias due to the use of HFD run call data. Study team members hypothesize that HFD run data contained some non-

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translocated patients; thus, more stringent guidelines were implemented when determining study inclusion criteria. It is possible that the data may include non-translocated patients, as patients may have had out-of-state insurance or gulf coast telephone numbers and present to a MHH only after Hurricane Katrina. Data on what states the participants were from was not available. Sensitivity analysis on the inclusion criteria was not possible as the necessary criteria were not collected during the data abstraction. Study data was obtained by retrospective chart review; thus, the possibility of selection and/or transcription bias is inherent. MHH provided inpatient level care to critically ill and other vulnerable patients who were evacuated directly from hospitals in Louisiana and were not included in this study; thus, the study sample is not truly representative of KE who received care from this hospital. Information about KE that did not utilize HFD services or present to the MHH system are not included in this study. Study data was limited to patients discharged from the ED. Thus, patients that were hospitalized, likely to have higher illness burden and resource utilization were excluded from this analysis. Publicly available, comparative information is limited. Access to nationally available data precluded the option of individual level data; thus, only a frequency analysis was feasible for comparative purpose.

CONCLUSIONS

Events associated with Hurricane Katrina revealed major gaps in available disaster preparedness for at-risk medical institutions, especially tertiary and/or quaternary care academic centers.[2,15,36-41] This study's findings contribute to future preparedness plans by defining pertinent characteristics of a translocated population post landfall of Hurricane Katrina. By eluding to the generalizability of these characteristics, at-risk metropolitan areas at large in this vulnerable region should include this information in their disaster preparedness plans, as lessons learned and suggestions for improvement are currently reported in the existing body of literature.[2,11,15,36,42] Published reports indicate lessons have not been learned, as many recommendations have been repeated or modified;[15] thus, issues thwarting recovery efforts must be confronted before the next disaster arises.[43] Lessons learned from Hurricane Katrina for medical providers challenge hospitals and health systems to develop a disaster based contingency plan and to become more involved in a state and local response plan.[11]

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONSENT

The 'Developing Effective Methods for Addressing Needs of Disaster Survivors (DEMANDS)' study, HSC-MS-07-0519, was approved by the UT Health IRB as a retrospective chart review; thus, participant consent was not required.

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