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Yellow may: an active campaign to prevent road traffic injury

Maio amarelo: um movimento ativo para prevenir lesões no trânsito

Gustavo Pereira Fraga, TCBC-SP[1]; Paulo Roberto Carreiro, TCBC-MG[2]; Hamilton Petry de Souza, TCBC-RS[3]; Sandro Scarpelini, TCBC-SP[4]

In 2015 the Journal of the Brazilian College of Surgeons brings, for the fourth consecutive year, edition 4, dedicated to themes of trauma and emergency surgery. With the support of the Brazilian Society of Integrated Assistance to the Traumatized (SBAIT) it is widely disseminated and invites the surgeons and their departments to submit articles, to be evaluated by guest editors in an agile and competent way[1]. The number of submitted articles is increasing annually; in 2012 and 2013 18 articles were received, in 2014 19 (with 11 being published) and this year 35 original articles and three review articles have been received, with a total of 15 (39.5%) being approved for publication. Within this number, readers can read interesting studies about pedestrian accidents, neck, chest, abdomen and extremity trauma, non-operative treatment of penetrating liver trauma, trauma registries, the risks of nocturnal admission of trauma patients and brief interventions for alcoholic trauma victims. In other words, research articles ranging from prevention to specialized treatments.

While we celebrate the increase in the production of trauma surgery articles in Brazil, a subject that brings great concern to all of society is the alarming number of traffic fatalities, as well as the thousands of patients admitted to emergency units every year. In 2010 the United Nations (UN) General Assembly proclaimed the period 2011-2020 as the "Decade of Action for Road Safety"[2]. Studies by the World Health Organization (WHO) showed that around 1.3 million deaths were caused by traffic events in 178 countries in the year 2009. Brazil appeared in 5th place among those countries with most traffic accidents, surpassed only by India, China, the United States of America (USA) and Russia[2]. In 2011 the federal government launched the "National Pact for the Reduction of Traffic Accidents - A Pact for Life", aiming to seek the participation of the executive, legislative and judicial powers, the three levels of government, and civil society in reducing traffic accidents and violence. Between 2001 and 2012, the number of deaths due to traffic accidents in Brazil increased almost 50%. In 2013 there were 42,266 traffic fatalities in Brazil[3], which is failing to achieve traffic fatality reduction, as proposed by the UN. In November of 2015, Brasilia will host the UN Road Safety Organization's Second Global Ministerial Conference in order to take stock of the achievements of the "Decade of Action for Road Safety". All health professionals who care for trauma patients need to spread the prevention efforts.

In the area of oncology, prevention campaigns are widespread and have provoked effective participation by the population. One example is "Pink October", which started in the USA in the 1990s, spreading the awareness and importance of the prevention of breast cancer by encouraging the population to participate in various initiatives. This campaign began in Brazil in 2008 with the support of several medical organizations.

In 2014 the "Yellow May" movement was launched in Brazil, in an effort to draw society's attention to the high rate of deaths and injuries which occur in traffic throughout the world[4]. The goal is to put road safety on the agenda and to mobilize society into participating in various education and prevention programs. The movement was launched by the "National Observatory for Road Safety" (ONSV)[5] and from the beginning, SBAIT has been committed to this cause, so much so that the national launch of Yellow May was held on April 24, 2015, in Campinas, during the election of the new SBAIT board, along with the opening of the two high-profile events "II Ibero-Afro-American Meeting on Trauma and Emergency Surgery (RIAATCE)" and "Intergastro & Trauma". The Brazilian Committee of Trauma Leagues (CoBraLT)[6] is also actively participating along with their students, participating in various prevention programs.

The participation of various organizations is boosting the effect of the "Yellow May" movement, which is an ongoing effort, with monthly thematic events, and which needs the involvement of surgeons and other health professionals. In 2015, the movement has been promoted in 21 countries on five continents, with the support of 600 organizations and companies, achieving over 30,000 'likes' on Facebook and over 200,000 views of the "Yellow May" videos.

SBAIT and The Brazilian College of Surgeons invite you to be part of this movement. Our goal is to enhance the research and teaching within the trauma and emergency

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ENSINO

REVISÃO

Yellow may: an active campaign to prevent road traffic injury

Maio amarelo: um movimento ativo para prevenir lesões no trânsito

Gustavo Pereira Fraga, TCBC-SP[1]; Paulo Roberto Carreiro, TCBC-MG[2]; Hamilton Petry de Souza, TCBC-RS[3]; Sandro Scarpelini, TCBC-SP[4]

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Original Article

Alcohol and brief intervention for trauma victims

Consumo de álcool e intervenção breve em vítimas de trauma

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A B S T R A C T

Objective: to describe the causes and severities of trauma in patients who met the criteria for alcohol abuse or dependence according to Mini International Neuropsychiatric Interview, and to display the pattern of alcohol consumption and subsequent changes one year after trauma. **Methods**: a transversal and longitudinal quantitative study carried out between November 2012 and September 2013 in the ED. Medical and nursing students collected blood samples, applied the J section of the Mini International Neuropsychiatric Interview (MINI) and submitted alcohol abusers and dependents to BI. One year after admission, patients were contacted and asked about their patterns of alcohol use and their reasons for any changes. **Results**: from a sample of 507 patients admitted to the ED for trauma, 348 responded to MINI, 90 (25.9%) being abusers and 36 (10.3%) dependent on alcohol. Among the abusers, the most frequent cause of injury was motorcycle accident (35.6%) and among the dependents it was predominantly interpersonal violence (22.2%). Positive blood samples for alcohol were identified in 31.7% of the abusers and 53.1% of the dependents. One year after trauma, 66 abusers and 31 dependents were contacted, and it was ascertained that 36.4% of the abusers and 19.4% of the dependents had decreased alcohol consumption. The main reported reason for the reduction was the experienced trauma. **Conclusion**: the motorcycle accident was the most common cause of injury. The detection of problematic alcohol use and implementation of BI are important strategies in the ED, however for alcohol abusers and dependents, BI was not the most reported reason for any changes in patterns of alcohol use.

Key words: Alcoholism, Wounds and Injuries. Emergencies. Alcohol-Related Disorders.

INTRODUCTION

Among the central nervous system depressants, alcohol is the psychoactive substance (PAS) most consumed around the world. There are around two billion people worldwide who consume alcohol regularly[1]. According to data from the World Health Organization (WHO), 3.2% of deaths worldwide are related to alcohol[2]. Nevertheless, the extent and magnitude of the role of alcohol in fatal and non-fatal injuries around the world is still not fully understood[2].

The early effects of alcohol are attention impairment, poor perception and poor critical judgment of reality, which can all increase the risk of traffic accidents[3]. Moreover, alcohol can be a catalyst in developing aggressive behavior[4].

In Brazil, trauma is a public health problem. It is the leading cause of death in the age group 1-39 years[5]. Currently, the most common causes of trauma in Brazil, and in the world, are acts of violence (homicides) and traffic accidents[5,6].

A review found that 10-18% of cases in the Emergency Department (ED) have some relation to alcohol[7]. Nevertheless, the use of PAS is still little detected, which limits the development of prevention strategies and appropriate approaches to problematic alcohol users[8].

The ED is often the first health service sought by alcohol abusers or alcoholics, and it should be seen as a strategic location for patient awareness regarding the harm caused by alcohol abuse, since the relationship between the use of PAS and the damage it causes is close, in terms of time[9-11]. A brief intervention (BI) is a form of assistance by way of a short interview, aiming to motivate a behavior change, alleviate any problems related to alcohol use, and to help the patient take decisions, such as looking for treatment or reducing use[8,10]. The advantages of a BI include low cost and ease of application since it is rapid (lasting from 10 to 45 minutes) and can be included in usual consulting appointments. Moreover, it can be performed by any trained health professional. Surveys have shown its effectiveness in the treatment of alcohol abusers, however there are limitations in its effectiveness for people with alcohol dependence[8-11].

The "Mini International Neuropsychiatric Interview" (M.I.N.I.)[12] is an elaborated standardized interview based on diagnostic criteria from the fourth edition

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of the "Diagnostic and Statistical Manual of Mental Disorders" (DSM)[13] and the "International Classification of Diseases" (ICD)[14]. Section J identifies criteria for alcohol abuse e dependency.

The objectives of the study were to describe the causes and severities of trauma in patients who met the criteria for alcohol abuse or dependence according to Mini International Neuropsychiatric Interview, and to display the pattern of alcohol consumption and subsequent changes one year after trauma.

METHODS

This is a quantitative, longitudinal, cross-sectional study, carried out in the ED of "*Hospital de Clínicas*" at the Universidade Estadual de Campinas (Unicamp), in the city of Campinas, Brazil. Data were collected between November 2012 and September 2013. Patients who arrived at the ED as a result of trauma were invited to participate in the study, signing an informed consent form. This study was approved by the Comitê de Ética em Pesquisa of Unicamp, with document number 185.108.

The inclusion criteria were: patients older than 18 years, admitted to the ED as a result of trauma, with primary care conducted by the Trauma Surgery Faculty of Unicamp, and length of stay in the ED or in the hospital for more than six hours. For the purposes of this study, trauma was defined as: "any damage to the human body which is caused by sudden exposure to physical agents such as mechanical energy, heat, electricity, chemicals or radiation that interact with the body to a degree that exceeds the limits of human tolerance"[15,16]. Alcohol abuse and dependence were diagnosed according to the M.I.N.I. criteria[12]. Alcohol abuse was diagnosed when an individual responded positively to three of the questions from the relevant M.I.N.I. section. Data collection was carried out at three times: early in the morning to collect the data of patients admitted during the night, at lunchtime for those admitted during the morning, and in the early evening for those admitted during the afternoon.

The importance of the brevity of care arose from the need for blood to be taken immediately after the trauma event. Blood alcohol levels decrease with time and become undetectable within six hours, by the methods available in this study. The inclusion of patients referred from other hospitals, who had already received first aid, would result in an increased number of negative samples, due to the metabolization of alcohol by the body, causing a high rate of false negatives.

After acceptance and signature, the patient was subjected to a semi-structured interview and section J of M.I.N.I., which evaluates alcohol abuse and dependence (Table 1)[12]. The subjects who met the criteria for PAS abuse (three or more positive responses to the questions listed in Table 1) or PAS dependence (three or more positive responses to the questions listed in Table 2), according to M.I.N.I., underwent BI.

The severity of the trauma was determined using the "Injury Severity Score" index (ISS)[17,18]. The subjects whose ISS values were higher than 16 suffered traumas considered more severe.

A blood sample was taken in a dry tube. The technique of choice for treatment of the samples was a "headspace" technique, which consists of heating and evaporating a sample (in an oven at 70°C for 30 minutes) within a glass vial. The conditioned sample is later injected into a gas chromatography system with flame ionization detection.

Patients who presented diagnostic criteria for alcohol abuse or dependence were submitted to BI at the hospital shortly after the interview and questionnaire. Follow-up was conducted one year after the trauma, by three professionals specialized in Mental Health, who asked, via telephone, about the patterns of alcohol use as well as the reasons for any changes in them.

Association between categorical variables was based on the chi-square test. The significance level adopted for the statistical tests was 5% and the confidence interval for "Relative Risk", 95%.

Table 1 - Criteria for alcohol abuse according to M.I.N.I.

During the last 12 months:
1. Have you become drunk or have a hangover several times, when you had things to do at work/school or at home? Has this caused you problems?
2. Have you ever been under the influence of alcohol in situations where it was physically risky, such as driving, using a machine or a dangerous instrument?
3. Have you had legal problems such as a summons, conviction or arrest because you had been drinking?
4. Have you continued to drink even though you knew that drinking caused problems with your family or others?

Source: Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, et al. The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. J Clin Psychiatry. 1998;59 Suppl 20:22-33.

Table 2 - Criteria for alcohol dependency according to M.I.N.I.

1. Have you drunk, in less than three hours, more than five bottles of beer, or a bottle of wine, or three of a strong alcoholic beverage (*pinga*, *caipirinha*, brandy, vodka, whiskey, etc.)?
During the last 12 months:
2. Have you found that you have needed increasing amounts of alcohol to achieve the same effect?
3. When you drank less, did your hands shake, did you sweat or feel agitated?
4. Have you ever drunk a dose to avoid these problems or to prevent a hangover?
5. When starting to drink, did you often drink more than intended?
6. Have you tried but failed to reduce your alcohol consumption or to stop drinking?
7. During the days that you drank, did you spend much time looking for drink, drinking or recovering from the effects of alcohol?
8. Have you reduced your activities (leisure, work, daily tasks) or spent less time with others because of drink?
9. Have you continued to drink even though it caused you health problems or psychological problems?

Source: Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, et al. The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. J Clin Psychiatry. 1998;59 Suppl 20:22-33.

RESULTS

All subjects, those excluded and those who answered the questionnaire are shown in figure 1.

Of the 453 subjects included in the study, 42 died and 63 remained unconscious or suffered injuries as a result of the trauma which prevented them from answering the questionnaire. The variables "gender", "education", "occupation" and "marital status" of alcohol abusers and dependents are shown in table 3. Considering the history of alcohol use, 65.6% of the dependents and 63.7% of the abusers reported initial alcohol use before the age of 18. Causes of trauma in subjects with alcohol abuse or dependence are described in Table 4. The values of ISS were higher than 16 in 16.9% of the abusers and 36.1% of the dependents. The samples were positive for alcohol in 31.7% of the abusers and 53.1% of the dependents.

During the follow-up, one year after admission, 66 alcohol abusers and 31 dependents were contacted.

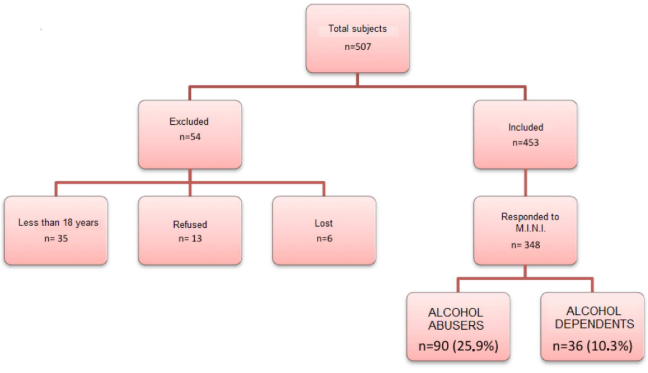

Figure 1 - *Included subjects and problematic users of alcohol admitted for trauma.*

Source: Unidade de Emergência Referenciada do Hospital de Clínicas da Unicamp.

Among the abusers, 40 (60.6%) had maintained their patterns of alcohol use, 20 (30.3%) had reduced them and six (9.1%) had discontinued alcohol use. Among the dependents, 25 (80.6%) had maintained their patterns of use, two (6.5%) had reduced them and four (12.9%) had discontinued alcohol use. The reasons reported for the discontinuations or reductions were: trauma sequelae (8 abusers and 2 dependents), the trauma event (three abusers and two dependents), the brief intervention (four abusers and one dependent). Eleven other patients (then abusers and one dependent) reported other reasons for discontinuation/reduction. None of the abusers or dependents, who responded to the BI, died.

DISCUSSION

The study focused on a sample of patients who were alcohol abusers and dependents (alcoholics) admitted to the emergency department due to trauma. The sociodemographic data indicated that most were young men with reasonable schooling, compared with the national average, and in active employment. It is important to note that the characteristics of those who seek emergency assistance are different from those of the general population, due to peculiarities such as morbidity, social status and the use of PAS which are specific to ED patients and therefore should not be generalized[19].

The sociodemographic characteristics of the sample are similar to those found in other studies which address trauma victims: men, young, actively employed[19-21]. If we consider the pattern of PAS use however, the employment situation differs from data within the general population, since alcohol abusers and dependents are mostly not in active employment. Compared to other health problems in Brazil, alcoholism is responsible for generating three times more sick leave, increasing the chances of work accidents fivefold,

Table 3 - Correlation of sociodemographic variables in patients who met criteria for alcohol abuse or dependence.

Variable	Abusers N (%)	*p-value**	Dependents N (%)	*p-value**
Gender				
Masculine	80 (88.9)	0.283	35 (97.2)	0.035
Feminine	10 (11.1)		1 (2.8)	
Education				
< 8 years	46 (47.7)	0.203	21 (60.1)	0.203
> 8 years	44 (52.3)		15 (39.9)	
Occupational Status				
Unemployed	9 (10.2)	0.092	4 (11.1)	<0.001
Employed	78 (86.7)		30 (83.4)	
Not applicable	3 (3.1)		2 (5.5)	
Marital Status				
Steady partner	28 (31.4)	0.038	15 (41.6)	0.007
No steady partner	62 (68.6)		21 (58.4)	

Source: Unidade de Emergência Referenciada do Hospital de Clínicas da Unicamp.
** Chi-square test*

Table 4 - Causes of trauma in subjects with alcohol abuse or dependence.

Cause of trauma	Abusers N (%)	Dependents N (%)
Motorcycle accident	32 (35.6)	5 (13.9)
Car accident	13 (14.4)	5 (13.9)
Running over	5 (5.6)	3 (8.3)
Fall from a height	7 (7.8)	3 (8.3)
Beating	6 (6.7)	8 (22.2)
Fall	3 (3.3)	2 (5.6)
Wound from firearm projectile	8 (8.9)	3 (8.3)
Knife wound	9 (10.0)	3 (8.3)
Others	6 (6.7)	4 (11.1)
Losses	1 (1.1)	-
TOTAL	90 (100)	36 (100)

Source: Unidade de Emergência Referenciada do Hospital de Clínicas da Unicamp.

increasing hospital visits eightfold and causing families to use medical and social assistance three times as much[22].

A positive blood alcohol level is indicative of recent alcohol use. In this study, approximately 30% of those who reported abuse, and 53% of those who met the criteria for addiction, gave positive samples, indicating alcohol use within six hours prior to admission. Several international studies show that alcohol intoxication is associated with admission to the ED for trauma, and they describe proportions of up to 50% of patients who are intoxicated at the time of trauma[23,24].

A study published by WHO showed that approximately 47% of trauma victims had positive blood alcohol levels, and that 40% of trauma patients with negative levels presented criteria for problematic use of PAS[2]. Thus, a negative sample is not sufficient to exclude problems related to alcohol use. The gold standard PAS usage detection is the combination of clinical history and laboratory measurement of PAS[3].

Most addicts and abusers reported initial alcohol use during adolescence. In addition to being the period in which PAS experimentation mostly occurs, starting during adolescence can increase the chances of an individual developing a more severe habit in adult life[25].

Among the dependents who have experienced trauma, a significant portion were the victims of acts of violence (mainly beatings), with 36.1% having ISS scores greater than 16, that is, they suffered traumas considered more severe. Alcohol use is related to violent acts as much for victims as for aggressors. A study, which examined victims of violent deaths, found positive blood alcohol levels in 70% of casos[26].

Alcohol poisoning causes a loss of ability to concentrate for several hours after ingestion, as well as a loss of psychomotor skills and an increase in impulsivity[27,28]. These reactions can catalyze personality traits, increasing or causing aggressive tendencies, which can culminate in illegal acts, which can lead to involvement in violent acts[29]. Offenders intoxicated by alcohol commit more than half of crimes[30]. Among abusers of alcohol, their most common cause of injury is from traffic accidents (56.2%).

Alcohol use is more prevalent among drivers who are involved in traffic accidents[31]. Drunk drivers have a higher frequency of involvement in accidents than those who are sober. Alcohol use slows reflexes and impairs motor coordination, increasing the chance of collision. In addition, drivers who use alcohol use seat belts less often drive at higher speeds and have a greater risk of distraction[32]. In a Brazilian survey on alcohol use, 21.6% of adults admitted that they had already driven drunk at least once in their lives[21].

At the time of the follow-up interview, one year after admission to the emergency department, it was found that a significant portion of abusers (36.4%) had discontinued or decreased alcohol use. Few, however, referred to the BI as the determining factor in discontinuing or reducing alcohol consumption. The consequences of trauma were cited as the main reason for change in PAS usage. Among abusers, the fact that they had suffered an injury, directly due to PAS usage, was considered sufficient to review their consumption. Although all were subjected to BI, this was the least cited reason among those who either stopped or reduced their alcohol consumption.

This can be explained by a lack of understanding of the patient's compliance with the role of BI, since it was carried out by graduate students with less experience in chemical dependency treatment, or by the greater impact made the trauma event itself.

Therefore, it is important that the training of emergency department professionals is well executed, so that the treatment of problematic users of PAS is appropriate and effective.

Among the dependents, the portion which reduced or stopped consumption, for whatever reason, was much lower. When the severity of use is greater, there is a need for other handling mechanisms in order to reduce usage or stop. This finding is consistent with other studies, carried out in the ED, which found little effectiveness of BI one year after its completion[8]. One of the reasons for this finding may be the need for continuity of user monitoring, by specialized services or with skilled professionals, who can support the patient, preserving motivation and preventing or dealing with relapses. Without regular monitoring, it is more difficult to maintain abstinence or reduce usage.

This study shows high rates of blood alcohol concentration and disorders related to alcohol use (abuse and dependence) among trauma victims. Following up after one year, there was a general reduction of alcohol consumption in one third of abusers and one fifth of dependents. Considering these data, the importance of preventative strategies, which address the association between use of alcohol and trauma, is reinforced. In addition, the treatment of trauma related to alcohol use can provide a window of opportunity in reducing the risky use of alcohol and consequently reducing morbidity and mortality within this population.

Considering the existing association between alcohol consumption and the occurrence of trauma, it is necessary to identify the presence of PAS use in trauma patients. Knowledge of the profile of these patients, and a better understanding of the determinants of PAS use, before and after the event, are useful tools in facilitating a more appropriate approach in the ED, and is the best strategy for intervention and prevention.

In conclusion, the motorcycle accident was the most common cause of injury, and among alcoholic abusers dependents, there was a reduction in the consumption of alcohol after the trauma, however the BI was not the most reported reason for the change in habit.

R E S U M O

Objetivo: *avaliar os mecanismos e a gravidade do trauma em pacientes que preenchessem critérios para abuso ou dependência de álcool de acordo com o* Mini International Neuropsychiatric Interview *e apresentar o padrão de consumo de álcool e as mudanças um ano após o trauma.* ***Métodos****: estudo quantitativo transversal e longitudinal realizado de novembro de 2012 a setembro de 2013 em Unidade de Emergência. O paciente era submetido a uma entrevista semiestruturada que avalia abuso e dependência de álcool. Os pacientes abusadores e dependentes de álcool foram submetidos à intervenção breve. Um ano após a admissão os pacientes foram contatados e questionados acerca do padrão de uso e as razões de eventuais mudanças.* ***Resultados****: de uma amostra de 507 pacientes admitidos na UE por trauma, 348 responderam ao MINI, sendo 25,9% abusadores e 10,3% dependentes de álcool. Entre os abusadores o mecanismo de trauma mais frequente foi o acidente de motocicleta (35,6%) e nos dependentes houve predomínio de espancamento (22,2%). Amostras de sangue positivas para álcool foram identificadas em 31,7% dos abusadores e 53,1% dos dependentes. Um ano após o trauma, 66 abusadores e 31 dependentes foram contatados, constatando-se que 36,4% dos abusadores e 19,4% dos dependentes diminuíram o padrão de consumo de álcool. A principal razão relatada de redução foi o trauma.* ***Conclusão****: o acidente de motocicleta foi o mecanismo de trauma mais frequente e entre os abusadores e dependentes de álcool houve redução do consumo de álcool após o trauma, porém a IB não foi a razão mais relatada para a mudança do hábito.*

Descritores: *Alcoolismo. Ferimentos e Lesões. Emergências. Transtornos Relacionados ao Uso de Álcool.*

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Original Article

Night admission is an independent risk factor for mortality in trauma patients – a systemic error approach

Admissão noturna é fator de risco independente para mortalidade em pacientes vítimas de trauma – uma abordagem ao erro sistêmico

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A B S T R A C T

Objective: to assess the impact of the shift inlet trauma patients, who underwent surgery, in-hospital mortality. **Methods:** a retrospective observational cohort study from November 2011 to March 2012, with data collected through electronic medical records. The following variables were statistically analyzed: age, gender, city of origin, marital status, admission to the risk classification (based on the Manchester Protocol), degree of contamination, time / admission round, admission day and hospital outcome. **Results:** during the study period, 563 patients injured victims underwent surgery, with a mean age of 35.5 years (± 20.7), 422 (75%) were male, with 276 (49.9%) received in the night shift and 205 (36.4%) on weekends. Patients admitted at night and on weekends had higher mortality [19 (6.9%) *vs.* 6 (2.2%), p=0.014, and 11 (5.4%) *vs.* 14 (3.9%), p=0.014, respectively]. In the multivariate analysis, independent predictors of mortality were the night admission (OR 3.15), the red risk classification (OR 4.87), and age (OR 1.17). **Conclusion:** the admission of night shift and weekend patients was associated with more severe and presented higher mortality rate. Admission to the night shift was an independent factor of surgical mortality in trauma patients, along with the red risk classification and age.

Key words: Wounds and Injuries. Mortality. Patient Admission. Time Factors. Emergencies.

INTRODUCTION

There is evidence that patients admitted in night shifts, weekends or holidays have higher rates of complications, hospitalization time and mortality[1-3]. Fatigue and lack of supervision to attending physicians may contribute to increased complications and hospital mortality. Such situations, also added to the circadian rhythm and dynamics of abnormal operating changes can be crucial factors for the worst performance in these periods. The cumulative presence of a number of unfavorable conditions is remarkable and very common in these periods, situations that favor and increase vulnerability to error[1-10].

Specific studies in patients with acute myocardial infarction, ischemic stroke and the Intensive Care Units showed higher rate of clinical complications and hospital mortality in the "off-hours" periods (nighttime or weekends)[4-12].

The volume of evidence demonstrating higher incidence of unfavorable outcomes in these adverse conditions weakens the idea of occasional errors as the cause of these events[4-10]. This highlights the need to analyze these situations trough of a model to interpret the error with a systemic view.

Due to the lack of Brazilian studies, this study aimed to verify the impact of the shift of admission of patients who have suffered trauma, underwent surgery, in hospital mortality. According to these results, interpretation models and error correction are discussed.

METHODS

This is a cohort study with retrospective collection of data, which were selected through electronic medical records, patients admitted from November 2011 to March 2012 in the emergency of *Hospital do Subúrbio* (HS) - a public hospital attending urgency and emergency and public-private administrative nature, in Subúrbio Ferroviário, district of the city of Salvador, Bahia. The study included trauma patients admitted to the emergency HS who underwent surgery and were classified according to International Classification of Diseases - 10th edition (ICD-10) in the postoperative as external causes[13].

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This study was submitted to the Ethics Committee of the Faculdade de Medicina of Universidade Federal da Bahia under number 234.541, in addition to having the consent of *Hospital do Subúrbio*. The signing of an Informed Consent Form was dismissed because of the observational and retrospective nature of the study.

The day shift was defined as from 08:00 to 17:59, the night shift from 18:00 to 07:59 and the weekend as any time from 18:00 on Friday until 07:59 on Monday. The exchange on duty hours were included in the "off hours" period because they have similar organizational adversity.

For statistical analysis, age was treated as a continuous variable. This approach was chosen, rather than dichotomizing in elderly and non-elderly, due to the low average age of the study population. The city of origin was ranked from the state capital, Salvador, or Country towns. The risk classification at admission was defined according to Manchester protocol[11] and categorized in blue, green, yellow and red, in ascending order of risk. The surgeries were classified as to the degree of contamination[12] as clean potentially contaminated, contaminated and infected. The admission shift was defined as daytime for patients with incoming record between 08:00 and 18:00 and night at other times and the day of registration, split at the weekend (Saturday and Sunday) or non-weekend. Categorical variables were expressed as their proportions, which were compared using the chi-square test with Yates or Fisher's exact test continuity correction. The means and standard deviations were calculated for continuous variables with normal distribution, which in turn were compared using the Student T test for independent samples or ANOVA, and medians and quartiles for the non-normal, which a comparison was made by the tests non-parametric Mann-Whitney or Kruskal-Wallis. Multivariate analysis to identify predictors of hospital mortality factors was performed by multiple logistic regression by the method "backward stepwise" with results expressed by *Odds Ratios* and their confidence intervals (CI) of 95%. Potential confounding variables identified by univariate analysis with p up to 0.10 were included in the multivariate models, as well as gender variable. All tests were two-tailed and were considered statistically significant results with pd"0.05.

RESULTS

Five hundred sixty-three patients were analyzed (Table 1), with average age of 35.5 (± 20.7) years, of which 422 (75%) were male and 474 (84%) singles. There were 337 (59.8%) "off-hours" admissions, with 276 night admissions and 205 weekend admissions. For the classification of risk of admission, 226 (47.5%) were classified as green, 118 (24.8%) as yellow and 107 (22.5%) as red. The hospital mortality was 4.4% (25 patients).

It was observed that at the night shift patients were younger, with an average age of 32.5 (± 20.7) *vs.* 38.1 (± 20.1), p=0.001 and with a tendency to higher proportion of men, 217 (78.6%) *vs.* 197 (71.1%), p=0.053. Most nightly admissions were on weekends, 144 (52.2%) *vs.* 59 (21.3%), p<0.001. During the night shift, there was a higher number of admissions of patients with single marital status, 250 (94.7%) *vs.* 217 (83.8%), p<0.001. According to the rating of risk, the most severe patients were admitted. Besides a larger number of contaminated surgery, 82 (29.7%) *vs.* 36 (13%), p<0.001. Mortality was

Table 1 - Clinical and demographic characteristics of patients admitted to the emergency, daytime vs. nightly and weekdays vs. weekend (n=563).

	Daytime (n = 277)		Nightly (n = 276)		p Value	Week days (n = 358)		Weekends (n = 205)		p Value
Age (average ± SD)	38,1	(± 20,1)	32,5	(± 20,7)	0,001	37,13	(± 21,9)	32,79	(± 18,0)	0,011
Male	197	(71,1%)	217	(78,6%)	0,053	261	(72,9%)	161	(78,5%)	0,167
Admission at the weekend	59	(21,3%)	144	(52,2%)	< 0,001	-		-		-
Night Admission	-		-		-	132	(37,7%)	144	(70,9%)	< 0,001
From Salvador	219	(79,1%)	205	(74,3%)	0,219	279	(77,9%)	155	(75,6%)	0,598
Single	217	(83,8%)	250	(94,7%)	< 0,001	295	(87,0%)	179	(92,7%)	0,058
Risk classification					< 0,001					0,041
Green	128	(58,7%)	94	(37,8%)		155	(52,4%)	71	(39,2%)	
Yellow	42	(19,3%)	73	(29,3%)		67	(22,6%)	51	(28,2%)	
Red	38	(17,4%)	67	(26,9%)		61	(20,6%)	46	(25,4%)	
Contaminated Surgery	36	(13,0%)	82	(29,7%)	< 0,001	68	(19,0%)	55	(26,8%)	0,040
Mortality	6	(2,2%)	19	(6,9%)	0,014	14	(3,9%)	11	(5,4%)	0,014

Source: electronic medical records, patients admitted from November 2011 to March 2012 in the emergency of Hospital do Subúrbio *(HS).*
Data are presented as n (%) valid unless specified.
SD: standard deviation.

higher in this same group, 19 (6.9%) *vs.* 6 (2.2%), p=0.014 (Table 1).

It was observed that the weekend patients were younger, with an average age of 32.8 (± 18.0) *vs.* 37.1 (± 21.9) p=0.011. There was no difference according to gender. There was a higher proportion of more severe patients admitted on weekends, as well as greater number of contaminated surgery, 55 (26.8%) *vs.* 68 (19%), p=0.040. Mortality was higher in patients admitted in this period, 11 (5.4%) *vs.* 14 (3.9%), p=0.014 (Table 1).

Patients who had in-hospital death and who have not died were compared (Table 2). It observed that the patients who died had greater age 47.2 (± 24.2) *vs.* 35.0 (± 20.4), p=0.004, with no differences according to gender and admission during the weekend. However, it was observed that the patient who died had higher night admission fee, 19 (76%) *vs.* 257 (48.7%), p=0.014; and that these were of highest risk, p<0.001.

To identify independent predictors of mortality was conducted multivariate logistic regression analysis.It was retained in the final model the age (for each five years, *odds ratio* 1.17, 95% confidence interval 1.12 to 1.23), red risk classification (OR=4,87, CI95%=2,07 a 11,46) and the night admission (OR=3.15, CI95% 1.19 to 8.35) (Figure 1).

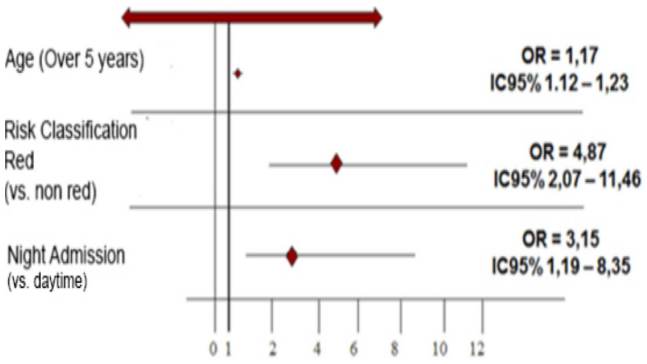

Figura 1 - *Independent predictors of hospital mortality.*

DISCUSSION

The study showed that the admission of victims of trauma patients who underwent surgery, occurs with considerable frequency in "off-hours" periods at the HS emergency service, which is also perceived in other trauma services. There were 563 patients in total in a period of four months in a row, with approximately 60% of admissions in "off-hours" periods.

The "off-hours" periods have a more complex operation and peculiar logistics. Failure to operate in its entirety, with some services not readily available, or even not available, leads to a delay in the execution and difficult logistics service. Some authors have given[3-5] that the multidisciplinary *ratio* (medical staff, nursing, pharmacy, laboratory, diagnostic imaging, management etc.) and referral to medical specialists is hampered due to fewer professionals, providing a smaller number diagnostic investigations and therapeutic procedures based on evidence[3-6,10,14-16]. Another factor that may have important association is related to the fatigue of professionals at night, and these are often the same professionals who worked during the day and stay at night, or who may already have come from other working hours; furthermore, the inversion of sleep-wake cycle can change and attention influence the procedures adopted[3,17-20].

This study, performed in a major hospital in the emergency area, is consistent with data in the literature regarding the morbidity and mortality of patients admitted in different shifts and in the middle or end of the week, showing a higher mortality in patients admitted in the "off-

Table 2 - Clinical and demographic characteristics of patients admitted to the emergency, no deaths *vs.* death (n=563).

	No death (n=538)		Death (n=25)		p Value
Age (average ± SD)	35,0 (± 20,4)		47,2 (± 24,2)		0,004
Male	404	(75,1%)	18	(72,0%)	0,910
Night Admission	257	(48,7%)	19	(76,0%)	0,014
Admissionat the weekend	194	(36,1%)	11	(44,0%)	0,553
From Salvador	412	(76,6%)	22	(88,0%)	0,278
Single	453	(88,8%)	21	(95,5%)	0,058
Risk classification					< 0,001
Blue	25	(5,5%)	1	(4,0%)	
Green	222	(49,1%)	4	(16,0%)	
Yellow	112	(24,8%)	6	(24,0%)	
Red	93	(20,6%)	14	(56,0%)	
Contaminated Surgery	116	(21,6%)	7	(28,0%)	0,607

Source: electronic medical records, patients admitted from November 2011 to March 2012 in the emergency of Hospital do Subúrbio *(HS). Data are presented as n (%) valid unless specified.*
SD: standard deviation.

hours" period[8,9,21]. It was shown that there was a higher mortality in trauma patients, who underwent surgery, admitted at night, and on weekends. After multivariate logistic regression analysis, age, red risk rating and night admission were identified as independent predictors of mortality, which was not observed for admissions over the weekend. Thus, age is an intrinsic factor to the patient, and the severity is an intrinsic factor to the mechanism of injury[11,22,23]. On the other hand, night admission is presented, therefore, as an intrinsic factor of systemic error[22-24].

Reason *et al*.[23] proposed a model that defines the error, or an unfavorable outcome in the case of medicine, as something systematic and to avoid them, there are numerous defense barriers. These barriers act as a Swiss cheese slices, each of which has intrinsic flaws, but an error to be realized must be a confluence of failures in all the barriers. The "Swiss Cheese Model"[23,24], brings a different analysis of the error, that instead of being seen as a consequence of a personal failure, is understood as a consequence of several factors that increase the chance of an error occurs. In this study, the various adverse conditions during the night shift already mentioned would be represented as new "holes" in the supervision and safety barrier, contributing to the higher incidence of adverse outcomes[24].

The fact that the causal error condition arise from potentially identifiable factors, and not appended the human factor, allows a better interpretation and a search for a permanent solution to the problem at hand. Because correct logistical failures is more viable than changing human behavior, this interpretation becomes of great value to the improvement of results.

Great centers of reference, with long-term established services have not identified differences in mortality in the "off-hours" period[4,9,10]. This fact points to the idea that the various adverse conditions (holes in the barriers) can and should be neutralized through critical analysis of the context of each service and higher organizational level. These studies suggest that the relationship between level of organization and higher mortality in the periods "off hours" should be recognized and used as an important indicator to improve care processes as well as the reformulation of these processes over the years[3,4].

Although well known for aviation and other business sectors, the Swiss cheese model is misunderstood and poorly put into practice in health care[24]. It is important to understand that the period "off hours" has its organizational peculiarities and should be managed in order to solve these peculiarities, not similar to daytime shift so there is the improvement of services.

Some limitations were found in this study. As this is a cohort study with retrospective collection, it cannot excluded the possibility of other confounding factors were not analyzed.it should be remembered that the assessment of this association involves several potentially confounding factors, such as the definition of daytime and nighttime periods or middle weekend, the population studied, the health service organization studied, as well as numerous other possible variables such as the severity of the trauma. During the study period, they had not been deployed indexes related to trauma (RTS, ISS, TRISS), by using the Manchester Protocol[11], which was already in use at the hospital. The study limitations are being corrected for improvement of trauma care service as well as the analysis of future studies through a specific procedure for taking care of polytrauma patients. Finally, data were collected in a short period, in a single center and the absence of a calculation to determine the sample size, which may limit its external validity.

The body of evidence suggests that these occurrences are part of a systemic error of the model at the time of the study. The analysis and interpretation of error for a systematic approach enables the effective resolution of the problem through measures to identify the peculiarities of night shift.

In conclusion, trauma patients, who underwent surgery, admitted to the night shift at a major hospital in emergency Salvador, Bahia, had higher in-hospital mortality, regardless of its severity and risk classification. The variables red risk classification, admission to the night shift and age were identified as independent predictors of mortality.

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R E S U M O

Objetivo: *verificar o impacto do turno de admissão de pacientes vítimas de trauma, submetidos ao tratamento cirúrgico, na mortalidade hospitalar.* ***Métodos:*** *estudo de coorte observacional retrospectivo no período de novembro de 2011 a março de 2012, com dados coletados através de prontuário eletrônico. Foram analisadas estatisticamente as variáveis de interesse: idade, sexo, cidade de origem, estado civil, classificação de risco à admissão (baseado no Protocolo de Manchester), grau de contaminação, horário/turno de admissão, dia de admissão e desfecho hospitalar.* ***Resultados:*** *Quinhentos e sessenta e três pacientes traumatizados foram submetidos ao tratamento cirúrgico no período estudado, com média de idade de 35,5 anos (± 20,7), sendo 75% do sexo masculino, 49,9% admitidos no turno noturno e 36,4% aos finais de semana. Os pacientes admitidos à noite e aos finais de semana apresentaram maior mortalidade, 6,9%* vs. *2,2%, p=0,014, e 5,4%* vs. *3,9%, p=0,014, respectivamente. À análise multivariada, os fatores preditores independentes de mortalidade foram a admissão noturna (OR 3,15), a classificação de risco vermelho (OR 4,87), e a idade (OR 1,17).* ***Conclusão:*** *a admissão no turno noturno e no final de semana foi associada com pacientes de maior gravidade e apresentaram maior taxa de mortalidade. A admissão no turno noturno foi fator independente de mortalidade em pacientes traumatizados cirúrgicos, juntamente com a classificação de risco vermelho e a idade.*

Descritores: *Trauma. Mortalidade. Admissão do Paciente. Fatores de Tempo. Emergências.*

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Evaluation of the use of tomography in penetrating neck trauma

Avaliação da utilização da tomografia computadorizada no trauma cervical penetrante

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A B S T R A C T

Objective: the study has the intention of evaluate the accuracy of computed tomography for the diagnosis of cervical lesions on penetrating neck trauma and also identify the most frequent mechanisms of trauma. Most injured structures, determine the age range and the most prevalent sex. **Methods:** observational descriptive retrospective study executed by the systematic retrospective review of medical records of all patients victims of penetrating neck trauma that went through surgery and CT scans, admitted into *Hospital do Trabalhador*, between January 2009 and December 2013. **Results:** the final sample was of 30 patients, 96.7% of the male sex, the median age was of 28 years old. Most patients suffered injuries by gun (56.7%) and 33,3% suffered stab wounds. The most stricken area of the neck was Zone II (77.8%) and the left side (55.2%). Regarding the structures injured, the CT showed 6.7% lesions on airways but the surgery showed 40% of damaged, with a value of *p=0.002*. As to damages of the esophagus and pharynx the CT detected 10% of lesions, while surgery found 30% of lesions, therefore with a significant value of *p=0.013*. As for the analysis the CT showed reliable. As for the analysis of vascular damage, the CT showed to be, in most cases, reliable to the findings during the surgical act. **Conclusion:** besides the great use of CT for the diagnosis of penetrating neck injuries we can say that this is an exam with low accuracy for the diagnosis of lesions of aerodigestive tract, therefore it is important a clinical correlation for a good diagnosis.as for the vascular lesions and of other structures, the CT had high sensibility and specificity, thus a good exam to be used in overall.

Key words: Neck Injuries. Wounds and Injuries. Diagnostic Imaging. Tomography, X-Ray Computed.

INTRODUCTION

Penetrating cervical injuries has been a major trauma mechanism, present in about 5-10% of trauma patients, with an estimated mortality of 3-10%[1]. Penetrating injuries are most commonly caused by fire gun, a mechanism that has higher mortality[2,3]. Anatomically, the neck is a region that contains a great amount of important structures - vascular, respiratory, digestive and nerve - in a small, confined space[4] so that injuries in this region has a tendency to achieve several vital structures. The evaluation and treatment of cervical penetrating wounds are still difficult to handle. There is currently a great debate on the approach to be adopted in such injuries and the operative management has been replaced by a more selective and conservative approach[5,6].

Cervical components most often injured in penetrating trauma are related to vascular injuries (21-27%), followed by spinal cord (16%) and aero digestive tract (6-10%) as the larynx or trachea and pharynx or esophagus[2,4,7]. There is a predominance of young patients and male victims of these injuries, aged in the third and fourth decades of life[2,8].

The diagnosis can be made by physical examination alone, or aided by additional tests such as radiography performed in three incidents (lateral, anteroposterior and trans-oral), computed tomography (CT) and magnetic resonance imaging (MRI). Currently, several studies indicate that the method of would be computed angiography, since it is a relatively quick scan, high resolution and with a sensitivity of 98%, plus it is an exam easily accessible and generally available in most services trauma[9].

The medical management in these cases is still controversial. The mandatory exploratory cervicotomy, previously recommended in these cases, is falling into disuse, lead to a large number of non-therapeutic surgical procedures[1]. Patients who underwent immediate surgical treatment are those with heavy bleeding, hemodynamic instability, dysphonia, air leakage, injury diagnosed on CT, platisma perforation, transcervical injuries by gunshot and subcutaneous emphysema[10]. The other cases should be carefully evaluated through physical examination and CT scan, to later be performed surgery if necessary[11].

Due to the complexity of the approach of these cases and the importance of imaging exam in the evaluation

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of the patient, this study aims to evaluate the accuracy of computed tomography in the diagnosis of cervical injuries in penetrating cervical trauma. Also, determine the epidemiology of affected patients and to recognize the regions and structures of the neck most commonly injured structures.

METHODS

The *Hospital do Trabalhador* (HT) is a center of excellence in trauma care patient, located in Curitiba, Paraná. It is responsible for the care of approximately 60% of urgency and emergency care of Curitiba and metropolitan region, it is considered a teaching hospital, a reference in training human resources for health[12].The Emergency Room of *Hospital do Trabalhador* (ER-HT) in Curitiba, State of Paraná, operates in a dual mechanism for admitting patients: spontaneous demand and referenced (SIATE/ SAMU). In 2012, the PS-HT attended 63,855 patients, and the highest percentage of this number was made up of accident victims[12].

This is a retrospective, descriptive and observational study. The study included patients suffering from penetrating cervical trauma who underwent CT scans at admission and subsequently underwent a surgical procedure to correct possible injury. The open surgical approach was considered the gold standard in this study for comparison with the findings of the CT scan. We analyzed all records of patients older than 18 years, admitted to the *Hospital do Trabalhador* between January 2009 and December 2013.

We collect epidemiological data of the study sample, such as age and gender, mechanism of injury, signs and symptoms on admission, complementary tests, findings of computed tomography, surgical findings, established treatment, complications and associated injuries to the cervical trauma. Data were collected and stored, checked, exported and statistically analyzed. We consider $p<0.05$ statistically significant.

RESULTS

The final sample consisted of 30 patients who met the inclusion criteria, 96.7% were male and only 3.3% were female. The ages ranged between 14 and 66 years, and the median age was 28 years. Regarding the mechanism of injury, 56.7% suffered injury by gunshot wounds and 33.3%, stab wound, other mechanisms were responsible for 10% of the lesions. Regarding the location of the entrance to injury, the neck zone 2 was the most commonly achieved in 77.8%, followed by zone 1, 22.2%. Thewounds on the left side corresponding to 55.2% of the sample, 34.5% on the right side and 10.3% of anterior lesions.

Pre admission data showed that most patients have stable vital signs (86.3%), 87% of the patients were normotensive in the prehospital exam and 13% were hypotensive. The airway was pervious in 79.3% of cases, 10.3% required intubation and mechanical ventilation. Only 13.7% of patients had lower scores than 8 on the Glasgow Coma Scale (GCS) on admission, the remaining 88.3% had ECG greater than 11.

The most common signs of injury in penetrating cervical trauma observed on physical examination on admission in hospital were evaluated, 65.5% of the sample had active bleeding injury, 17.2% hematomas, 6.9% had stridor and only one had dysphonia. Subcutaneous emphysema was observed in 27.6% of cases.

Comparing the data observed on CT angiography with the data of the open surgical procedure, considered the gold standard in this study, we found injuries of carotid arteries in 6.7% of the sample in the CT and 16.7% in surgery. As for the jugular veins, 16.7% were injured in CT and 23.3% in cervicotomy (Table 1). The vertebral arteries were injured in 13.3% on imaging exam and only 3.3% in surgery. Injuries in other arteries were found in surgery in 10% of cases and on CT in only 3.3%. As the airways, the tomography showed 6.7% of alterations, while surgery found 40% of injuries, this data has statistical significance, with $p=0.002$. In angiography had esophageal and pharynx damage 10% of patients, compared to 30% in open surgery, data that also presented significance with $p=0.013$.We found thyroid injuries in 20.7% of patients in angiography and 10.3% during the cervicotomy ($p=0.375$).

As treatment of vascular injuries found in the exploratory cervicotomy in 26.7% of patients suture of veins were required and in 23.3% suture of arteries. No grafts were used, but ligature and prosthesis were made in 3.3% of patients and two people received drain. Tracheostomy was performed in 33.3% of cases, laryngeal suture in 20%, suture elsewhere as pharynx in one case and esophagus in two cases. It was found simultaneous injury to the larynx and esophagus in one patient and injury to the trachea associated with larynx also in one patient.

The postoperative complications were neurological deficit, esophagus cutaneous fistula, bleeding and neck infection were less prevalent (Table 2). Only one patient died. Six patients (20%) had gunshot wound the chest simultaneously, one patient had head trauma.

DISCUSSION

The penetrating cervical injuries are of high complexity due to the presence of a large amount of vital structures housed in a small space, resulting at high rates of morbidity. Moreover, these injuries can be interpreted as evidence of increasing at urban violence and therefore it is really worth mentioning this in trauma services[7,9].

Table 1 - Comparison of the injuries found in CT angiography with those found in open surgery.

Injured structure	CT angiography N (%)	Surgery N (%)	P value
Right CCA	1 (3.3%)	2 (6.7%)	-
Left CCA	0	1 (3.3%)	1
Right ICA	1 (3.3%)	2 (6.7%)	1
Left ICA	0 0	-	
Right IJV	2 (6.7%)	4 (13.3%)	0.500
Left IJV	1 (3.3%	1 (3.3%)	1
Right EJV	1 (3.3%)	0	1
Left EJV	1 (3.3%)	2 (6.7%)	1
Right vertebral artery	2 (6.7%)	1 (3.3%)	1
Left vertebral artery	2 (6.7%)	0	0.500
Airways	2 (6.7%)	12 (40%)	0.002
Esophageal/pharynx	3 (10%)	9 (30%)	0.013
Thyroid	6 (20.7%)	3 (10.3%)	0.375

N: number; CCA: Common carotid artery; ICA: Internal carotid artery; IJV: Internal jugular vein; EJV: External jugular vein.

The neck corresponds to a region of great importance in the management of trauma, the injuries can be penetrating when they exceed the platysma or superficial injuries when do not. Anatomically it is divided into three zones (I, II and III). Zone I is bounded by the cricoid cartilage, sternum and clavicle. In this region are located structures such as arteries and veins subclavian, common carotid artery, trachea, esophagus, thoracic duct, and nerves recurrent laryngeal and vague. Zone II is the one with higher incidence of lesões[2] and it has as lower limit the cricoid cartilage and the superior angle of the jaw, and its main structures are the larynx, pharynx, carotid arteries and jugular veins. The zone III is located between the angle of the mandible and the skull base and contains the internal and external carotid, vertebral artery and the sympathetic trunk[7,13].

According Munera*et al.*[14] penetrating injuries of the neck leading to mortality rate ranging between 2and 10% and morbidity of 5%. The carotid lesions and vertebral arteries are the main factors that determine the prognosis of patients, and they are account for a large number of complications and sequelae resulting from trauma. However, until now there are controversies about the best method to diagnosis these injuries[14,15].

In our research, as well as in other studies, we obtained a predominance of males with 96.7% of cases, other study have shown a male prevalence also around 90%[2]. It was also compatible the age, 28 at our study, in other words, most young adults[2]. About the most affected areas, the II was the most one (77.8%), similar as found in the reviewed studies[7,16-18].

It is known that the clinical examination may be sufficient to identify the injured structures at neck trauma thus leading to diagnosis. As physical examination findings, 70% of patients with vascular lesions showed bleeding type

Table 2 - Postoperative complications.

Complications	N	%
Neurological déficit	2	6.66
Esophageal-cutaneous fistula	2	6.66
Infection	1	3.33
Bleeding	1	3.33
Death	1	3.33

'drooling' on admission, do not been characterized as big bleeding or expanding hematoma, which allowed doing research imaging tests. At airway, esophagus and pharynx lesions, we do not obtained specific signs, however the esophageal lesions are known to be usually asymptomatic until the moment of very severe situation[10,19,20].

Currently, CT angiography has been a non-invasive method, effective and readily available for evaluation of neck trauma, reducing significantly the number of surgical procedures, as well as non-therapeutic cervicotomy, therefore, it is replacing previously tests performed, such as angiography or MRI[21].

Studies show that CT angiography has a high capacity diagnosed mainly in identifying lesions at arteries and veins of the neck, with a specificity of about 100% and sensitivity of 90%. This fact was confirmed in our study, since tomography identified blood vessels lesions, which, for the most part, were corroborated by surgery[15,22].

Regarding the airways and digestive tract, it is known that injuries are associated with high morbidity and mortality trauma, which may lead to complications such as sepsis mediastinine and, therefore the diagnosis is of

paramount importance. In our study, CT was shown to be an examination with low diagnostic sensitivity for this type of injury, and in 54% of cases the examination did not identify airway changes or digestive tract, which were present at the time of surgical exploration, presenting a p value with statistical significance (p=0.002 and p=0.013, respectively).

Regarding the treatment of penetratinginjuries of the cervical blood vessels, the preference was for surgical repair at the expense of vascular ligation, except in the case of coma associated with absence of anterograde flow[23]. In the present study, 100% of arterial lesions were treated with reconstruction of the blood vessel.

The airway lesions were managed with pre-hospital orotracheal intubation at 16.67%, a tracheostomy was performed in 75% of patients, 50% required suture at laryngeal/tracheal. There is need early intervention in airway injury at penetrating neck trauma, tracheal intubation is indicated in most cases, but in this study the majority of the sample was conducted with tracheostomy. The primary suture tends to good results, and so was the treatment used at who required surgical intervention[24].

Finally, we noted in this study that CT shown not to be one of the best options to make the diagnosis of airway and digestive tract injuries in penetrating neck trauma. What highlights the need for a high index of suspicion and the correlation with physical examination data for a more accurate diagnosis of alterations involving these structures[1,9,11,25-27].However, this is a test available in most trauma services, besides being a non-invasive, relatively rapid achievement test and which can evaluate different structures at the same time. CT angiography is also the method of choice for the diagnosis of vascular damage in penetrating neck trauma, which do not allow us to reduce the importance of the exam.

We have found some limitations throughout the study regarding at the fill to the form of patients and the book of computed tomography during some periods of time. Patients included in the study are part of a select group of individuals, which were stable during the initial approach, enabling the realization of research imaging tests and therefore feature a bias for research. Therefore, we emphasize the importance of further studies on the subject, especially with regard to the diagnosis of airway and digestive tract lesions.

In conclusion, besides the great use of CT for the diagnosis of penetrating neck injuries we can say that this is an exam with low accuracy for the diagnosis of lesions of aerodigestive tract, therefore it is a important clinical correlation for a good diagnosis. As for the vascular lesions and of other structures, the CT had high sensibility and specificity, thus a good exam to be used in overall.

R E S U M O

Objetivo*: avaliar a acurácia da tomografia computadorizada no diagnóstico de lesões do trauma cervical penetrante.* ***Métodos:*** *estudo retrospectivo descritivo observacional realizado através da revisão de prontuários de todos os pacientes vítimas de trauma cervical penetrante que foram operados e submetidos à tomografia computadorizada no pré-operatório.* ***Resultados****: a amostra final compreendeu 30 pacientes, sendo 96,7% do sexo masculino e a mediana de idade foi 28 anos. A maioria dos pacientes sofreu ferimento por arma de fogo (FAF) em 56,7% dos casos e 33,3% foram ferimentos por arma branca (FAB). A zona do pescoço mais acometido foi a zona II (77,8%) e no lado esquerdo (55,2%). Em relação às estruturas lesadas, a tomografia computadorizada (TC) mostrou 6,7% de lesões em vias aéreas e durante a operação encontrou-se 40% de alterações (p=0,002). A tomografia computadorizada detectou 10% de leões do esôfago e faringe, durante a operação encontrou-se 30% de lesões (p=0,013). Já, para análise de danos vasculares, a TC se mostrou, na maioria dos casos, fidedigna aos achados durante o procedimento operatório.* ***Conclusão:*** *apesar do grande uso da tomografia computadorizada no diagnóstico de lesões cervicais penetrantes, pode-se afirmar que este é um exame com baixa acurácia no diagnóstico de lesões de trato aerodigestivo, sendo importante uma correlação clínica para um bom diagnóstico. Já para lesões vasculares e de outras estruturas, a TC apresentou alto grau de sensibilidade e especificidade, sendo assim um bom exame a ser utilizado nesses casos.*

Descritores: *Lesões do Pescoço. Ferimentos e Lesões. Diagnóstico por Imagem. Tomografia Computadorizada por Raios X.*

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Complementary exams in blunt torso trauma. Perform only radiographs and fast: is it safe?

Exames complementares na condução do trauma contuso do tronco. É seguro realizar apenas radiografias e fast?

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A B S T R A C T

Objective: to evaluate effectiveness of using chest X-ray (CXR), pelvis X-ray (RXP) and FAST (Focused Abdominal Sonography on Trauma) to exclude significant lesions of the body in blunt trauma. **Methods**: a prospective study involving 74 patients whom made the three tests (CXR, RXP and FAST) during the initial evaluation between October 2013 and February 2014. The results were compared to the tomography of the same patients or clinical outcome. If the patient did not have alterations on the CT scans or during the observation time, the initial workup was considered safe. All patients were evaluated at the Hospital João XXIII, Belo Horizonte, Brazil. **Results**: of the 74 patients studied the average age was 33 years, RTS: 6.98, ECG: 12. From 44 (59.45%) patients with exams (radiographs and FAST) unchanged, three had significant injuries (two splenic injuries and one liver injury) diagnosed by clinical monitoring. The remaining patients - 30 (40.55%) - had at least one alteration in conventional tests. Of these group 27 (90%) had significant injuries and three (10%) minor injuries. The sensitivity of all three tests for screening considerable lesions was 90% and the specificity was 93%. The negative predictive value was 93% and the positive predictive value 89%. **Conclusion**: this research showed that all the three exams - chest X-ray, pelvis and FAST - are safe to lead with the blunt trauma if well used and associated with clinical examination.

Key words: Medical Examination. Trauma. Torso. Evaluation. Damage Assessment.

INTRODUCTION

Trauma is a global disease, being the fifth greatest global cause of death and the first when considering people less than 40 years of age[1]. In Brazil, it represents an even more alarming epidemiological behavior, since it corresponds to the third greatest cause of death and the first when considering the age group 1-44. It accounts for 50.2% of all deaths from external causesin this age group, and 74% of deaths in the range 15-24[2]. Trauma, therefore, should be seen as a serious public health problem, a disease which requires dedication and experience from the professionals involved. Due to its high prevalence, medical professional experience is essential, even if it is from a field devoid of propaedeutic resources.

In order to evaluate whether minimum research resources are sufficient in relation to tomography, it was decided to investigate the extent to which radiological examinations of primary trauma assessments (pelvic and chest X-rays and FAST - focused abdominal sonography trauma) are sufficient in indicating the best approach for the initial care of polytrauma patients.

METHODS

Seventy four patients were studied, all blunt trauma victims, and the three exams chest X-ray, pelvic X-ray and FAST were performed on admission. Data were collected on admission using a protocol developed for this purpose. The data collection period was October 2013 to February 2014 and took place at *Hospital João XXIII*.

Because there is no specific protocol on image methodology during the initial care at *Hospital João XXIII*, there was no interference in the surgeon's conduct dealing with each patient. Computed tomography was used selectively as the initial investigation method, according to the cause of injury. The study was based on chart data and examinations, without care intervention, without identification of the patient and therefore with no ethical-legal implications.

To determine whether the request for only three exams (chest X-ray, pelvic X-ray and FAST) would be sufficient for the complementary study of the torso in patients suffering from blunt trauma, two judgment criteria were considered: 1- The initial results of the three exams were

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compared to a CT scan of the torso of the same patient; 2- Clinical progress: the patients who did not have a CT scan of the torso during initial examinations were accompanied according to the following protocol: seven days for those who were intubated; 48 hours for those who were conscious but required hospitalization for some other reason (e.g.: orthopedic fracture); 12 hours for those who remained in hospital for only the minimum observation time, according to the standards of the Surgery Department of *Hospital João XXIII*, in order to present mild trauma, without significant injuries.

RESULTS

Of the 74 patients studied, their average age was 33, mean (Revised Trauma Score) RTS 6.98 and ECG 12. Of these 74 patients, 44 (59%) showed unchanged tests (radiography and FAST). However, three patients in this group had significant injuries (two splenic injuries and one liver), diagnosed by another imaging method; computed tomography (CT). The CT scans for these patients were performed within 24 hours after admission, since two of them complained of abdominal pain and the other had a severe tattoo trauma, identified during clinical examination.

The other 30 patients had, in this image set, at least one alteration, for example: free intra-abdominal fluid or rib fracture. Of these 30, 27 patients (90%) had significant injuries which were diagnosed either by primary examinations (e.g. pelvic fracture identified by pelvic X-ray) or by a complementary method (tomography). Significant injuries were defined as those which needed: an evaluation by another expert, a longer observation time and/or an invasive procedure. Only three patients (10%) had minor injuries, remaining only under hospital observation and were discharged after 12 hours (Table 1).

Therefore, the sensitivity of all three tests for the screening of significant injuries was 90% and the specificity was 93%. The negative predictive value found was 93% and a positive predictive value, 89%.

Tabela 1 - Associação de alteração no conjunto de exames – radiografia de tórax, bacia e FAST – com o diagnóstico de lesões consideráveis.

Diagnóstico	RxF +	RxF -	Total
LC+	27	3	30
LC-	3	41	44
Total	30	44	74

LC+: lesões consideráveis diagnosticadas; LC-: sem lesões consideráveis diagnosticadas; RxF+: alteração no conjunto dos exames de radiografias com o FAST; RxF-: sem alteração no conjunto dos exames.

DISCUSSION

The study clearly showed that the set of three exams (chest X-ray, pelvis X-ray and FAST) has a sensitivity and specificity of 90% and 93% respectively. Therefore its use is recommended when treating blunt trauma to the torso. For those patients who show no alteration in all three exams, and whose clinical examination of the torso is normal, it is inferred that the patient does not have any significant injury within that body segment. Thus, the patient could be referred to another specialist to treat specific injuries or even be discharged early if there are no other associated injuries, according to relevant protocols.

If on the other hand, some of these tests show alterations or the patient has alterations in a clinical examination of the torso, it is necessary for further diagnosis or to pay closer attention, to avoid unnoticed injuries. These findings are consistent with other studies in literature which show the safety of treating patients without tomography scanning as a tracking method[3].

There are other issues in literature that reinforce the safety of the conduct of cases through conventional studies, leaving the CT as an supplementary examination. Firstly, the effectiveness of the reduction in mortality by way ofa full-body CT scan during initial evaluation remains uncertain in literature[4-9]. There is a lack of important randomized and controlled studies on the subject and there are articles that do not show an associated reduction in mortality[4]. In addition, there is literary support for the use of radiography and ultrasound, since they are validated methods and are used by the most accepted protocols and applied worldwide, in relation to the approach to trauma victims, as defined by ATLS (Advanced Trauma Life Support)[9]. Another important issue to consider is that the use of full-body CT scans during initial assessment does not eliminate the possibility of unnoticed injuries[8,10]. Such an examination has a sensitivity of around 85%, variable in relation to the analyzed region, however its use does not suggest replacement of the well-established diagnostic methods of monitoring and detailed clinical follow-ups[4,10].

In this study, the group of tests used in the initial evaluation of trauma victims, together with a clinical examination, was able to diagnose any alterations, discarding therefore, any significant torso injury. Of the three "false negative" patients, two had abdominal pain during observation and one had a traumatic abdominal tattoo that suggested a biomechanical high energy trauma, which led to a request for additional tomography.

Another important point of this discussion is the lack of infrastructure in Brazil in relation to the establishment of trauma centers and the large volume of trauma patients attended in Brazilian institutions. In this context, there are strategic benefits to conventional imaging. Among them are reduced costs, fewer skilled professionals and the ease of access to tests in smaller centers, thereby putting them to better use and reducing the burden on major centers. In

addition, lower doses of radiation should be considered, especially in children and the young. Although there are no Brazilian data on the subject, it is estimated that, in the United States, between 1.5 and 2% of all diagnosed neoplasms are related to hospital radiation use[5]. Such data is relevant to this discussion, since full-body CT scans generate a radiation dose of 10-30mSv[6,8,11-15], which is up to 1,000 times greater than that of a PA chest X-ray, whose estimated dose is 0.01mSv[16]. Thus, a study which can demonstrate the safety of conventional tests, compared to full-body CT scans, can contribute greatly in improving the logistics of referrals to large Brazilian trauma centers[17,18]. Many recent articles describe the benefits of full-body CT scans, however few compare this strategy with conventional imaging, or selective tomography[4]. Thus, little is known about the comparison of these methods and more studies are needed to show that full-body CT is a more effective procedure during the initial evaluation of trauma victims. In this publication, there were no disadvantages apparently with the use of X-rays and fast exams.

Criticisms of this study are based on the lack of homogeneity within the approach in relation to diagnosinga requested image, and the fact that not all patients were examined, which can taint the study. Regarding the lack of homogeneity with the diagnoses, it should benoted that this fault is explained by the extensive knowledge within the institution of the trauma causes. Despite the criticisms, it is clear from above, that the use of pelvic and chest X-rays, in addition to FAST and clinical examinations, are still effective tools and must be encouraged in the initial approach to treating trauma patients. In our study, no patient had significant unnoticed injuries, using said methods for an initial evaluation.

It is concluded that CT can be used selectively in cases of altered clinical examinations or when the patient shows alterations in these requested examinations. A full-body CT scan therefore need not be used for an initial diagnosis for all polytrauma patients, which is in tune with Brazilian reality, the reality of a developing country which is seeking to reduce medical costs wherever possible.

This is a pilot study for investigation and the improvement of hospital service. It presents a reliable and applicable option for other Brazilian trauma centers.

R E S U M O

Objetivo*: avaliar a efetividade do uso da radiografia de tórax (RxT), pelve (RxP) e FAST (*Focused Abdominal Sonography on Trauma*) em excluir lesões significativas do tronco no trauma contuso.* ***Métodos****: estudo prospectivo envolvendo 74 pacientes no período de outubro de 2013 a fevereiro de 2014 que fizeram, durante a avaliação inicial, os três exames (RxT, RxP e FAST). Os resultados destes exames foram comparados à tomografia de tronco do mesmo paciente ou com a sua evolução clínica com base no tempo de observação protocolado pelo hospital. Todos os pacientes foram atendidos no Hospital João XXIII, Belo Horizonte/MG, Brasil.* ***Resultados****: Dos 74 pacientes estudados, a média de idade foi 33 anos, RTS: 6,98, Escala de Coma de Glasgow (ECG): 12. Desses, 44 (59,45%) possuíram os exames (radiografias e FAST) sem alterações, porém três pacientes desse grupo apresentaram lesões importantes (duas lesões esplênicas e uma hepática) suspeitadas através do acompanhamento clínico e definidas pela tomografia posterior. O restante dos pacientes, 30 (40,55%), tiveram pelo menos uma alteração nos exames convencionais, sendo que, dentro desse grupo, 27 (90%) apresentaram lesões significativas e três (10%) lesões leves. A sensibilidade do conjunto dos três exames para triagem de lesões significativas foi 90% e sua especificidade, 93%. O valor preditivo negativo encontrado foi 93% e o valor preditivo positivo, de 89%.* ***Conclusão****: O estudo demonstrou que o conjunto dos três exames (radiografia de tórax, pelve e FAST) é seguro para conduzir o trauma contuso do tronco, se for bem utilizado, associado ao exame clínico.*

Descritores: *Exames Médicos. Trauma. Tronco. Avaliação. Avaliação de Danos.*

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Associated factors to empyema in post-traumatic hemotorax

Fatores associados ao empiema em pacientes com hemotórax retido pós-traumático

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A B S T R A C T

Objective: to analyze the associated factors with empyema in patients with post-traumatic retained hemothorax. **Methods**: prospective observational study. Data were collected in patients undergoing PD during emergency duty. Variables analyzed were age, sex, mechanism of injury, side of the chest injury, intrathoracic complications of RH, laparotomy, specific injuries, rib fractures, trauma scores, days to diagnosis, diagnostic method of RH, primary indication of PD, initial volume drained, length of the first tube removal, surgical procedure. Cumulative incidence of empyema, pneumonia and pulmonary contusion and the proportion of patients with empyema or without empyema in each category of each variable analyzed were obtained. **Results:** the cumulative incidence of PD among trauma patients was 1.83% and the RH among those with PD was 10.63%. There were 20 cases of empyema (32.8%). Most were male in the age from 20 to 29, victims of injury by firearm on the left side of the thorax. The incidence of empyema in patients with injury by firearms was lower compared to those with stab wound or blunt trauma; higher among those with drained volume between 300 and 599 ml. The median hospital lenght of stay was higher among those with empyema. **Conclusion:** the incidence of PD was 1.83% and RH was 10.63%, these results are consistent with the low severity of the patients involved in this study and consistent with the literature. The incidence of empyema proved to be negatively associated with the occurrence of injury by firearms and positively associated with a drained volume between 300 and 599 ml, compared with lower or higher volumes.

Key words: Empyema. Thoracic Injuries. Thorax. Drainage. Hemothorax.

INTRODUCTION

Thoracic trauma is the main cause of mortality in all age groups. This type of trauma has increased around the world[1]. Thoracic injuries are still the second leading cause of mortality due to trauma, corresponding to 20% to 25% of deaths[2,3]. Blunt trauma due to automobile accidents corresponds to 70% to 80% of all thoracic injuries in the United States[2,4] and deaths occur in 25% of the cases[3]. When the mechanism of injury is penetrating, only 40% of the cases are chest injuries[2-4].

Most of the traumatic thoracic injuries are treated with pleural drainage (PD), a simple procedure performed by the physician during the initial care approach[2]. When the diagnosis is hemothorax, 85% to 90% are satisfactorily treated by PD without complications[5]. The permanence of the drain is determined by lung expansion, which in ideal conditions of treatment, usually occurs in the early days after drainage[5]. Fluid accumulation in the pleural cavity, sometimes, can be identified on imaging, after removing the drain or even when the drain remains in place.This finding has been recognized as residual or retained hemothorax (RH). However, this definition is still not uniform in the medical literature[6].

Less invasive procedures have been early indicated for treatment of RH[7-12] . The main goal of the early treatment is to avoid the RH progression to other complications, especially to empyema, one of the most severe complication which frequently requires a complex approach for treatment[5,12,13]. The RH is the main predisposing factor for post-traumatic empyema and the incidence varies from 4% to 20%[5,7,13,14].

The phase of the empyema determines the treatment's modality. Less invasive treatments can be indicated for the earliest phase. The purulent phase is the most complicated and usually requires Eloesser's pleurostomy[15,16]. Other recommended treatment modalities range from conservative treatment, involving only observation, to guided thoracic puncture, redrainage, intrapleural injection of fibrinolytic agents, thoracoscopy (VATS) and thoracotomy with pulmonar decortication[5,8,17]. After these treatments the prognosis of the empyema tends

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to be better because they are performed in exudative and fibrinopurulent stage. However, in the purulent stage, thoracoscopy and open pulmonary decortication have less chance of success.

The literature also highlights selected factors associated with the presence of empyema such as age, mechanisms of trauma (blunt or penetrating), side of the thoracic injury, exploratory laparotomy, severity of the patient, time and the RH diagnostic method, primary indication for PD, drained volume, permanence of the drain, need of redrainage, length of stay and surgical procedures[18,19]. It is generally agreed that aseptic techniques of PD and complete evacuation of RH are necessary to avoid complications. According to the clinical situation and appearance of the effusion on radiography or computed tomography, RH can be observed after drainage, depending of the pleural absorptive capacity[8,17,20,21].

Over a period of three years, this study analyzes the associated factors with empyema in patients with post-traumatic RH in one reference hospital for trauma in Belo Horizonte, Minas Gerais.

METHODS

This is an observational prospective study of patients admitted in the Risoleta Tolentino Neves (HRTN) Hospital. This work was approved by the Hospital Research Center's Board (Protocol number 01/2012).

Data were collected from 21 November 2009 to 07 March 2013 and stored in particular data collection form. All patients underwent to pleural drainage in the HRTN by the trauma team during emergency duty. The PD was held in water seal in the operating room or the emergency room, according to hospital protocol.

For the total number of trauma care in the period of the study an estimate was made based on the information generated by the MV2000®, management software and electronic registration records. For the number of PD, the Collector®, trauma registry software HRTN, deployed since 2009, provided information for the years 2011, 2012 and 2013. Further information about the Collector® are available in the literature[22]. It was considered that the average monthly drainage from January 2011 to March 2013 could be extrapolated for the months of November 2009 to December 2011.

The study included multiple patients victims of blunt or penetrating trauma diagnosed with RH; with hemodynamic stability at admission; Revised Trauma Score (RTS) greater than seven and Injurity Severity Score (ISS) less than 25. Patients aged less than 15 years and those who died due to related injuries, without the possibility of monitoring were excluded. Patients submitted to PD who did not develop RH also did not take part of this study, as well as those with empyema not related to RH. The imaging methods were radiography and computed tomography scan.

To calculate the sample size, the percentage found in the literature equal to 26.8% was used as a starting point relative to patients with retained hemothorax that developed empyema[17]. Since August 2012 the use of antibiotics has been routinely used in all patients with hemothorax in our institution, then we decided to use a lower percentage (20%) of cases. Thus, there was obtained a sample of 61 patients, given a margin of error of 10% and 95% of confidence level.

The variables analyzed were: age (continuous in years and stratified in 15- 20; 20-29; 30-39; 40 and over 40); gender; mechanism of injury (blunt trauma, stab wound, injury by firearm); the side of the thoracic injury (right, left, right and left); intrathoracic complications associated with RH (empyema, pneumonia, other); laparotomy (yes, no); specific lesions (extrathoracic complications; diaphragm injury, other injuries); fracture of the ribs (number of fractures count); trauma indices (RTS, ISS; TRISS - Trauma and Injury Severity Score); time in days to diagnosis (continuous); diagnostic method of HR (radiography, computed tomography scan); primary indication for PD (hemopneumothorax; pneumothorax, hemothorax); drained initial volume (less than 300ml, 300-599 ml, 600ml or higher); days of the first tube removal (continuous); surgical procedure (yes/no, based on the following inclusion criteria: thoracotomy, thoracoscopy, pleurostomy and decortication).

The cumulative incidence of empyema, pneumonia and pulmonary contusion among patients with RH was obtained in the study period. Then it was calculated the proportion of patients who developed or not empyema in each category of each variable analyzed. Afterwards the association of each variable with empyema was evaluated.

Pearson's chi-square was used for comparison of categorical data and Fisher's exact when $n< 5$. The Mann-Whitney test (nonparametric test to compare median) was used to compare the count or continuous variables. Mean was not used in any of the count or continuous variables, once the distributions of these variables after been evaluated by Shapiro-Wilk test for skewness and kurtosis did not reveal normality in a level of significance of 5%. The significance level for analysis of associations and difference in medians was 5%.

RESULTS

Of 31.406 patients seen between November 2009 and March 2013 on HRTN, there were 574 thoracic drainages, of which 61 developed into HR.

The cumulative incidence of PD among patients victims of trauma was 1.83% (574/31.406) and the RH among those with pleural drainage was 10.63% (61/574). Thirty three infectious pleuropulmonary complications were observed in 24 patients. There were 20 cases of empyema,

ten cases of pneumonia, and three cases of infected lung injury, corresponding to 32.8%; 16.4% and 4.9% respectively, in the 61 patients with RH.

The median age of the patients was 30 years, most were male between 20 and 29 years old, victims of firearms injuries on the right side of the thorax. Laparotomy was performed in seven patients. Diaphragm injury occurred in 10 patients and extrathoracic complications in 32. The median for RTS was 7.84, ISS 9.0 and TRISS 0.99. The median time for the diagnosis of HR was four days, ranging from 1 to 38 days. Radiography was the most commonly diagnostic method and hemopneumothorax occurred in 39 patients. The initial volume drained ranged from 300ml to 599ml in 35 patients. The median time to remove the first thoracic drain was five days, ranging from zero to 19 days. The median hospital lengh of stay was 10 days, ranging from two to 42 days. Observation, without major surgical procedure (only the initial drainage), was performed in 38 patients (Table 1).

When the stratification of the sample was made by the presence of empyema, there was a higher incidence for: age above 39 years; men; stab wound; injury on the left side of the thorax; patients with extrathoracic complications; patients who did radiography; hemothorax as primary indication for drainage; initial volume drained from 300 to 599 ml and those submitted to surgical procedure (Table 2).

The incidence of empyema in patients with injury by firearm was significantly lower compared to those with stab wound or blunt trauma (p=0.008); It was higher among those with volume drained between 300 and 599 ml compared to those with lower or higher volume (p=0.030). The median hospital length of stay was significantly higher among those with empyema compared to those without empyema (p=0.001).

DISCUSSION

This study addressed the evolution of post-traumatic RH in 61 patients among the 574 patients with PD between 2009 and 2013. The cumulative 10.5% incidence of RH was consistent with other reports in the literature, where the incidence ranges from 4% to 20%[7,9,17].

The trauma indices were consistent with low severity of the patients. Twenty-four patients had intrathoracic infectious pleuropulmonary complications resulting from RH - empyema, pneumonia and infected lung injury. Previous studies indicate incidences ranging from 3% to 27% for these complicações[11,14,23,24]. In this work the incidence was 32.8%, 16.4%, and 4.9% for empyema, pneumonia and infected pulmonary contusion, respectively. Empyema demands surgical treatment in some cases, being one intrathoracic complication with serious damage for patients[19].

Patients with penetrating trauma by firearms had significantly lower risk of empyema compared to those with penetrating trauma with knives and blunt trauma. The literature tends to high quote the penetrating mechanism as a risk factor for empyema, but this is controversial and the reasons are not objectively clarified[3,4,12,16]. Another study in Brazil has found similar results to this work regarding the incidence of empyema according to the mechanism of trauma[19]. In this work, the finding may be explained by the patient's age effect, once among the 33 patients with penetrating trauma by firearms, only two were older than 40 years (6%), as opposed to 13 among the remaining 28 with penetrating trauma by knife or blunt trauma (46.4%) (data not shown). This fact means that, in the present study, patients with different trauma of those by firearms were older, with higher incidence of empyema (compared to the other age groups) among those over 40 years. Age is a risk factor in post-traumatic pleural empyema, because elderly patients have less cardiovascular and respiratory physiological reserves and more associated chronic diseases with propensity to retain pulmonar secretions[19]. There was a higher incidence of empyema when the injury was on the left side of the thorax, but without statistical significance. Evidence indicates that the rib fractures on the left side would be more associated with empyema[8,12,17], corroborating with the findings of this study.

The diagnostic method most used for RH was radiography, performed in 53 patients (86.9% of total), held on the occasion of the chest tube removal. Perhaps this is the reason for underestimated diagnosis of RH and empyema, considering that CT scan was used to study the characteristics of the collection only after this one be seen on radiography, or during the initial phase of the trauma care. Another interesting factor is that chest radiography, in some cases of trauma, consists only of the anteroposterior position, a fact that reduces the possibility of diagnosis of small amounts of liquid which is better seen in the lateral view. If the CT scan had been used in all patients, certainly the amount of fluid in the pleural cavity would be higher, since it is known that CT is an excellent imaging method for rapid diagnosis, especially for evaluation of hemodynamically stable patients with blunt abdominal trauma[25]. However, even if the number of complications due to the RH had been underestimated in this study, the routinely use of CT scan would be unthinkable due to financial cost and the radiation risk. Another form of reasoning would be think that, if there is no presentation on plain thoracic radiography, there is no clinical manifestation and, consequently, no complication.

The primary indication for drainage was hemopneumothorax in 39 patients (65.0%) corroborating previous findings[12]. Patients with hemothorax had a higher incidence of empyema (38.9%) than those with isolated pneumothorax (33.3%) or hemopneumothorax (30.8%), which is quite reasonable since, in the former case, the risk to develop empyema is increased when blood accumulates in the pleural cavity, working as a culture medium for bacteria.

Table 1 – Description of the patients with RH.

Variables	Total (n=61; 100.0%)	
Age		
Median (IIQ)	30	(22; 38)
(Min-Max)		(15; 73)
Age (groups) (n; %)		
< 20	11	(18.0)
20-29	19	(31.0)
30-39	16	(26.2)
≥ 40	15	(24.6)
Gender (n; %)		
Male	57	(93.4)
Female	4	(6.6)
Mechanism of trauma		
Blunt	17	(27.9)
Stab wound	11	(18.0)
Injury by firearm	33	(54.1)
Side of the injury (n; %)		
Right	32	(52.5)
Left	26	(42.6)
Right and Left	3	(4.9)
Laparatomy (n; %)		
Yes	7	(11.5)
No	54	(88.5)
Specific injuries (n; %)		
Extrathoracic complications	18	(29.5)
Diaphragm injury	10	(16.4)
Other injuries	25	(41.0)
Rib fractures		
Median (IIQ)	0	(0;2)
(min-Max)		(0; 11)
Index of trauma		
RTS		
Median (IIQ)	7.84	(7.84-7.84)
(Min-Max)		(4.09-7.85)
ISS		
Median (IIQ)	9	(9-16)
(Min-Max)		(4-32)
TRISS		
Median (IIQ)	0.99	(0.98-0.99)
(Min-Max)		(0.72-0.998)
Time until the HR diagnosis (days)		
Median (IIQ)	4	(2; 6)
Min-Max		(1; 38)
Method of diagnosis (n; %)		
Radiography	53	(86.9)
ComputedTomography Scan	8	(13.1)
Diagnosis (n; %)		
Hemopneumothorax	39	(57.4)
Pneumothorax	3	(4.9)
Hemothorax	18	(29.5)
Initial drained volume (n; %)		
<300 ml	7	(11.5)
300 ml to 599 ml	35	(57.4)
≥ 600 ml	12	(19.7)
Length of the first drain (days) (n; %)		
Median (IIQ)	5	(4; 7)
Min-Max		(0; 19)
Hospital Length of stay (n; %)		
Median (IIQ)	10	(6; 19)
Min-Max		(2; 42)
Surgical Treatment (n; %)		
Yes	16	(26.2)
No. with redrainage	7	(11.5)
No. only observation	38	(62.3)

Source: HRTN (2009-2013)

Table 2 - Empyema incidence in patients with RH.

Variable	Total (n=61; 100%)		Empyema (+) (n=20; 32,8%)		Empyema (-) (n=41; 67,2%)		p
Age							
Median (IIQ)	30	(22; 38)	30	(21; 43)	30	(22; 38)	0.994(*)
(Min-Max)		(15; 73)		(15; 59)		(15; 73)	
Age groups							
< 20	100.0%	(11/11)	36.4%	(4/11)	63.6%	(7/11)	0.999(ä)
20-29	100.0%	(19/19)	31.6%	(6/19)	68.4%	(13/19)	0.568(ξ)
30-39	100.0%	(16/16)	18.8%	(3/16)	81.3%	(13/16)	0.222(ä)
≥ 40	100.0%	(15/15)	46.7%	(7/15)	53.3%	(8/15)	0.187(ξ)
Gender							
Male	100.0%	(57/57)	33.3%	(19/57)	66.7%	(38/57)	0.999(ä)
Female	100.0%	(4/4)	25.0%	(1/4)	75.0%	(3/4)	
Mechanism of trauma							
Blunt	100.0%	(17/17)	47.1%	(8/17)	52.9%	(9/17)	0.140(ξ)
Stab wound	100.0%	(11/11)	54.5%	(6/11)	45.5%	(5/11)	0.090(ξ)
Injury by firearm	100.0%	(33/33)	18.2%	(6/33)	81.8%	(27/33)	0.008(ξ)
Side of the injury							
Right	100.0%	(32/32)	31.3%	(10/32)	68.7%	(22/32)	0.788(ä)
Left	100.0%	(26/26)	38.5%	(10/26)	61.5%	(16/26)	0.416(ä)
Right and Left	100.0%	(3/3)	0.0%	(0/3)	100.0%	(3/3)	0.544(ξ)
Laparatomy							
Yes	100.0%	(7/7)	28.6%	(2/7)	71.4%	(5/7)	0.999(ξ)
No	100.0%	(54/54)					
Specific injuries							
Extrathoracic complications	100.0%	(18/18)	27.8%	(5/18)	72.2%	(13/18)	0.590(ä)
Diaphragm Injury	100.0%	(10/10)	10.0%	(2/10)	80.0%	(8/10)	0.355(ξ)
Outher injuries	100.0%	(25/25)	24.0%	(6/25)	76.0%	(19/25)	0.223(ä)
Rib fractures							
Median (IIQ)	0	(0;2)	0	(0;4)	0	(0;1)	0.223(*)
(min-Max)		(0; 11)		(0; 11)	(0; 9)		
Índex of trauma							
RTS							
Median (IIQ)	7.84	(7.84-7.84)	7.84	(7.84-7.84)	7.84	(7.55-7.84)	0.999(*)
(Min-Max)		(4.09-7.85)		(7.55-7.85)		(4.09-7.85)	
ISS							
Mediana (IIQ)	9	(9-16)	9	(9-17)	9	(9-16)	0.586(*)
(Min-Max)		(4-32)		(4-32)		(9-29)	
TRISS							
Median (IIQ)	0.99	(0.98-0.99)	0.99	(0.98-0.99)	0.99	(0.98-0.99)	0.570(*)
(Min-Max)		(0.72-0.998)		(0.95-0.998)		(0.72-0.998)	
Days until the diagnosis of RH							
Median (IIQ)	4	(2; 6)	5	(2;6)	4	(2;6)	0.478(*)
Min-Max		(1; 38)		(1; 10)		(1; 38)	
Methods of diagnosis							
Radiography	100.0%	(53/53)	34.0%	(18/53)	66.0%	(35/53)	0.622(ξ)
Computed Tomography	100.0%	(8/53)	25.0%	(2/8)	75.0%	(6/8)	
Diagnosis							
Hemopneumothorax	100.0%	(39/39)	30.8%	(12/39)	69.2%	(27/39)	0.655(ä)
Pneumothorax	100.0%	(3/3)	33.3%	(1/3)	66.7%	(2/3)	0.999(ξ)
Hemothorax	100.0%	(18/18)	38.9%	(7/18)	61.1%	(11/18)	0.515(ä)
Inicial drained volume							
<300 ml	100.0%	(7/7)	14.3%	(1/7)	85.7%	(6/7)	0.660(ξ)
300 ml a 599 ml	100.0%	(35/35)	40.0%	(14/35)	60.0%	(21/35)	0.030(ä)
≥ 600 ml	100.0%	(12/12)	8.3%	(1/12)	91.7%	(11/12)	0.084(ξ)
Length of the first drain (days)							
Median (IIQ)	5	(4; 7)	6	(4;8)	5	(4;7)	
Min-Max		(0; 19)		(4; 19)		(0; 10)	0.563(*)
Hospital length of stay (days)							
Median (IIQ)	10	(6; 19)	19	(12;23)	8	(6;12)	0.001(*)
Min-Max		(2; 42)		(5; 35)		(2; 42)	
Surgical treatment							
Yes	100.0%	(16/16)	43.8%	(7/16)	56.3%	(9/16)	0.277(ä)
No. with redrainage	100.0%	(7/7)	42.8%	(3/7)	57.2%	(4/7)	0.416(ξ)
No. only observation	100.0%	(38/38)	26.3%	(10/38)	73.6%	(28/38)	0.166(ä)

Source:HRTN (2009-2013)
Notes: (*) Mann-Whitney test,(ä) Fisher's exact test, (î) Pearson Chi-Square test.

Regarding the initial volume drained, it seems reasonable and believable that the amount of blood at the first pleural drainage leads to the complications of RH and empyema, because liquid in high quantity in the peural cavity can accumulate instead to be drained. On the other hand, the increased liquid volume in the pleural cavity could also increase the drainage rate and thereby dragging the entire fluid to the drain, decreasing the amount of blood. Furthermore, the high drained volume may mean more severe trauma, meaning in fact, a greater number of associated lesions and increased risk of complications. The finding in this study is that the higher incidence of empyema occurred when the drained volumes ranged from 300-599 mL, in addition of being the most commonly drained volume. It seems that this volume can be key reference for predicting complications such as empyema.

The median times, minimum and maximum stay of the drain were higher among patients with empyema, although not statistically significant. Empyema associated to longer time is expected, once the incidence of infection is increased after 72 hours of the drain insertion in the pleural cavity[19]. But the length of hospital stay was significantly higher among patients who developed empyema, which is predictable because, in the presence of complication, the patients have more suffering, besides an extended hospital staying and also, more costs to the patients, hospital and society itself.

Nearly two-thirds of the patients did not undergo any surgical procedure. Previous findings indicate success around 80% for observation of the RH[8,12,17,20]. In this study the lowest incidence of empyema was associated with observation (26.3% *versus* 42.8% for redrenaige and 43.8% for surgical approach).

Among those without empyema, the difference among the three groups occurred in the mean of the hospital length of stay, having been progressively greater for those with surgery, followed by patients with redrainage, and finally to those without operation (results not shown). This could be explained by the attempt of frustrated nonoperative approach, plus the postoperative period. These features with hospitalized patients could be allocated to other situations if prevention of RH had been done, and consequently reduction of empyema.

The small number of patients who developed empyema, irregular use of prophylaxis for other associated injuries, antibiotic treatment for other conditions may have influenced our results. Perhaps in the last one lies the biggest limitation of this study, which is the inability to evaluate the effect of antibiotic prophylaxis, once this one started to be routinely used after the start of the present study. Still, it draws attention to the high incidence of empyema, which could even be underestimated. Ultrasound was also not evaluated. Another interesting aspect would have been assessed the incidence of different complications for drainage in the operating room or in the emergency room. There was one single patient drained in the emergency room and this one had pneumonia and empyema. However, because only one case was done in this situation, it was not possible to establish the existence of any association between the occurrence of empyema and pleuropulmonary complication.

Little is known about the RH. Not long time ago, the rule for treatment of RH was conservative approach, and surgery was the exception. Lately, with the incorporation of new technologies, with low morbidity, it seems that the craving for surgical approach have been raised only to sort out problems in short time. Regarding the treatment of the diseases, morbidity and mortality must be considered according the risks to the patients. A proper recognition of the entity RH can clarify the need or not of surgical approach. Thus, future studies still need to be done.

The conclusions of this study are: the incidence of PD was 1.83% and RH was 10.63%, these results are consistent with the low severity of the patients involved in this study and consistent with the literature. The incidence of empyema proved to be negatively associated with the occurrence of injury by firearms and positively associated with a drained volume between 300 and 599 ml, compared with lower or higher volumes.

R E S U M O

Objetivo: *analisar os fatores associados ao empiema em pacientes com hemotórax retido pós-traumático.* ***Métodos****: estudo prospectivo observacional. Os dados foram coletados de pacientes submetidos à drenagem pleural de emergência. Foram analisadas: idade, sexo, mecanismo de trauma, lado da lesão torácica, complicações intratorácicas decorrentes do hemotórax retido, laparotomia, lesões específicas, fratura de arcos costais, índices de trauma, dias até o diagnóstico, método diagnóstico do HR, indicação primária da drenagem pleural, volume inicial drenado, dias de permanência do primeiro dreno, procedimento cirúrgico. Obteve-se a incidencia acumulada de empiema, pneumonia e contusão pulmonar e a incidência de empiema em cada categoria das variaìveis analisadas.* ***Resultados****: a incidência acumulada de drenagem pleural por trauma foi 1,83% e a de hemotórax retido entre aqueles com derrame pleural foi de 10,63%. Houve 20 casos de empiema (32,8%). A maioria tinha entre 20 e 29 anos, era do sexo masculino e sofreu ferimento por arma de fogo. A incidência de empiema entre pacientes com ferimento por arma de fogo foi inferior aos demais mecanismos; superior entre aqueles com volume drenado entre 300 e 599 ml. O tempo mediano de permanência hospitalar foi maior nos pacientes com empiema.* ***Conclusão****: as incidências de derrame pleural e hemotórax retido entre aqueles com DP nessa amostra de baixa gravidade dos pacientes foram, respectivamente, 1,83% e 10,63%. A incidência de empiema revelou-se negativamente associada à ocorrência de ferimento por arma de fogo e positivamente associada a volume drenado entre 300 e 599 ml, bem como, ao tempo mediano de permanência hospitalar.*

Descritores: *Empiema. Traumatismos Torácicos. Tórax. Drenagens. Hemotórax.*

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The impact of a chest tube management protocol on the outcome of trauma patients with tube thoracostomy

Impacto de um protocolo de cuidados a pacientes com trauma torácico drenado

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A B S T R A C T

Objective: to investigate the effect of standardized interventions in the management of tube thoracostomy patients and to assess the independent effect of each intervention. **Methods:** A chest tube management protocol was assessed in a retrospective cohort study. The tube thoracostomy protocol (TTP) was implemented in August 2012, and consisted of: antimicrobial prophylaxis, chest tube insertion in the operating room (OR), admission post chest tube thoracostomy (CTT) in a hospital floor separate from the emergency department (ED), and daily respiratory therapy (RT) sessions post-CTT. The inclusion criteria were, hemodynamic stability, patients between the ages of 15 and 59 years, and injury severity score (ISS) < 17. All patients had isolated injuries to the chest wall, lung, and pleura. During the study period 92 patients were managed according to the standardized protocol. The outcomes of those patients were compared to 99 patients treated before the TTP. Multivariate logistic regression analysis was performed to assess the independent effect of each variable of the protocol on selected outcomes. **Results:** Demographics, injury severity, and trauma mechanisms were similar among the groups. As expected, protocol compliance increased after the implementation of the TTP. There was a significant reduction (p<0.05) in the incidence of retained hemothoraces, empyemas, pneumonias, surgical site infections, post-procedural complications, hospital length of stay, and number of chest tube days. Respiratory therapy was independently linked to significant reduction (p<0.05) in the incidence of seven out of eight undesired outcomes after CTT. Antimicrobial prophylaxis was linked to a significant decrease (p<0.05) in retained hemothoraces, despite no significant (p<0.10) reductions in empyema and surgical site infections. Conversely, OR chest tube insertion was associated with significant (p<0.05) reduction of both complications, and also significantly decreased the incidence of pneumonias. **Conclusion:** Implementation of a TTP effectively reduced complications after CTT in trauma patients.

Key words: Traumatology. Thoracic Injuries. Physical Therapy Specialty. Empyema, Pleural. Thoracostomy.

INTRODUCTION

Trauma has a staggering effect in society given that this disease afflicts patients during their most productive years. The World Heath Organization considers trauma a disease of the XXI century.[1] Trauma patients have prolonged hospital length of stay (LOS) and survivors frequently sustain incapacitating injuries. Traumatic injuries are the third most common cause of death in Brazil, adding up to 150,000 deaths a year, and three times as many permanently disabled patients.[2]

It is estimated that in 2011 more than 112,000 patients between the ages of 15 and 59 years-old died from external causes in Brazil. Making trauma, the most common cause of death among patients between 5 and 39 year-old since 1980. Moreover, it is known that trauma is one of the most important causes of potential years of life lost by premature death; three times greater than cardiovascular disease.[1,3] Hence it is extremely important to implement management changes that could reduce morbidity and mortality in trauma patients. Quality improvement strategies to enhance trauma care through best practice guidelines are important tools towards that goal. Those strategies originate from retrospective data analysis and provide risk adjusted information that allows hospitals to evaluate their performance relative to other centers. Thus, contributing to improvement in patient care.[1,4,5] Trauma registries are also important source of data that can be used to improve the quality of care of injured patients. Moreover, those registries provide information for scientific research and resource management in trauma centers.[5] This is particularly important in injuries associated with high mortality rates.

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Thoracic injuries are responsible for approximately 20 to 25% of all trauma deaths. Those injuries are also linked to high complication rates. The incidence of empyema in patients with thoracic trauma can be as high as 27%.[6,7,8] The majority of those cases are associated with chest tube thoracostomy (CTT). Moreover, the complication rate in thoracic trauma is also determined by injuries remote from the chest. Our group recently showed that the incidence of empyema was 19% higher in patients who underwent trauma laparotomy in conjunction with CTT, compared to patients who underwent CTT alone.[9]

The present study was designed to investigate the effect of standardized interventions in the management of tube thoracostomy patients and to assess the independent effect of each intervention.

METHODS

The impact of the tube thoracostomy protocol (TTP) was assessed in a retrospective cohort study from January 1, 2011 to December 31, 2013. Data for the study was obtained from the hospital's trauma registry (Collector®). This study was approved by the research ethics committee of the "Hospital Risoleta Tolentino Neves" (protocol 3/201) and by the research ethics committee of the Universidade Federal Minas Gerais (UFMG), Brazil (CAAE 39504714.3.0000.5149). It was carried out at a 360-bed public/academic high volume trauma center affiliated with the UFMG.

The TTP began in August 2012 wherein all patients were triaged according to the Manchester[10] triage system and were initially assessed in the ER. Once the need for CTT was confirmed, patients were taken to the operating room for the procedure. Contrarily, chest tube insertion in the ER was the norm before the implementation of the TTP. The protocol also called for antimicrobial prophylaxis (cefazolin 1g) immediately before chest tube insertion. Chest tube was inserted in order to comply with the Advanced Trauma Life Support (ATLS®) guidelines. Transfer of patients who underwent CTT to a hospital floor or to the intensive care unit was considered a priority in the TTP. In contrast, before the protocol, CTT patients frequently waited for long periods in the ED before being transferred to a hospital floor bed. Patients managed according to the protocol received at least two sessions of respiratory therapy a day. In contrast, that intervention was infrequent before the implementation of the protocol. All CTT patients were seen in follow up visits within 30 days of the hospital discharge date.

Patients were distributed between two groups (A1 and A2). Group A1 comprised chest trauma patients treated before the implementation of the TTP. Group A2 patients were managed according to the TTP. Thoracic traumas were both blunt and penetrating. The latter included gunshot mechanism and stab wounds.

The inclusion criteria were hemodynamically stable trauma patients (systolic arterial pressure e" 90mmHg), between the ages of 15 and 59 years who underwent CTT within the first 24h after injury. The injury severity scores (ISS) were < 16, the revised trauma scores (RTS) were > 6, and the trauma and injury severity score (TRISS) > 0.99. Chest tube insertion was in keeping with the Advanced Trauma Life Support (ATLS®) guidelines.

Patients with co-morbidities (diabetes, chronic renal failure, chronic liver failure) and those who underwent a surgical procedure within 24 hours preceding or following the first CTT were excluded from the study. Any patient who received antibiotic prophylaxis for reasons other than CTT was also excluded.

Statistical analysis was performed with univariate analysis of the medians of continuous variables in the two groups was performed using the non-parametric Mann Whitney test. Categorical variables were analyzed with the Chi-Square test or Fisher's exact. Results are reported as proportions, medians and interquartile range. Multivariate logistic binary regression analysis was performed to determine the independent effect of each protocol variable on the outcome. Lastly, the phenomenon of complete separation was also addressed in the statistical analysis[11]. An estimated model was produced for each outcome by the inclusion of all the items of the protocol obtaining adjusted odds ratios with confidence interval of 95% (IC 95%), and p values < 0.05 were considered statistically significant. Whereas, p values < 0.10 or > 0.05 were described as a trend towards significance[12].

RESULTS

A total of 191 patients were included in the study, 92 were managed in accordance with the TTP (Group A2), whereas 99 patients were treated before the implementation of the protocol (Group A1). A total of 305 patients did not meet the inclusion criteria, thus were excluded from the study. There were no statistically significant differences between groups A1 and A2 with respect to demographic data, ISS, and trauma mechanisms (Table 1).

Implementation of the protocol was successful as shown by the increase of all components of the protocol in group A2 compared to group A1 (Table 2); respectively (respiratory therapy 96.7% vs. 1%), operating room chest tube insertion (75% vs. 59.6%), usage of prophylactic antimicrobial (54.3% vs. 31.3%). Moreover, there was a significant decrease in the number of patients who spent more than 24 hours in the ED in group A2 compared to group A1 (16.3% vs. 43.4%).

Furthermore, 45% of the patients in group A2 were managed according to at least four of the five protocol components. Only 18.7% of the patients were managed with 2 or less components of the protocol. (Table 3)

The only outcome that did not show a statistically significant improvement with the implementation of the TTP (group A2) was the need for a new surgical procedure, i.e, thoracotomy, thoracoscopy, and insertion of a new or an additional chest tube (Table 4). Furthermore, the median hospital length of stay and the number of chest tube days (median) also reduced significantly in group A2 compared to group A1.

The independent effects of each component of the protocol on selected outcomes are shown in table 5. The need for a new surgical procedure was not associated with any protocol component. However, results demonstrated an unequivocal effect of respiratory therapy twice a day (group A2) in the improvement of the selected outcomes. As shown by a 79% decrease in retained hemothoraces in group A2 compared to group A1 (OR=0.21; $p < 0.01$). Insertion of the chest tube in the operating room resulted in a statistically significant decrease in the incidence of empyemas (OR=0.33), pneumonias (OR=18), and surgical site infections (OR=0.17). Interestingly, prophylactic antimicrobials showed only a trend in reducing the rates of empyemas and surgical site infections ($p < 0.10$) after chest tube insertion.

DISCUSSION

Our findings showed that the protocol described herein resulted in significant improvement in the management of patients who underwent chest tube thoracostomy. This study also underscored the importance of the trauma registry. Given that the data obtained from the registry served, not only, to demonstrated the problem but also provided means to develop the protocol and to verify the results[4].

Our study showed that the components of the protocol could be implemented in a high volume trauma center of a public health system. The results demonstrated that the protocol led to a reduction in the incidence of several complications frequently seen in patients who undergo CTT for trauma. Most importantly, retained hemothoraces, empyema, pneumonia and surgical site infection. Furthermore, the protocol also led to other improvements in patient care, such as, decrease hospital LOS, decrease in the number of chest tube days, and a reduction in complications detected during follow-up visits. For the most part, the aforementioned findings could help improve patient flow within the hospital and resource

Table 1 – Gender, age, *Injury Severity Score*, trauma mechanisms. Total, Group A1, Group A2.

	Total (n=191; 100%)	Group A1 (n=99; 100%)	Group A2 (n=92; 100%)	p
Gender Male (n;%)	179 (93.7%)	93 (94.0%)	86 (93.5%)	0.896
Age (median; IIQ)	28 (21; 38)	28 (21; 37)	28 (21; 39)	0.508
ISS (median; IIQ)	9 (9; 9)	9 (9; 10)	9 (9; 9)	0.594
Trauma mechanism (n;%)				
— Gunshot wound	89 (46.6%)	52 (52.5%)	37 (40.2%)	0.214
— Stab wound	63 (33.0%)	28 (28.3%)	35 (38.0%)	
— Blunt	39 (20.4%)	19 (19.2%)	20 (21.7%)	

Source: Hospital Risoleta Tolentino Neves, MG (2011 – 2013).
Note: IIQ: Interquartile range; Chi square; Mann-Whitney test (significance set at p*<0.05)*

Table 2 – Hospital admission site, respiratory therapy, operating room chest tube insertion, prophylactic antimicrobial. Total, Group A1, Group A2.

	Total (n=191; 100%)	Group A1 (n=99; 100%)	Group A2 (n=92; 100%)	p
Hospital admission site (n;%)				
— ICU	7 (0.4%)	5 (5.1%)	2 (2.2%)	0.447
— Floor bed	184 (96.3%)	95 (96.0%)	89 (97.0%)	0.999
— Emergency Department >24h.	58 (30.4%)	43 (43.4%)	15 (16.3%)	<0.001
Respiratory therapy 2x day (n;%)	90 (47.1%)	1 (1.0%)	89 (96.7%)	<0.001
OR chest tube insertion (n;%)	128 (67.0%)	59 (59.6%)	69 (75.0%)	0.032
Prophylactic antimicrobial (n;%)	81 (42.4%)	31 (31.3%)	50 (54.3%)	0.001

Source: Hospital Risoleta Tolentino Neves, MG (2011 – 2013).
Chi square and Fisher's exact test

Table 3 – Compliance to protocol in Group A2.

Number of protocol components	n (%)
One	1 (1/92=1.1%)
Two	17 (17/92=18.7%)
Three	32 (32/92=34.7%)
Four ou Five	41 (41/92=44.5%)

Source: Hospital Risoleta Tolentino Neves, MG (2011 – 2013).

Table 4 – Intra-thoracic complications, surgical site infection, need for new operation, patients with complications detected in follow-up, hospital length of stay, chest tube length of stay. Group A1, Group A2.

	Group A1 (n=99; 100%)	Group A2 (n=92; 100%)	p
Intra-thoracic complications (n;%)			
— Retained hemothorax	31 (31.3%)	6 (6.5%)	<0.001
— Empyema	22 (22.2%)	2 (2.0%)	<0.001
— Pneumonia	11 (11.1%)	0 (0.0%)	<0.001
Surgical site infections (n;%)	10 (10.1%)	0 (0.0%)	0.002
New surgical procedure (n;%)	13 (13.1%)	9 (9.8%)	0.469
Complications detected in follow-up (n;%)	12 (12.1%)	3 (3.3%)	<0.001
Hospital length of stay (median; IIQ)	5 (7; 11)	4 (5; 8)	<0.001
Chest tube length of stay (median; IIQ)	4 (5; 7)	3 (4; 5)	<0.001

Source: Hospital Risoleta Tolentino Neves, MG (2011 – 2013).
Chi-square, Fisher's exact test, Man-Whitney test; new surgical procedure: thoracotomy, thoracoscopy, and insertion of a new or an additional chest tube.

Table 5 – Odds Ratio, Intra-thoracic complications, surgical site infection, patients with complications detected in follow-up, hospital length of stay, chest tube length of stay; multivariate analysis.

	Selected Outcomes OR (IC95%)						
Protocol variables linked to any selected outcome	Retained hemothorax	Empyema	Pneumonia	Surgical site infection	Complication detected in follow-up	Hospital LOS<6 days	Chest tube LOS<5 days
— Resp. Therapy	0.21*** (0.08-0.54)	0.11*** (0.03-0.44)	0.05** (0.03-0.90)	0.04** (0.002-0.73)	0.33*** (0.16-0.69)	0.46** (0.25-0.85)	0.26**** (0.14-0.48)
— Hospital admission site diferente from ED	1.23 (0.52-2.91)	0.52 (0.18-1.47)	0.55 (0.14-2.15)	0.22* (0.05-1.01)	1.11 (0.51-2.41)	1.95* (0.90-4.20)	1.27 (0.60-2.70)
— Chest tube insertion in the operating room	0.88 (0.37-2.06)	0.33** (0.12-0.91)	0.18** (0.04-0.75)	0.17** (0.04-0.72)	0.72 (0.34-1.53)	0.91 (0.44-1.89)	0.78 (0.38-1.60)
— Prophylactic antimicrobials	0.40** (0.17-0.94)	0.40* (0.14-1.14)	0.65 (0.17-2.49)	0.19* (0.03-1.16)	0.62 (0.31-1.25)	1.34 (0.72-2.49)	1.12 (0.60-2.10)

Source: Hospital Risoleta Tolentino Neves, MG (2011 – 2013).
p<0.10; p<0.05; *** p<0.01; **** p<0.001. LOS (length of stay), ED (emergency department). Statistical significance set at p<0.05.*

management in high volume trauma centers[13]. For instance, it became clear, after the beginning of the study that two additional respiratory therapists were needed to provide adequate care for CTT patients.

The implementation of the protocol involved the work of several health care professionals. Firstly, the institution's chief of trauma/acute care surgery had to endorse the plan and promote it amongst the staff surgeons,

residents, and interns. The trauma nurse coordinator was the cornerstone of the project, providing supervision to prevent protocol drift, maintaining protocol compliance, and collecting data. Secondly, the nursing staff of all hospital sectors involved with patient care, and the respiratory therapy team had to coordinate the execution of the protocol. An example of that coordination was the fact that daily respiratory therapy was practically inexistent before the implementation of the protocol, increasing from 1% to 97%. Previous studies have shown the importance of the respiratory therapist professional in the rehabilitation of chest trauma patients, particularly those who undergo CTT[14-18].

A major finding of the present study was that chest tube placement in the operating room was independently associated with a reduction in the incidence of major complications, such as empyema, pneumonia and surgical site infection compared to chest tube placement in the ED. Therefore, whenever possible, CTT should be performed in the operating room. Obviously, that is not the case in emergency situations.

Because chest tube placement is usually considered a minor procedure, keeping those patients in the ED was an acceptable practice in our institution.[19] However, our results showed that the disposition of CTT patients to appropriate hospital sectors could also contribute to reduce complications. Furthermore, despite the high volume of trauma in our institution, classifying CTT patients as priority facilitated the access of those patients to a floor bed. Thus, decreasing the time spent in the ED and reducing complications. In summary, we believe that the ED is an inappropriate setting for the management of CTT[20].

This study has several limitations. Most importantly, the lack of video-assisted thoracoscopy surgery (VATS) in our institution prevented us from assessing the role of this procedure. Video-assisted thoracoscopy surgery is considered a major tool in the treatment of patients who sustain traumatic chest injuries and their complications[20,21]. The lack of that tool in our institution could explain the absence of a significant difference in the need for a new surgical procedure between the groups. Moreover, we did not apply negative pressure to the underwater seal chest drainage systems. Therefore, the effect of that intervention was not investigated.

Another important limitation of the study was that before the implementation of the protocol (Group A1) only 1% of the patients underwent respiratory therapy. One should consider that low number when interpreting the similarities between the two groups. Nonetheless, our results showed that the demographic data, injury severity and trauma mechanisms were similar in the groups.

In our institution, the use of prophylactic antimicrobial in CTT was practiced prior to the beginning of the protocol. This could explain the lack of effect of that intervention on the reduction of empyemas and surgical site infections. However, compliance with that practice was only 31% in group A1. The implementation of the protocol resulted in a 20% increase in the use of prophylactic antimicrobial in CTT patients.

In summary, our findings showed that protocolized management of trauma patients who undergo CTT results in a significant reduction in chest complications. Moreover, the protocol described herein helped to improve patient flow and the management of resources in a high volume trauma center.

R E S U M O

Objetivo: *avaliar a implantação do Cuidado Padronizado com o Dreno de Tórax (CPDT) em um hospital público, referência para o trauma, e o impacto independente de cada um dos itens do protocolo no período do estudo sobre desfechos selecionados.* ***Métodos:*** *coorte retrospectiva avaliando implementação do Cuidado Padronizado para o Dreno de Tórax (CPDT). Foram incluídos pacientes entre 15 e 59 anos de idade, hemodinamicamente estáveis, com* Injury Severity Score *inferior a 17, com lesão isolada na parede do tórax, pulmão e pleura. Foram comparados 99 pacientes antes do CPDT com 92 depois do CPDT. Foi realizada comparação de desfechos selecionados por meio de diferença de proporções. A regressão logística multivariada foi feita para análise do efeito independente de cada variável do protocolo.* ***Resultados:*** *não houve diferença entre os grupos quanto às variáveis sociodemográficas, índice de gravidade e mecanismo de trauma. A implementação do CPDT resultou no aumento no percentual de todos os itens do protocolo. Houve redução significativa (p<0,05) de hemotórax retido, empiema, pneumonia, infecções de ferida operatória e nova operação, queda do percentual de pacientes retornados com complicações, tempo de internação e de permanência do dreno. A fisioterapia revelou-se independentemente associada à redução de sete dos oito desfechos (p<0,05). O antibiótico presuntivo revelou tendência de associação com a redução de empiema e de infecções de ferida operatória (p<0,10) e esteve associado à redução do hemotórax retido (p<0,05). A drenagem no centro cirúrgico esteve associada à redução de empiema, pneumonia e infecção de ferida operatória (p<0,05).* ***Conclusão****: a implementação do CPDT foi efetiva na redução de complicações de pacientes com dreno de tórax.*

Descritores: *Traumatologia. Traumatismos torácicos. Fisioterapia. Empiema Pleural. Toracostomia.*

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Isolated liver gunshot injuries: nonoperative management is feasible?

Lesão hepática isolada por arma de fogo: é possível realizar tratamento não operatório?

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A B S T R A C T

Objective: to evaluate the safety and effectiveness of non-operative management (NOM) of liver injury, being the only abdominal injury, from gunshot wounds to the abdomen. **Methods:** patients who had liver damage diagnosed as single abdominal injury caused by PAF in the right thoracoabdominal region, hemodynamically stable were studied. All underwent examination with computed tomography. Were analyzed: age, gender, levels of trauma, hemodynamic condition and the abdominal examination on admission, the results of the CT scan, the extra-abdominal lesions found, the serum levels of hemoglobin, clinical course, complications, length of hospital stay, outpatient treatment and death. **Results:** during the study period 169 patients, treated non-operatively, presented liver gunshot wounds. Of these, only 28 patients (16.6%) had liver injury as the only abdominal injury and consequently met the inclusion criteria for this study. The average age was 27.7 years and 25 patients (89.2%) were male. The overall average of verified trauma scores were: RTS 7.45, ISS 10.9, and TRISS 98.7%. The most frequent injuries were grade II and grade III (85.7%). Complications occurred in only one patient who presented a progressive decline in hemoglobin. He underwent a CT scan which showed blush in the liver parenchyma. An arteriography was performed, which showed a successfully embolized arteriovenous fistula. There were no deaths in the patient sample. The average hospital stay was 5.3 days. **Conclusion:** isolated hepatic injury in gunshot abdominal trauma is uncommon. However, the NOM protocol for this type of injury is safe and has low morbidity. This approach should only be followed in institutions with adequate infrastructure, where an experienced and cohesive team is able to follow a specific protocol, with rigorous periodic evaluation of its results.

Key words: Wounds and Injuries. Trauma Severity Indices. Liver/surgery. Wounds, Penetrating. Abdominal Injuries.

INTRODUCTION

The improvement and increasing use of imaging methods, particularly computed tomography (CT), has significantly changed injury management of abdominal solid organ, particularly the liver. The non-operative management (NOM) of blunt liver injury is a reality and, principally in reference trauma centers, it is considered the treatment of choice, provided that the protocol inclusion criteria are met. Currently, NOMis commenced in around 86.3% of such cases[1], with success rates varying from 82 to 100%[2,3]. Even forblunt liver injurieswhich are considered complex, the success of NOMreaches satisfactory levels[4].

Due to these good results associated with blunt liver injury, NOM has also been extended to penetrating liver injuriescausedby both stab and gunshot wounds (GSW). In penetrating trauma, due to the frequency of associated intra-abdominal injuries, NOM candidates should be selected with great rigor and discretion. Currently, various services have used this approach forliver injuries from both stab and gunshot wounds, with success rates ranging from 67-100%[5-15].

However there is still no consensus for NOM for penetrating liver injuries, mainly by GSW. It is performed in few trauma centers, despite the encouraging results from sites where it is practiced. However, to date, there are no analyses of NOM results for penetrating isolated liver injuries in published studies, that is, which presented no compromised chest, diaphragm or other abdominal viscera. Therefore, the aim of this study is to analyze strictly the results of experiencesof NOM regardingliver GSW as single abdominal injuries without associated abdominal and/or chest injuries.

METHODS

A longitudinal, prospective study conducted on patients with GSW on the right thoracoabdomen, with

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isolated liver injuries,received at Hospital João XXIII, from January 2005 to December 2014. Patients who met the inclusion criteria, determined by the service protocol of general surgery and trauma at Hospital João XXIII[15], were included in this study. It was approved by the Ethics Committee of the institution and filed under number 049/2009.

The inclusion criteria were: patients with liver damage as the only abdominal injury, caused by GSW on the right thoracoabdomen, and who, on admission, presented hemodynamic stability, defined as systolic blood pressure greater than 90mmHg, heart rate lower than 110bpm, and no signs of peritonitis. The presence of these criteria prompted CT scans. The performance of a CT scan of the abdomen is mandatory to fulfil the protocol criteria. The liver injuries were classified by grade using the classification proposed by The American Association for the Surgery of Trauma (AAST)[16]. Patients with associated injuries to the thoracic cavity (hemothorax, pneumothorax, etc.), and to the abdominal cavity, besides the liver, were excluded from the study. Patients with signs of peritonitis, hemodynamic instability on clinical examination, or signs of injury to the gastrointestinal tract, suggested by imaging tests, were referred for surgical treatment and therefore excluded from the study. Only patients with isolated liver injuries were analyzed.

The data analyzed were: age, sex, trauma scores, hemodynamic status and abdominal examination on admission, CT results, existing extra-abdominal injuries, serum levels of hemoglobin, clinical outcome, the presence of complications and their treatment, length of hospital stay, outpatient follow-up and death.

Patients which, during the treatment period, showed persistent signs of bleeding (fall in hemoglobin or hematocrit), suggestive signs of liver damage complications (jaundice, fever, liver enzyme abnormalities, gastrointestinal bleeding) or abdominal pain, were referred for new scans and subsequent treatment, according to any abnormalities found.

Patients with at least grade IV liver damage remained hospitalized until the seventh day after trauma when another CT scan was performed to examine the progress of the injury. Hospital discharge was granted when the patient was eating adequately, with normal bowel habits and no abdominal pain or fever. Patients were told to return for out patient monitoring after fifteen, thirty and sixty days after trauma. In the last review of each patient a CT scan of the abdomen was requested to check that the liver injury was completely healed. Long term monitoring is being performed at six, 12, 18 and 24 months from the date of injury. These are the conditions laid down by the current protocol.

RESULTS

During the study period, 176 patients met the inclusion criteria for NOM of GSW on the right thoracoabdomen, with 169(96%) having liver injury. However, only 28 (16.6%) of the 169 patients had isolated liver injuries (Table 1). Only these 28 patients were studied. Regarding the distribution of gender, 25 patients (89.2%) were male and only three patients (10.8%) female. The average age was 27.7 ranging from 16 to 59 years of age. All patients studied were stable on admission with no signs of peritoneal irritation. The overall average of trauma indices was Revised Trauma Score (RTS) 7.45; Injury Severity Score (ISS) 10.9; Trauma and Injury Severity Score (TRISS) 98.7%. The average hemoglobin levels on admission was 12.4g/dL and on discharge, 11.7g/dL. Transfusion was given to three patients (10.8%) with an average of two units of packed red blood cells per patient. A CT scan of the abdomen was performed on all patients. The most frequent injuries were grade II and III (Table 2).

Injuries associated with other regions, excepting the chest and abdomen, were present in 21.4% of patients (Table3). During the period, five patients (17.8%) repeated imaging exams (ultrasound or CT). The main reasons for repeating these was a change in symptoms (abdominal pain, fever) and a progressive drop in hemoglobin.

Complications were present in only one patient (3.6%), with agrade II injury. This patient had a progressive fall in hemoglobin and underwent another CT scan on the fifth day after trauma, which showed blush of contrast within

Table 1 - Main types of diagnosed injuries in patients with liver injury in patients with GSW of the right thoracoabdmen.

Diagnosed Injuries	Patients (%)
Liver+Diaphragm+Lung	106 (62.7%)
Liver	28 (16.6%)
Liver+Diaphragm+Lung+Kidney	19 (11.2%)
Liver+Kidney	16 (9.5%)
Total	169 (100%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-1014).

Table 2 - Classification of Hepatic Injury by Grade (AAST) and its incidence.

Grade of Liver Injury	Number of patients (%)
Grade I	2 (7.1%)
Grade II	14 (50%)
Grade III	10 (35.7%)
Grade IV	2 (7.1%)
Grade V	0 (0%)
Total	28 (100%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-1014).

Table 3 - Associated injuries found.

Associated Injury	Patients (%)
Extremity fractures	3 (10.7%)
Vertebrae fractures	2 (7.1%)
Femoral Vessels	1 (3.6%)
Total	6 (21.4%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-1014).

the lesion. He was referred for angiography which showed an arteriovenous fistula with a low flow, and embolization was performed. The failure of NOM did not happen in any of the 28 patients studied. In this study no patients died. The average length of hospital stay was 5.3 days; for patients without complications it was 5.1 days and for those with, eight days.

Regarding follow-ups after hospital discharge, only 18 patients (64.42%) attended the two-month appointment for clinical examination, laboratory review and control CT. In all of them, hemoglobin levels were within normal limits and the injuries were completely healed, except for one of them (with a grade IV injury) in which the injury was found to still be in the process of healing. This patient repeated the CT scan at the six-month appointment, and it showed the injury to be completely healed. At the two-year control point, only 15 patients (53.6%) returned, even after an active search. All received final discharge.

DISCUSSION

NOM for penetrating abdominal trauma, although not universally employed, is evolving. Particularly on GSW, several publications have accumulated significant evidence on its safety and success over the past three decades[6-15]. This is understandable because, to carry it out safely, the environment must be properly prepared, having the necessary infrastructure and being qualified with a readied, united and cohesive medical team. Clinical examinations and detailed studies of imaging (CT) of the projectiles' paths, to find or exclude the presence of abdominal injuries, are indispensable to perform NOM. Computed tomography of the abdomen, besides being one of the protocol items, has a number of advantages and is essential for this kind of approach, there being evidence level II recommendations[16]. With the advancement of technology, multidetector CT has a sensitivity of 91% to 97%, a specificity of 96% to 98% and an accuracy of 96% to 98% in detecting intra-abdominal injuries in patients with GSW abdominal injuries[17-19].

Among the benefits of NOM are the decreasing frequencies of unnecessary laparotomies and their complications, length of hospital stays and overall treatment costs. Several publications show that 20-30% of patients with abdominal GSW who underwent laparotomies had unnecessary operations, strengthening the importance of approaches such as NOM[6,7,20,21].

In recent review articles and guideline about NOM of penetrating abdominal trauma, the method was considered effective with success rates ranging from 69% to 100%[16,22,23]. Lamb and Garner, in their review analyzing 6,072 patients, found that only 15.5% required laparotomies for the treatment of complications or failure of NOM[22]. In Singh and Hardcastle's review about 6,468 patients, only 14.8% required laparotomies due to NOM failure. Of those, 28.2% were unnecessary[23]. There commendations of these reviews and guideline, based on the level of evidence, were: a) patients with abdominal GSW who are hemodynamically stable and without signs of peritonitis maybe candidates for NOM: level II, and b) patients with isolated injuries of solid viscera due to abdominal GSW, in the presence of hemodynamic stability and no worsening of the clinical condition nor abdomen examination, may be candidates for NOM: level III[16,22,23].

Liver injuries have certain important features which allow NOM to be performed with high success rates. Currently, it is the first choice of treatment adopted in institutions that have the essential conditions for its use. Most of the time, bleeding which originated from the liver damage ceases spontaneously, a fact often noted by trauma surgeons during surgical approaches to liver damage in hemodynamically stable patients[24]. Trunkey

et al., in the period of 1947-1963, documented the surgical findings of 205 liver injuriesfrom stab wounds and 428 from GSW. In that sample, 86% of stab wounds and 72% of GSWdid not require any treatment, except for drainage at the time of surgery[25]. This highlights the ease with which this injury can be sealed. However, during surgery, or manipulation of the injury, massive bleeding may occur due to loss of the clot. This bleeding is often difficult to control, requiring complex surgical maneuvers, and is associated with high morbidity[26]. In some circumstances of heavy bleeding in critical injuries, it is not possible toachieve satisfactory hemostatic results using conventional surgical techniques, so damage control surgery maneuvers are required instead. All this can occur in a patient that was hemodynamically stable with no active bleeding. Furthermore, it is known that the hepatic parenchyma has a great capacity for healing and regeneration, whether due to traumatic or surgical injury, maintaining the organ architecture. Work in experimental models shows that three to six weeks after the occurrence of an injury, the force required to teara scar formed is equal to that which would damage a normal parenchyma, whether aliver injury was sutured or not[27]. This healing ability is one of the most important factors in the indication, use and success of NOM for liver injuries, even for those considered complex. Patients followed in this study showed healed injuriesin subsequent CT scans. They also maintained adequate coagulation and did not show signs of liver failure, regardless of the extent of the injuries.

As already mentioned, NOM for liver GSW is not routinely performed and the main reason is the high incidence of associated injuries of other viscera and abdominal structures that require surgical treatment. A laparotomy, in most cases, is still the safest approach. However, in a highly selective group of patients, NOM may be a feasible option for this type of injury, being safe and demonstrating high success rates[8,26,28-30]. The most difficult and important aspect, no doubt, is the selection and appropriate monitoring of the patients. The use of CT, in this situation, principally aims to understand the trajectory of the projectile and therefore to avoid any concomitant surgical injury. It is an essential condition to perform NOM.

Recent studies, including this one, specifically address NOM for liver injuries GSW, showing its safety and efficacy in selected patients. These publications show that NOM was possible for between 26.6% and 32.3% of the patients with liver GSW[28-30]. They show an incidence of complications that varies from 3.8% to 50%, the less frequent being directly related to the liver injuries. The success rates varied from 68.5% to 100%[26,28-30]. Although severe injuries are associated with increased complication rates, the grades of injury, per se, are not shown to be an independent factor for NOM failure, justifying its performance even for injuries considered complex, i.e. for grade IV and V injuries[26,30]. The presence of contrast blush on a CT, which means to the presence of vascular injury, a pseudoaneurysm or arteriovenous fistula, is a factor that predisposes NOM failure. This finding justifies performing angiography and embolization, increasing the possibilities of NOM success.

The increase in abdominal pain or the onset of jaundice, fever or gastrointestinal bleeding, suggest complications related to the actual liver injury, and must be studied by performing another CT scan. Most of these complications (bilioma, biliary fistula, infected hematoma, bilhemia, among others) can be treated with minimally invasive methods such as endoscopic retrograde cholangiopancreatography (for papillotomy and the insertion of stents), puncture and drainage of collections guided by ultrasound or videolaparoscopy. However, the most frequent complications are related to associated injuries, particularly thoracic (retained hemothorax, empyema, infected pulmonary contusion) and, sometimes, to renal injuries[8,26,28-30]. This higher frequency of subsequent complications to associated injuries explains, at least partially, the low rate of complications found (3.8%) in this study.

We not found, in English-language literature, a specific publication that assesses NOM for liver GSW as the only abdominal injury and with no associated chest injury that required some kind of treatment. The results of this study showed that the incidence of isolated liver injuries, which fulfill the NOM criteria, is low (16.6%) and that morbidity and failure rates were lower when compared to studies in which liver injuries were associated with other abdominal or thoracic injuries. NOM for this specific type of injury is safe, for a well-selected group of patients, presents a low morbidity and can be performed, in principle, for all grades of liver injury. However, even for isolated liver injuries, this approach should only be carried out in environment with adequate infrastructure, where an experienced and cohesive team is capable of following the specific protocol, under strict periodic evaluation of their results. Otherwise, it would be an adventure into the unknown which, of course, is not recommended.

RESUMO

Objetivo: *analisar a segurança e efetividade do tratamento não operatório (TNO) da lesão hepática, como única lesão abdominal, em vítima de perfuração por projétil de arma de fogo (PAF) no abdome.* ***Métodos****: Foram estudados os pacientes com lesão hepática diagnosticada como única lesão abdominal provocada por PAF na região toracoabdominal direita, hemodinamicamente estáveis. Todos foram submetidos ao exame com tomografia computadorizada. Foram analisados: idade, sexo, índices de trauma, condição hemodinâmica e exame do abdome à admissão, resultados da tomografia computadorizada, lesões extra-abdominais existentes, níveis séricos de hemoglobina, evolução clínica, presença de complicações, tempo de permanência hospitalar, acompanhamento ambulatorial e óbito.* ***Resultados:*** *no período do estudo, 169 pacientes do protocolo de TNO apresentaram lesão hepática por projétil de arma de fogo. Destes, apenas 28 pacientes (16,6%) possuíam lesão hepática como única lesão abdominal e preencheram os critérios de inclusão no estudo. A média de idade foi 27,7 anos e 25 pacientes (89,2%) eram do sexo masculino. A média global dos índices de trauma verificada foi: RTS 7,45; ISS 10,9; e TRISS 98,7%. As lesões mais frequentes foram a grau II e grau III (85,7%). Um paciente apresentou complicação. Não houve óbito na série. A média de permanência hospitalar foi 5,3 dias.* ***Conclusão****: A lesão hepática isolada no trauma penetrante por PAF é pouco frequente e o tratamento não operatório desse tipo de lesão é seguro e apresenta baixa morbidade.*

Descritores: *Ferimentos e Lesões. Índices de Gravidade do Trauma. Fígado/cirurgia. Ferimentos Penetrantes. Traumatismos Abdominais.*

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Vascular trauma in the Amazon – the challenge of great distances

Trauma vascular na Amazônia – o desafio das grandes distâncias

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A B S T R A C T

Objective: to evaluate the incidence of unfavorable outcomes in vascular trauma patients and their possible correlation to the distance between the city where the injury was sustained and the hospital where the patient received definitive treatment. **Methods:** descriptive and retrospective study. Data were collected from medical records of patients submitted to surgical procedures for arterial or venous injuries from February 2011 to February 2013 at the only trauma center providing vascular surgery in a vast area of the Amazon region. Trauma date, patient gender and age, mechanism and anatomic topography of injury, surgical management, need for surgical re-intervention, hospitalization period, postoperative complications, mortality and limb amputation rates were analyzed. The incidence of unfavorable outcomes was assessed according to the distance between the city where the vascular injury was sustained and the trauma center. **Results:** One hundred seventy-three patients with 255 vascular injuries were analyzed; 95.95% were male ($p<0.05$), mean age of 28.92 years; 47.4% were caused by firearm projectiles ($p<0.05$); topographic distribution: 45.66% lower limbs ($p<0.05$), 37.57% upper limbs, 6.94% abdominal, 5.2% thoracic and 4.62% were cervical vascular injuries; 51.42% of patients required hospitalization for seven days or less ($p<0.05$); limb amputation was necessary in 15.6% and the overall mortality was 6.36%. **Conclusion:** distances greater than 200Km were associated to longer hospitalization period; distances greater than 300Km were associated to increased limb amputation probability; severe vascular trauma have an increased death probability when patients need to travel more than 200Km for surgical treatment.

Key words: External Causes. Wounds and Injuries. Vascular System Injuries. Blood vessels. Ulnar Artery.

INTRODUCTION

Trauma due to violence and traffic accidents represents the major cause of mortality and morbidity related to external causes worldwide[1,2]. Besides limb amputation risk, vascular injuries are among the most frequent death mechanisms on traumatized patients, representing considerable demand on civilian and military hospitals[3-5].

Many studies have shown that penetrating mechanisms prevail in vascular lesions and that lower limbs are the most frequent sites of injury[6-8]. Blunt trauma has worse prognosis than penetrating ones; as external bleeding is commonly absent, there can be no obvious sing of vascular trauma at the initial evaluation of the multi injured patient, delaying the suspicion of the vascular injury, particularly in the patient with altered level of consciousness[9,10]. Concomitant non-vascular lesions are frequent. Fractures, nerve and muscle injuries are common associations that increase amputation probability even at specialized trauma centers[9-12]. That explains why limb amputation rate differs from penetrating (10%) to blunt (30%) vascular traumas[13].

Irreversible ischemia usually develops six hours after trauma, depending on the arterial injury anatomic level, trauma mechanism, collateral circulation, and hemorrhagic shock severity[14]. Aiming a better functional outcome, limb revascularization must be undertaken before this interval[8,15].

In Brazil, hospitalization due to trauma had a near 30% increase in the last five years[16]. Pará state is the second largest in Brazil. It has a 1.247.954.666km^2 area (twice the territory of France), and is the most populated state in the Brazilian Amazon region; its capital and surroundings concentrates a 2.1 million population[17]. A single trauma center with vascular surgeons team is available statewide. Long transportation periods to the hospital impact the severely injured victims survival [18].

This study aims to evaluate the outcomes of patients operated for vascular trauma at the only center providing specialized assistance in such a large area, which brings medical rescue and definitive care challenges.

METHODS

Descriptive and retrospective study. Data were collected from medical records of patients treated at the

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Hospital Metropolitano de Urgência e Emergência (HMUE) from February 2011 to February 2013. Individual patient consent forms were not obtained since this research concerned only retrospective analysis and the authors stated that no personal data that could lead to patient identification would by reviewed or published. This research was approved both by the University Center of Pará ethics committee (protocol number 309.707) and the Brazil Platform, a national electronic registration system with ethics committee that is currently a requirement for any study involving human data in Brazil. HMUE is the state reference for median and high complexity traumas and burn victims; around 2000 patients are monthly treated[19]. Trauma date, patient gender and age, the city where the trauma has occurred, mechanism and anatomic topography of injury, surgical management, outcome, need for surgical re-intervention and hospitalization period were analyzed.

Inclusion criteria: patients submitted to surgical procedures for arterial or venous injuries (blunt or penetrating) at the HMUE from February 2011 to February 2013. Exclusion criteria: if surgical exploration revealed no vascular injury; iatrogenic vascular injuries; traumatic limb amputation; primary limb amputation burns and vascular injuries treated by surgeons other than vascular.

Regarding the trauma mechanism, injuries were classified as firearm's projectile wound (FPW) (inflicted by firearms of any kind), cutting wounds (CW) and traffic accidents (TA). Arterial and venous lesions were classified as compressible vascular injuries (CVI), if hemorrhage could be interrupted by direct wound compression or by tourniquet, and as non-compressible vascular injuries (NCVI), if bleeding could not be contained by neither of these maneuvers as suggested by Markov *et al.*[20].

Postoperative complications: operative site hematoma and infection that required abscess or clot surgical drainage, debridement and/or limb amputation. Concerning surgical re-interventions, only those related to vascular injury, as for example, fasciotomies or amputations after revascularization failure, were included. Any second non-vascular procedure was excluded for this analysis (second look laparotomy, e.g.).

To establish vascular injuries mortality, patients who sustained non-vascular injuries at a different topography, (for example, a patient with a superficial femoral artery and a brain injury secondary to firearm's projectile) were excluded. Death, limb amputation and hospitalization for more than seven days were considered as unfavorable outcomes. The distance between the city where the vascular injury was sustained and the hospital was measured in Kilometers (Km) with Google Maps® on line application (www.maps.google.com.br/maps). Distances ranges were classified as 50Km or less, between 51 and 100 Km, between 101 and 200 Km, between 201 and 300 Km and more than 300Km. The non-parametric χ^2 test was used; statistical significance was considered when $p<0.05$.

RESULTS

There were 304 patients operated by the HMUE vascular surgery team from February 2011 to February 2013; 131 were excluded; the remaining 173 patients (255 vascular injuries) were analyzed. Patient's characteristics regarding gender, age, trauma mechanism and injury topography are exposed in table 1.

Isolated arterial injury was found in 97 patients (56.07%), while exclusively venous trauma happened in 20 patients (11.56%). Simultaneous arterial and venous trauma was found in 56 cases (32.37%). Compressible vascular injuries (CVI) accounted for 143 (86.67%) of all arterial and 63 (70%) of all venous injuries. Among non-compressible vascular injuries (NCVI) there were 22 arterial lesions (13.33%) and 27 venous traumas (30%). Difference between CVI and NCVI for arterial and venous lesions was statistically significant ($p<0.0001$ and $p=0.0002$, respectively). The most frequently injured arteries were the superficial femoral and the ulnar, each accounting for 26

Table 1 - Patients characteristics.

Age (years)	(n)	(%)	Trauma Mechanism	(n)	(%)	Topography	(n)	(%)
< 12	2	1.16	Firearms projectile wounds	82	47.40	Abdominal	12	6.94
13 – 18	25	14.45	Cutting wounds	71	41.04	Cervical	8	4.62
19 – 24	43	24.86	Traffic accidents	15	8.67	Lower Limb*	79	45.66
25 - 49*	95	54.90	Fall	2	1.16	Upper Limb	65	37.57
50 – 60	6	3.47	Others	3	1.73	Thoracic	9	5.20
> 60	2	1.16						
p-value	< 0.0001*		p-value	< 0.0001*		p-value	<0.0001*	
Total	173	100	Total	173	100	Total	173	100

Source: Hospital Metropolitano de Urgência e Emergência.
Statistical Test: χ^2; n: Number of cases p-value = < 0,0001; %- Percentage of cases

cases (15.75% of all arterial lesions – p<0.0001). The most frequently injured veins were the superficial femoral with 16 cases (17.77%) and the popliteal with 13 (14.44%) of all venous lesions. Others venous injuries are listed below. There was no statistical difference between the venous injuries rates (P>0.05 χ^2 test). The anatomic distribution of the vascular injuries is presented on table 2.

Nonvascular injuries were found in 75 patients (43.35%, P=0.09). Bone fractures were the most common ones among them (44 patients or 25.43% of all patients) and accounted for 49.07% of all nonvascular injuries (p=0.0008). Other concomitant injuries included peripheral nerves (15.6% of all patients), thoracoabdominal organs (7.51% of all patients).

The most frequently used surgical technique for arterial injuries was autologous vein graft interposition (64 cases = 36.57% – P<0.0001 χ^2 test) and the great saphenous vein was the most frequently used vessel for this procedure (57.14%). The superficial femoral (33.33%), brachial (23.33%) and popliteal (18.33%) arteries were the most common sites of vein graft interposition. No synthetic graft was used. Arterial ligature was performed in 51 cases (29.14%), most of than were radial or ulnar injuries (22 cases) or below the knee arteries (21 cases).

Other surgical procedures for arterial injuries included 30 end-to-end anastomosis (17.14%), throboembolectomies, arteriorrhaphies and one case of temporary intravascular shunt as damage control technique. In two cases arterial injury management was not completed because of patient's death during surgery. In six patients, operated for bone fractures, an arterial injury was not promptly diagnosed; these patients developed limb ischemia and were amputated. For venous injuries treatment, ligature was the most frequent surgical technique (85% – p<0.0001). Venorrhaphy was performed in 11 cases (13.75%). In one case venous injury management was not completed because the patient died during surgery (Table3).

Patients were followed only during hospitalization period. Almost half of them were hospitalized for a maximum seven days period (51.42% – p=0.0064), 20.8% hospitalizations last for eight to 14 days, 17.34% last for 15 to 30 days and 10.39% of patients were hospitalized for more then 30 days. Most patients, 63%, developed no postoperative complications and the remaining 37% presented at least one postoperative complication (p<0.0001). Infection was the most common complication (40.74% – p<0.0001). Postoperative limb ischemia was present in 22.22% and neurological deficit in 16.04% of patients (Table 4).

Among all patients, 84 required more than seven days of hospitalization (48.55%). Five patients with abdominal injuries (41.66%), two patients with cervical injuries

Table 2 - Anatomic distribution of the vascular injuries.

Arterial Injuries	Artery	(n)	(%) Art.**	Venous Injuries	Vein	(n)	(%) Vein**
	Axillary	8	4.84		Inferior Vena Cava	6	6.66
Non-compressible	Subclavian	7	4.24	Non-compressible	Axillary	5	5.55
	ONCA	7	4.24		ONCV	16	17.77
	p-value***	1.00			p-value***	1,00	
	Superficial Femoral*	26	15.75		Superficial Femoral *	16	17.77
	Ulnar*	26	15.75		Popliteal	13	14.44
	Brachial	24	14.54		Brachial	12	13.33
Compressible	Popliteal	18	10.90	Compressible	Common Femoral	7	7.77
	Posterior Tibial	14	8.48		Posterior Tibial	5	5.55
	Radial	12	7.27		OCV	10	11.10
	Anterior Tibial	12	7.27		p-value	0.1048	
	Deep Femoral	5	3.03				
	OCA	6	3.62				
	p-value***	< 0.0001*					
Total of non-compressible		22	13.33	Total of non-compressible		27	30.00
Total of compressible *		143	86.67	Total of compressible *		63	70.00
	p-value		<0.0001*		p-value	0.0002*	

Source: Hospital Metropolitano de Urgência e Emergência.
*Statistical Test: χ^2; n – Number of cases; * = p-value < 0.05; % - Percentage of cases.*
*ONCA: Other non-compressible arteries. Each one presents less than five cases (common carotid, external carotid, hypogastric, external iliac and renal); OCA: Other compressible arteries. Each one presents less than five cases (tibiofibular trunk, fibular and common femoral); ONCV: Other Non-Compressible Veins. Each one presents less than five cases (external iliac, external jugular, internal jugular, common iliac, internal iliac, subclavian and hypogastric); OCV: Other Compressible Veins. Each one presents less than five cases (fibular, anterior tibial, ulnar, basilica, cephalic, deep femoral and radial; ** - Percentage of total affected arteries and veins; *** - p-value obtained by comparison of arteries with at least five cases.*

Table 3 - Surgical techniques used for vascular injuries treatment.

Arterial Injuries Treatment	(n)	(%)
Vein graft*	64	36.57
Ligature	52	29.14
End-to-end anastomosis	30	17.14
Thromboembolectomy	13	7.42
Arteriorrhaphy	7	4.00
ANIVI	6	3.42
Intraoperative death**	2	1.14
Temporary intravascular shunt	1	0.57
p-value	< 0.0001*	
Total***	175	100
Venous Injuries Treatment	**(n)**	**(%)**
Ligature*	68	85.00
Venorrhaphy	11	13.75
Intraoperative death**	1	1.25
p-value	< 0.0001*	
Total***	80	100

Source: Hospital Metropolitano de Urgência e Emergência.
** = p-value <0.05%; % = Percentage of cases; n = Number of cases; ** - Intraoperative death without arterial or venous treatment; ANIVI: Amputation for non-identified vascular injuries; Statistical Test: χ^2; *** - 80 venous injuries detected in 173 patients; *** - 175 arterial injuries detected in 173 patients.*

(25%), 49 patients with lower limb's injuries (62.02%), 24 patients with upper limb's injuries (36.92%) and four patients with thoracic injuries (44.44%).

Forty-four patients needed surgical re-interventions (25.43%), most of them because of ischemia, infectious complications and compartmental syndrome. The majority of patients were re-operated for limb amputation (39.13% – p<0.0001); debridement was performed in 31.88%, skin grafts in 11.59% and fasciotomies in 7.25% of re-operations.

Table 4 - Postoperative complications in patients treated for vascular trauma.

Postoperative Complications	(n)	(%)
Infection*	33	40.74
Limb ischemia/ Arterial thrombosis	18	22.22
Neurological deficit	13	16.04
Compartmental Syndrome	5	6.17
Acute renal failure	3	3.7
Enteric fistula	2	2.46
Hematoma	2	2.46
Iatrogenic injuries**	2	2.46
Intestinal adhesions	1	1.23
Disseminated intravascular coagulation	1	1.23
Urinary fistula	1	1.23
TOTAL	81	100
p-value	< 0.0001*	
Patients without complications*	109	63.00
Patients with complications	64	37.00
p-value	< 0.0001*	
TOTAL	173	100

Source: Hospital Metropolitano de Urgência e Emergência.
*Statistical Test: χ^2; n – Number of cases; * = p-value <0.05; % - Percentage of cases.*

Limb amputation was necessary in 27 patients (15.6%); 21 cases presented lower limb's vascular injuries (26.58%) and six patients with upper limb's vascular injuries (9.23%). Popliteal arteries were injured in 33.33% of lower limb's amputation, superficial femoral arteries were injured in 23.8% and below the knee arteries trauma was present in 14.29%. In 28.57% of all lower limb's amputation cases, patients presented limb ischemia but the injured artery was not informed.

Eleven patients died; hence, the overall mortality was 6.36%. Two patients had isolated arterial injuries (18.18%), five had isolated venous traumas (45.45%) and four presented combined arterial and venous injuries (36.36%). It was not possible to apply statistical tests to these data because of the low incidence of lethal injuries in this series. Three patients died during surgery (27.27%), three during the first 24 hours after surgery (27.27%), two between two and seven days after surgery (18.18%), one between ten and 15 days after surgery (9.09%) and one patient died more than 25 days after surgery (9.09%). Cause of death was hypovolemic shock and sepsis (Table 5).

Concerning the travelled distance from the city where the trauma was sustained to the hospital (Table 6), 102 patients came from a distance of 50Km or less; 16, travelled between 51 and 100 Km; 30 came from a distance between 101 and 200 Km; 18 came from a distance between 201 and 300 Km; and seven came from a distance greater than 300Km. Patients covering 50Km or less were statistically more frequent (p<0.0001).

When unfavorable outcomes were assessed concerning the distance ranges, it was found that amputation incidence was directly proportional to distance, especially for patients who travelled more than 300Km; this distance range was statistically associated to higher limb amputation probability (p=0.0197).

Hospitalization for more than seven days was observed in 48.04% of patients who were less than 50Km away (Table 6). The incidence of hospitalization longer than seven days was statistically different according to the distance range from the city where the trauma was sustained and the hospital (P<0.0001).

When the hospitalization period was compared among the distance ranges, hospitalizations of three days or less were more frequent among patients who travelled 50Km or less (26.47%) and those who travelled from 51 to 100 Km (43.75%); hospitalizations period of 15 to 30 days were more frequent among patients who covered distance ranges of 101 to 200 Km (23.33%) and 201 to 300 Km (38.89%). For distances greater than 300Km the most common hospitalization period was from eight to 14 days (57.14%). Statistical difference was observed for the 15 to 30 days hospitalization period among patients who travelled between 201 to 300 Km (p=0.0167) and for the eight to 14 days period among those who covered distances of more than 300Km (p=0.0228). No lethal injuries were treated in

Table 5 - Anatomic distribution of lethal vascular injuries, cause and time of death.

LLethal injuries		(n)	(%)	Total		Cause and Time of Death		(n)	(%)
Injuried / Vessels**				(n)	(%)	Cause of death	Shock Hypovolemic*	9	81,82
Arterial injury	Common Carotid	1	9,09				Septic shock	2	18,18
	Subclavian	1	9,09				p-value	0,0348*	
				2	18,18		Total	11	100
Venous Injury	Inferior vena cava	3	27,27			Time of death**	Intraoperative	3	27,27
	External iliac	2	18,18				IPO	3	27,27
				5	45,45		2° to 7° PO	2	18,18
	Popliteal a. and v.	1	9,09				10° to 15° PO	1	9,09
	Renal a. and Inferior vena cava	1	9,09				20° to 25° PO	1	9,09
Arterial and Venous Injury	Sup. Fem. a. and Com. Fem. v.	1	9,09				Aver 25° PO	1	9,09
	Subclavian a. and v.	1	9,09				Total	11	100
				4	36,36				
				11	100				

Source: Hospital Metropolitano de Urgência e Emergência.
*Statistical Test: χ^2; n – Number of cases; * = p-valor <0.05; % - Percentage of cases; **- The low frequency of death prevented the statistical test application; PO – Postoperative; IPO – Immediate Postoperative.*

patients who travelled more than 200Km to the hospital (Table 6).

When unfavorable outcomes were assessed concerning injury topography six deaths were detected among the abdominal lesions (50%), two among lower limbs injuries (2.53%), one lethal neck injury (12.5%) and two among thoracic traumas (22.22%), no upper limbs lethal injury (0%) (Table 7). Hospitalization longer than seven days happened in five abdominal injuries (41.66%), two neck injuries (25%), 49 lower limbs injuries, 24 upper limbs traumas (36.92%), and four thoracic lesions (44.44%). When amputation and hospitalization longer than seven days rates were assessed, there was significant statistical difference between lower limbs traumas and the other topographies (p=0.0071 and <0.0001, respectively). Statistical evaluation regarding death data was not possible due to low occurrence of these events (Table 7).

DISCUSSION

Vascular injuries can be a surgical challenge because of the aggressive trauma mechanisms and increasing severity of associated lesions. It's association to hemorrhagic shock, according to experimental researches, decreases the probability of limb functional recovery if blood flow restoration is delayed for more than three hours[21-23]. As early diagnosis and treatment of vascular injuries is of paramount importance to prevent limb functional limitation, amputation and death. The fact that a single center in such a vast area is capable to provide specialized treatment for these injuries rises a valid concern regarding patients clinical outcomes.

Male patients prevailed among those operated for vascular injuries (95.95%). This is probably justified by the fact that men are more exposed to violence and traffic accidents risky situations[8,21,24]. The mean age of 28.92 years old, also matches the literature[9,11,12,21]. Most patients sustained penetrating traumas (88.44%), mainly firearm's projectile wounds (FPW) (47.4%), a data supported by other studies[12,21]. Nevertheless, an author found an equal incidence of FPW and blunt trauma and other detected cutting wounds (CW) as the most frequent mechanism[5,8]. Such a high incidence of FPW highlights the fact that the majority of vascular injuries at the Amazon region were caused not by accidental mechanisms but for violence.

The predominance of isolated arterial injuries over isolated venous ones here presented is similar to other reports and also the fact that extremities, specially lower limbs, sustained most of vascular traumas (83.24%)[4,21,25,26]. For most authors the superficial femoral artery is the most commonly traumatized and the present study agrees with this. However, diverging from previous papers, the frequency of ulnar artery injury was as high as the superficial femoral artery (15.75%)[5,11,15,21]; this is related to the high incidence of cutting wounds (41.04%) in the present series, a mechanism frequently associated to upper limb's trauma and is surely due to the fact that victims usually use the

Table 6 - Occurrence of unfavorable clinical outcomes according to the distance range between the city where the trauma was sustained and the hospital.

	50Km		51-100 Km		101-200 Km		201-300 Km		>300 Km		p-value
	n=102	(%)	n=16	(%)	n=30	(%)	n=18	(%)	n= 7	(%)	
Amputation	12	11.76	2	12.5	6	20	4	22.22	3	42.85	0.0197*
Death	7	6.86	1	6.25	3	10	0	0	0	0	STNA
Hospitalization> 7 days	49	48.04	5	31.25	15	50	10	55.55	5	71.42	<0.0001*
Total	68		8		24		14		8		

Source: Hospital Metropolitano de Urgência e Emergência.
*Statistical Test: χ^2; n – Number of cases; * = p-value <0.05; % - Percentage of cases; STNA: statistical test is not applicable.*

Table 7 - Unfavorable clinical outcomes regarding vascular injury topography.

	Abdomen		Neck		LL*		UL		Thorax		p-value*
	(n=12)	(%)	(n=8)	(%)	(n=79)	(%)	(n=65)	(%)	(n=9)	(%)	
Amputation	0	0.00	0	0.00	21	26.58	6	9.23	0	0.00	0.0071*
Death	6	50.00	1	12.50	2	2.53	0	0.00	2	22.22	STNA
Hosp.> 7 days	5	41.66	2	25.00	49	62.02	24	36.92	4	44.44	< .0001*
TOTAL	11		3		72		30		6		

Source: Hospital Metropolitano de Urgência e Emergência.
*UP= upper limbs; n – number of cases; % - percentage of cases Statistical test: χ^2; * = p-value < 0.05; STNA: statistical test is not applicable; Hosp. = hospitalization; LL= lower limbs.*

ulnar forearm border to defend themselves from machete inflicted injuries, a particularly common mechanism in the Amazon region that has not been described before[8,27]. Venous injuries were also more frequent on the lower limbs, which was reported by many authors[5,24]. In this study the superficial femoral vein was the most injured (17.77%) and the popliteal vein, the second most injured (14.44%), similarly to many references report[24]; nevertheless, other researchers pointed the popliteal vein as the most injured one in their prepares[5].

Although a few authors consider end-to-end anastomosis the most common management for arterial trauma, our data, in consonance with some articles pointed autologous vein graft interposition as the most adopted surgical technique[14,11,21,24]. Ligature was the most performed technique for venous injuries, similarly to other study[24] and although the best surgical strategy for venous injuries management remains uncertain, for hemodynamically unstable patients, ligature is still considered the best choice.

In this study 15.6% of patients were amputated. The popliteal artery injury is usually described as the most related to limb amputations due to vascular lesions[5,11]. In this study, it presented the highest limb amputation rate (33.33%).

The overall mortality of 6.36% is similar to many reports on the literature. As previously described, the hypovolemic and septic shocks were the most common causes of death[20,21,24]. Agreeing with previous data, among lethal cases, isolated arterial injuries or it's association to venous injuries were found in nearly half of cases; it has been show that NCVI carry higher mortality rates than CVI. NCVI caused 45.45% of deaths, mainly the inferior vena cava trauma, which accounted for 60% of these cases. The lethality of this specific injury corroborates previously published data[28]. Although this study has analyzed only civilian patients, the incidences of CVI for arterial (86.67%) and venous (70%) trauma were similar to the ones reported by Markov *et al.* concerning Middle East military conflicts[20]. The facts that NCVIs are associated with higher mortality and that many patients were brought from long distances likely explain why all deaths in NCVI patients in this study occurred in patients traveling less than 200km. Patients with NCVI coming from further away likely died before reaching the hospital and, therefore, were not included in our data.

The issue that 41.05% of patients came from cities outside the capital metropolitan area and 33.51% of them needed to travel more than 100Km to be operated highlight the need for vascular surgery assistance at more distant locations from the metropolitan area. This affirmation is confirmed by the 2013[29] published Brazilian Medical Demography that shows the north region of Brazil as the one with the lowest vascular surgeons concentration allover the country and by the Regional Medical Council, which stands that 79.16% of the 24 vascular surgeons registered on Pará state work at the metropolitan capital area[30]. Even thought there are two helicopters and one speedboat available for patients rescue, the most common mean of victim's transportation was the ambulances from the city where the trauma was sustained (52.02%). Even thought no air or water rescues have ben registered during this study, it surely happened since four patients came from Marajó island, which has no bridges connections to the continental portion of the state. These patients were probably rescued by helicopter but landed at nearby areas (an heliport is not available at the hospital) and from there they were removed by ambulance to the hospital and only the last mean of transportation was recorded. Such low frequency of air transportation may be due to difficult in communication between isolated locations and the capital or the fact that these resources availability is unknown by doctors assisting patients at such distant locations.

This study presents some limitations such as a bias selection, as patients constituted a convenience sample, as the HMU is the only regional specialized center for vascular trauma cases and patients sometimes arrive after a delay that can lead to unfavorable clinical outcomes. Unfortunately the elapsed time from the trauma until transportation to the hospital was found in only 38.15% of the cases. Other limitations include the fact that the two-year-period that was studied didn't allow a more significant amount of cases and patients were not followed after hospital discharge, thus late post-operative evaluation has not been analyzed.

Nevertheless, databases research (Pubmed, Scielo, Bireme, Medline and Lilacs) didn't provide similar studies concerning vascular trauma in the Amazon region. Researches like this highlight the fact that patients are at risk of a worse prognosis after suffering vascular injuries due to the fact that specialized assistance is not available at a reasonable distance from the city where the injury was sustained. If providing vascular surgeons availability is not short term possible solution, mainly because of the scarce number of specialists at the Amazon region or geographic isolation of some cities, perhaps a strategy using general surgeons trained on vascular trauma damage control techniques staying at strategic locations and expedite air rescue to the trauma center can benefit vascular trauma patients in this area.

In conclusion, the overall mortality related to vascular trauma was 6.36% and the main cause of death was hypovolemic shock. Limb amputation was required in 15.6% of vascular trauma cases. Distances greater than 200Km between the city where the trauma was sustained and the hospital where the definitive treatment was accomplished were associated to prolonged hospitalization period and distances greater than 300Km were associated to increased limb amputation probability. Severe vascular trauma have an increased death probability when patients need to travel more than 200Km for surgical treatment.

R E S U M O

Objetivo: *avaliar a incidência de desfechos desfavoráveis, em pacientes operados por trauma vascular, e sua relação com a distância entre o local do acidente e o hospital onde o paciente recebeu o tratamento definitivo.* ***Métodos****: estudo descritivo e retrospectivo. Dados coletados nos prontuários de pacientes operados por lesões vasculares, entre fevereiro de 2011 e fevereiro de 2013, no único hospital de trauma com atendimento especializado em cirurgia vascular em uma vasta área da Amazônia. Foram analisados data do trauma, sexo, idade, mecanismo e topografia da lesão, tratamento cirúrgico, reintervenção, período de internação, complicações, amputação e mortalidade. A incidência de desfechos desfavoráveis foi avaliada de acordo com a distância entre a cidade onde ocorreu a lesão vascular eo hospital.* ***Resultados****: foram estudados 173 pacientes, com 255 lesões; 95,95% do sexo masculino (p<0,05), média de idade de 28,92 anos; 47,4% das lesões por projéteis de arma de fogo (p<0,05); distribuição topográfica: 45,66% (p<0,05) nos vasos dos membros inferiores, 37,57% nos membros superiores, 6,94% de lesões abdominais, 5,2% torácicas e 4,62% lesões do pescoço; 51,42% tiveram hospitalização por sete dias ou menos (p<0,05); amputação foi necessária em 15,6% e a mortalidade 6,36%.* ***Conclusão****: distâncias superiores a 200km foram associadas à internação prolongada; distâncias superiores a 300km foram associadas à maior probabilidade de amputação de membros; traumatismos vasculares graves estiveram associados a uma maior probabilidade de óbito quando os pacientes precisaram ser transportados por mais de 200km para o tratamento cirúrgico.*

Descritores: *Causas Externas. Ferimentos e Lesões. Lesões do Sistema Vascular. Vasos Sanguíneos. Artéria Ulnar.*

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Original Article

Comparative analysis of the frequency and the severity of diagnosed lesions between pedestrians struck by motor vehicles and other blunt trauma mechanisms victims

Análise comparativa das lesões diagnosticadas e de sua gravidade entre vítimas de atropelamento e outros mecanismos de trauma fechado

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A B S T R A C T

Objective: to compare the frequency and the severity of diagnosed injuries between pedestrians struck by motor vehicles and victims of other blunt trauma mechanisms. **Methods:** retrospective analysis of data from the Trauma Registry, including adult blunt trauma patients admitted from 2008 to 2010. We reviewed the mechanism of trauma, vital signs on admission and the injuries identified. Severity stratification was carried using RTS, AIS-90, ISS e TRISS. Patients were assigned into group A (pedestrians struck by motor vehicle) or B (victims of other mechanisms of blunt trauma). Variables were compared between groups. We considered $p<0.05$ as significant. **Results:** a total of 5785 cases were included, and 1217 (21,0%) of which were in group A. Pedestrians struck by vehicles presented ($p<0.05$) higher mean age, mean heart rate upon admission, mean ISS and mean AIS in head, thorax, abdomen and extremities, as well as lower mean Glasgow coma scale, arterial blood pressure upon admission, RTS and TRISS. They also had a higher frequency of epidural hematomas, subdural hematomas, subarachnoid hemorrhage, brain swelling, cerebral contusions, costal fractures, pneumothorax, flail chest, pulmonary contusions, as well as pelvic, superior limbs and inferior limbs fractures. **Conclusion:** pedestrian struck by vehicles sustained intracranial, thoracic, abdominal and extremity injuries more frequently than victims of other blunt trauma mechanism as a group. They also presented worse physiologic and anatomic severity of the trauma.

Key words: Accidents, Traffic. Multiple Trauma. Trauma Severity Indices. Accident Prevention. Wounds and Injuries.

INTRODUCTION

Road vehicle accidents are a major public health problem worldwide. Such accidents constitute the eighth leading cause of death, accounting for 1.24 million fatalities per year[1]. Road accidents are the leading cause of death among young individuals aged 15-29 years. The majority of these deaths occur in underdeveloped or developing countries[2].

Pedestrians account for 22% of victims of road accidents globally and 20% in Brazil[2,3]. Brazilian mortality rates in this subgroup have remained constant (at around 20 deaths per 100,000 persons), despite a more than 200% increase in the fleet of vehicles in the past 15 years (DENATRAN)[4]. According to data from *DATASUS*, the number of pedestrian deaths remained at a relatively stable absolute rate over the past decade (9,000-10,000 deaths/year) but has declined proportionally:from 36% in 1998 to 20% in 2011, explained by the fact that motorcyclists and cyclists now represent a larger proportion of overall traffic-related deaths[3,5]. The most common lesions in individuals struck by vehicles are musculoskeletal and head injuries, depending on the population studied[6,7]. According to Hefny *et al.*, in 2014, the main cause of death was severe traumatic brain injuries[8]. Few studies have investigated long-term sequelae in this patient group. The disability rate is believed to be high but national data remains scarce.

A search of the available literature revealed no studies comparing the rate and severity of injuries among pedestrians struck by vehicles versus patients with other mechanisms of blunt trauma.This data could be valuable in assisting first-responders to establish adequate triage procedures and promoting more rational use of complementary exams, allocating the resources available to the treatment of these patients.The

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The TR is a database which holds specific characteristics of trauma cases, including demographic and epidemiological data, trauma mechanism, pre-hospital care information, diagnostic procedures, treatment administered, patient evolution and costs[5,9-11]. These registries must store information on traumatic injuries, classify them, define their severity and group the information for individual and collective analyses.

The study hypothesis is that the Trauma Registry (TR) is a useful and cost effective tool for identifying specific points to be addressed in a patient trauma care quality improvement process. However, implementation of this system within a hospital that predominantly treats users from the Unified Health System (SUS) poses certain challenges, particularly related to the absence of a local culture for data collection.Few hospitals in Brazil have this experience.

The objective of this study was to analyse the process of implementing a Trauma Registry in a university teaching hospital delivering care predominantly to SUS users, and its ability to identify issues and their impact on improving quality of the process.

METHODS

The study was submitted to the Research Ethics Committee of the Irmandade da Santa Casa de São Paulo Hospital and approved under decision number 656.666.

The software used for the collection and storage of data was *itreg,* developed by *ECO - Empresa de Consultoria e Organização em Sistemas e Editoração Ltda.*, in conjunction with the Brazilian Society of Integrated Care for the Trauma Patient (SBAIT).The *itreg* uses the internet and a site only accessible by authorized users holding the password. Besides the data entry screens, there are pre-established dashboards which allow a clear assessment of the most important points for assessing the quality of trauma patient care in real time.

Briefly, the *itreg* stores data pertaining to patient identification, trauma mechanism, pre-hospital care, transport, initial care, complementary exams (laboratory and imaging), injuries diagnosed, severity of sample (trauma scales), treatment administered, complications, hospital discharge, quality filters (national and international) and ICD, among others. Stratification of severity is performed based on calculation of the following scales: Glasgow coma scale (GCS)[12], Revised Trauma Score (RTS)[13], Abbreviated Injury Scale (AIS-1990)[14], Injury Severity Score (ISS)[15], NISS, NTRISS[16] TRISS[17].

Data collection was carried out by the Trauma Study Group (GET), formed by students from medicine and nursing courses of the School of Medical Sciences of *Santa Casa de São Paulo*. First, a ten hours theoretical-practical training course on data collection for trauma patients was given. A pilot study was then conducted in which data were collected for all trauma patients admitted to the emergency room of the Central Emergency Service of the *Irmandade da Santa Casa de Misericórdia de São Paulo Hospital* over a period spanning three months, commencing in March 2014. After assessing the quality of the data and refining the process, definitive data collection was started for an initial period of 12 months.

During this period, the Quality in Trauma Patient Care Project (PQAT) was implemented within the Emergency Service of the ISCMSP, based on the information from the Trauma Registry (TR).First, meetings were held involving all the attending physicians from the surgical team of the emergency service to present the project and take suggestions to be incorporated into the program. Meetings were also held with the resident doctors from the Surgical Department, showing how the program operates. After these preliminary definitions, the PQAT was officially deployed and run using the following tools: **Routine discussion meetings (RD) -** These meetings were held monthly on the 2nd Tuesday of each month, with discussions centered mainly on routines for patient care. Those wishing to provide input were also invited to take part. A number of matters were tabled and included in an agenda for future discussions; **Morbidity and mortality meetings (MM) –** MM meetings were split into two parts.TR reports are presented first, along with the key numbers and indicators. The next topic is the review of cases pre-selected based on the quality filters of the TR. Auditing filters are variables which are more frequently associated with breaches of protocol or failed care. This calls for thorough case by case review, in a bid to identify the underlying circumstances that led to these occurrences. This process is carried out by an independent auditor (not involved with care of the patient), who reports at the morbidity and mortality meetings of the group. The case reporter makes pertinent comments at this time. Based on this discussion, the points to be addressed by the PQAT are identified. This meeting is confidential in order to protect the parties involved in the discussion of the clinical case. **PQAT Reports –** Based on the ideas raised at RD and MM meetings, a report is produced, which is reviewed by the Director of the Emergency Service and by the other participants.Following approval, this report is sent to those interested (attending physicians, resident doctors, nurses, managers, etc.) via the internet as required. Upon conclusion of the project, the group intends to produce a manual containing all the reports discussed in order to assist in the PQAT of other interested institutions. **Continued education –** Drawing on the points discussed at the previous meetings, an issue is chosen for weekly review.As decided by the attending doctors, an article is sent by email to all participants for review of the subject and updating of the team. Depending on the topic, a specific meeting to define the protocol is decided and scheduled.

In the present study, the process of implementing the TR as a whole was analyzed, including the obstacles

encountered and solutions found.An assessment of the data collected was carried out in an effort to identify key points on which trauma patient care can be improved by specific interventions and training of the group. The preliminary phase of the PQAT was also evaluated, specifically the problems observed and the proposed solutions to remedy them.

RESULTS

Data collected

As of 24/11/2014, data for 1344 trauma patients had been input to *itreg*. Around 87% were blunt trauma patients, among which the most common mechanisms were falls from the same level (17.3%), followed by falls from height (16.1%), motorcyclists (15.6%) and being struck by a vehicle (15.2%).

Analysis of sample severity revealed that the vast majority of patients (89.1%), at admission, had a Glasgow coma scale score of 13-15 while only 7.6% had systolic arterial pressure under 100mmHg.The sample was characterized by the large number of patients (59.6%) with RTS>7.0 (without significant physiological changes) and ISS<9 (67%) (without serious injuries) (Figure 1).

From these records, 292 were reviewed and completed, forming the sample for the assessment of the quality control variables. Figure 2 shows patient destination following assessment. The majority of those admitted remained within the emergency service, either in a ward bed, emergency room bed or semi-intensive care unit. Only 21 out of the 292 closed files were admitted directly (<24 hours) to intensive care. Among patients with closed files, the most common treatments administered were thoracic drainage (12%), laparotomies (6.8%) and conservative management of limb fractures (5.8%).

The most frequent complications were respiratory failure and hemodynamic shock.Iatrogenic pneumothorax was noted in seven out of the 292 patients with closed files (Figure 3). Twenty-seven patients died, representing 9.2% of closed files.The most common causes of death were traumatic brain injury (11) and hemorrhage (5).

The auditing filters most frequently identified were laparotomy four hours after admission (3.4%), commencement of nonoperative management for injuries to the liver, spleen, kidney and/or pancreas (2%), and drainage of acute subdural hematomas four hours after admission (1.7%) (Figure 4). Lethality was highest for RTS scores <2 and for ISS scores >25 (Figure 5).

Figure 1 - *Severity of the sample.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

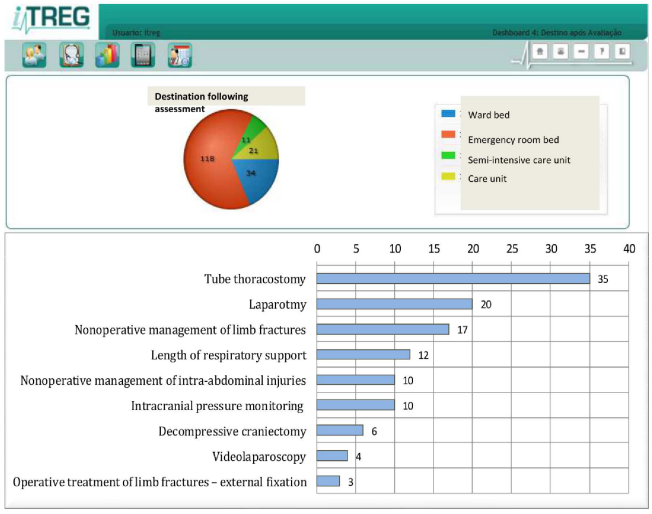

Figure 2 - *Destination after initial assessment and most frequently administered treatment options in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

DISCUSSION

There is no question that TR yield valuable information[4,5,18]. In the context of quality control and trauma care, the outcome and the costswould be more accurately assessed. The main challenge might be implementing the TR, particularly in settings without a culture of data collection and quality control processes[19-22].

Analysis of TR implementation

The pilot project brought many obstacles to light. The first of these was identifying and locating trauma patient amid the flow of patients through the emergency room,

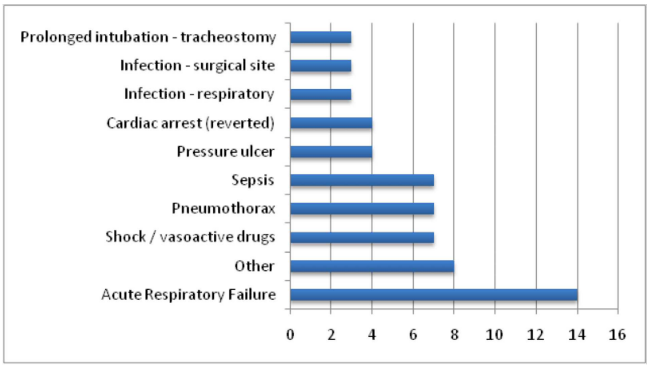

Figure 3 - *Most frequent complications observed in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

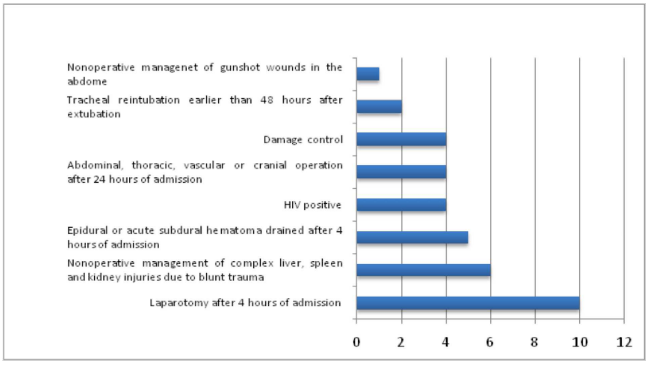

Figure 4 - *Auditing filters for trauma observed in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

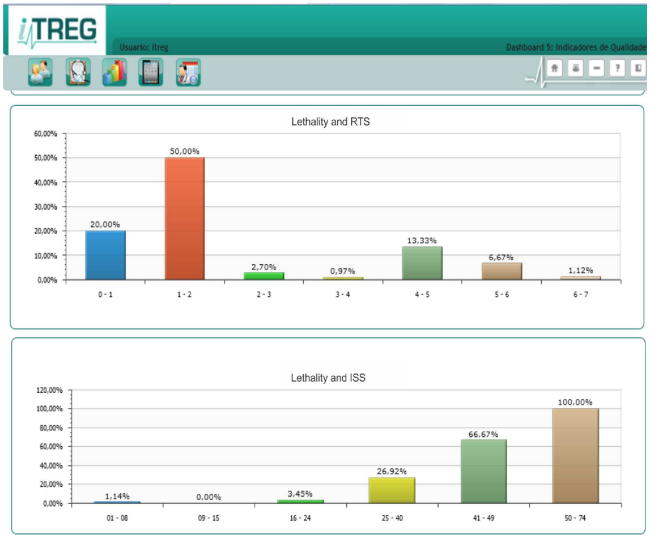

Figure 5 - *Distribution of lethality (within 30 days) according to RTS and ISS severity scales.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

whose occupancy averages 100-120 clinical and surgical cases (despite having "only" 62 beds).

The entry point of trauma patients is via the Emergency Room at "Trauma Room 1". Depending on the case, the patient may be referred to undergo complementary exams, or transferred to the ward, intensive care and/or surgical center. Since there are often no beds available initially, patients may remain on gurneys for a period. The space within the PSC where patients are placed temporarily varies according to demand and availability, and changes throughout the day, precluding attempts to list the patients. Given that the service handles an average of 20-30 trauma patients daily, besides other PSC patients, locating a particular patient amidst this volume became problematic.

This was exacerbated by the fact that only one GET member was present per shift (12-hour night shift) where covering all these locations at once proved impossible. The members of the GET were often not in the trauma room at the time of patient arrival. The most obvious alternative was to ask administrative clerks and or resident doctors to advise GET members upon entry of a trauma patient, but this often did not take place, compromising admissions data collection.

In an effort to complete the necessary information, data was drawn from patient medical charts. One of the major points was identified during the initial phase: the information needed for quality control of trauma care was missing from medical charts. This relates mainly to data on respiratory rate and Glasgow coma scale, needed to calculate the trauma measures and probability of survival. In some cases, the description of the clinical decision-making process in the charts was unclear, which hampered the GET team members who had problems completing the TR.

The situations above led to another problem: some files were "opened" by scholarship holders but not closed (i.e. not completed with all the necessary data) prior to patient discharge from the hospital. This resulted in a very large number of "open" files, which contained only information collected at admission plus exams ordered, yet not including exam results, injuries diagnosed and treatment proposed nor details of complications and deaths. Without this data, setting up a quality program would not be possible. The *itreg* revealed this problem, showing a large number of open files together with a low rate of injuries and complications.

The existence of a learning curve for data collection was clear. The GET comprised medical students in their second or third yearand nursing students in their fourth year of the course. All had an evident learning curve. During the pilot project period, numerous basic doubts were brought up at the meetings and all learned from the experience. The main limitations were difficulty understanding the written annotations in the medical charts, treatment procedures, clinical outcomes and grading

anatomical injuries using the AIS-90 table.

These issues were discussed at the GET meetings and those of PQAT members. The primary objective was to set-up an information system to alert the GET upon entry of a trauma patient to the trauma room, and to facilitate the process of finding the trauma patients still in the central emergency room and those who had been transferred to other units of the hospital. To this end, the following steps were taken: a) The residents responsible for attending the trauma patients were made aware that if no GET member was present upon admission of a trauma patient then a member should be alerted; b) A group was set-up on the *WhatsApp* application called *Trauma alert*. The most qualified residents on the shift sent a daily alert to GET members detailing the trauma patients undergoing follow-up and/or operated in the last 12 hours, along with their diagnosis, registration and procedures performed; c) A table of patients admitted to hospital and followed by the GET was created and made available on the "cloud" using the spreadsheet application and updated daily by GET members. This listing served less to locate the patient bed but more to inform whether the patient had left the hospital; d) A log book registering all trauma patients included in the *itreg* during each shift was introduced. A photograph of the log book page was sent daily by the shift leader to the *WhatsApp* group GET it and served as a control for patients input into the program; e) GET members were tasked with starting their shift by doing a "round" of all the trauma patients present in the PSC, done together with the group of residents and assistants taking over the shift, thereby guiding objectives; f) A subgroup of the GET responsible for the daily visit to the hospitalized patients was set–up. This subgroup was called "horizontal" as its work times were spread over the five working days of the week to allow linear follow up. Because they had the afternoons free, nurses and nursing students were chosen for this task. This was an important point, since it established a "trauma visit" which involved not only the scholarship holders but also the group researchers.

Another solution found to help optimize the closure of files was to schedule "closure meetings", held weekly at a dedicated time outside shifts or other commitments. Based on the information drawn from medical charts, the data on the *itreg* was reviewed and incomplete fields filled out up to the time of patient exit. The presence of a more experienced researcher was found to be fundamental to ensure the information entered into *itreg* was truly reliable. Interpreting the medical chart is often challenging for students, calling for more clinical experience.

Despite all these resources, it was noted that gaps existed in the shift roster, reducing the number of patients input into *itreg*. Since there were a number of scholarships unused because they were different types, a request for reallocation of the available funds to TT1 type scholarships was made. A further 15 TT1 scholarships were approved and another selection process began. Since then, the GET has scholarship holders carrying out data collection during the night shift (12 hours) seven days a week, while coverage is 24 hours at weekends and there is also the afternoon group (horizontal group) during week days.

In Brazil, the vast majority of trauma patients are first attended in hospitals under the *SUS*.The financial difficulties faced by some of these institutions are well known.Most of the hospitals cannot afford to hire (through public admissions procedures) specialized personnel solely to collect data. Resources are generally allocated to other areas, particularly in healthcare delivery.

Nevertheless, there are numerous benefits of quality control in trauma care, the "heart" of which is the information collected and stored in the TR. It is important to grasp the concept that quality control is not a means to punish people but a tool for protecting them. Once the initial obstacles have been overcome, the analysis of the data becomes the main tool for improving the service. We believe that when results improve, the rate of complications will fall, also promoting shorter hospital stays, lower costs with intensive therapy, nutritional support and antimicrobials, among a series of other advantages.

Many challenges were faced during the implementation of the project as a whole. We provided a detailed description of the most important points in order to help pave the way for other researchers and hospital managers who choose to pursue this path. These obstacles go far beyond mere tailoring of the software for use in Brazil, but also involve the training of an inexperienced group to carry out a relatively complex procedure. Once all the elements have been put in place, the challenge is to keep the group together and working smoothly, since many individuals are having to work together as a team, giving rise to specific problems.

The TR originated in the developed trauma systems from North America, which spread quickly to Europe. The culture of quality control is directly linked to improvements in performance on many fronts, including financial.Centers that fail to submit their data to regulatory agencies do not receive funding.This does not occur in Brazil, which may be one of the reasons explaining the low number of services with active TR.

There is a major difference between the model proposed in the present study and that observed in centers with TR experience. At more developed trauma centers, data collection is done professionally. There is the role of Trauma Nurse, with specific training and paid solely for working on TR[7]. This professional has access to the medical charts containing information on treatment and feeds this data into the TR retrospectively. The present project also differs in another respect. If this professional model had been implemented instead, invaluable information on pre-hospital care and admission would have been lost, since this data often goes unrecorded in medical charts.One of the insights gleaned from implementing this program in the hospital was the need to create tools to improve the

filling out of information in medical charts. Until this need is addressed, a system of "prospective collection" has been introduced, requiring the efforts of a large group of people.

Regarding the data collected, there is much to be done to achieve complete analysis. Ideally, all the open records should be "closed" when the patient leaves the hospital. This proved impossible under the current conditions, generating information which does not lend itself to scientific interpretation. Current efforts are focused on attempting to reduce the number of open files through the closure meetings outlined earlier.

However, a number of key points have been identified in this initial assessment. A large number of trauma patients treated by the service were found to have no major injuries. Only a small percentage of patients presented serious injuries and remained hospitalized after initial assessment. This phenomenon is known as "overtriage" and occurs when mild cases are referred to advanced trauma centers (tertiary, quaternary and/or university teaching hospitals), when they could be treated in secondary hospitals. The consequences are clear and exacerbated in an emergency service with a high volume of patients such as ours: patients, even devoid of serious injuries, require professionals for care, and also for ordering and scheduling complementary exams. This diverts some of the team to a group of trauma patients without major injuries, whilst other more serious cases need their assistance; gurneys and physical space are occupied in the emergency service until all the teams have gone over the patient and exam results again; there is high demand for use of imaging methods, such as X-ray, ultrasound and tomography. The patient flow of the service is negatively impacted by a large number of exams testing negative.

The occurrence of a high rate of negative exams may be due to several factors:the cause of this phenomenon may be related to failure to follow protocols for ordering exams, which may indicate the need for targeted actions in the quality program for group training; the protocols for ordering exams are flawed and should be revised. This is because some protocols allow a high rate of negative exams.In trauma, many severe injuries can be present in asymptomatic patients and an active search can lead to negative exams; these exams overload the group of professionals that attend trauma patients and also the equipment available, causing the problems cited above.

The most frequent complications observed were systemic in nature: respiratory failure and shock requiring vasoactive drugs. Local complications were less common. These complications are likely related to the systemic inflammatory response secondary to trauma (first hit) or to an infectious insult (second hit). Other important points for deployment in the quality program were the presence of iatrogenic pneumothorax and pressure ulcers. Both of these complications can be addressed by the application of protocols to reduce their occurrence through education and preventive measures. As observed in most casuistics, traumatic brain injury was the most common cause of death, followed by hemorrhaging. Likewise, specific protocols can be developed and applied to target these problems.

The evaluation of the quality filters in the TR revealed that some of these situations were clearly more frequent, such as subdural hematoma drainage four hours after admission. Each of these cases was reviewed to identify the issues that contributed to delays in surgical procedures or to ascertain whether failures in the process took place. Employing the TR for its primary purpose, namely, to identify key points where the quality program can be most effective, produced important results. One of the most effective ways of improving quality was the identification of cases for review at the closed MM meetings. The TR was pivotal in flagging those cases associated with points to be improved in the process. This appeared to be one of the greatest benefits of implementing the TR.

Concerted efforts to maintain the quality of care delivered to trauma patients have been made for years in the institution. The PQAT served to organize and standardize this process. The engagement of the group of professionals hired is variable and hinges wholly on personal motivation. However, many physicians hired to practice in emergency services have time available only for healthcare assistance. Extra meetings and continued education were not envisaged, which can sometimes pose a problem. Attendance at routine discussion and MM meetings depends on this variable. In order to raise the knowledge level of the group on the PQAT, reports were made available to the attending physicians of the service by email. We feel that, within a mature quality program, all professionals involved in trauma patient care should have a remunerated dedicated period every week to participate in the PQAT, which also includes continued education.

Another positive aspect observed at the meetings for defining routines is the involvement of various professionals including those from different medical specialties. This forms a task force which, working together, is better able to resolve problems and pursue action on different fronts.For example, at a meeting to define transfusion protocols, there was involvement from not only the general surgeon but also blood bank professionals, hematologists, the nursing area, transport, anesthesiologists and intensivists, among others. Consequently, the protocol becomes more widely disseminated outside the specific area, facilitating its application. At morbidity and mortality meetings, this multi-disciplinary approach was maintained in the medical chart review process. Suggestions for enhancing the process were made to the group as a whole and not only the professionals that handled the cases. All the specialties and professionals involved are kept abreast from an educational standpoint.

The *Itreg* was developed by ECO in conjunction with SBAIT based on the San Diego trauma registry (CA).

Tailoring to meet Brazilian needs was overseen by a working group from the SBAIT that drew on services with greater experience in data collection in Brazil, with the wider goal of devising a Brazilian Trauma Registry (Brazil TR). The Brazil TR can provide an overview of the characteristics of trauma on a national scale hitherto never seen. The possibility of benchmarking would allow more effective self-assessment, contributing to an improvement in the quality of trauma patient care. In the present study, this software was applied in a pioneering program which, allied with an appropriate quality program, proved highly effective in evidencing the needs for improvements in the service. Moreover, application of the *itreg* software makes the creation of the Brazil TR feasible.

It is noteworthy that the mere implementation of the quality program has led to clear changes in the registering of information. The fact that professionals are aware there is documentation and observation of events has had an extremely positive effect. The trauma registry and trauma care quality improvement program have proven fundamental and vital tools for hospitals responsible for handling this special patient group.

R E S U M O

Objetivo: *analisar a implantação de registro de trauma em hospital universitário com atendimento ao SUS, bem como, sua capacidade em identificar pontos para melhorada qualidade no atendimento.* ***Métodos:*** *o grupo de coleta de dados foi composto por alunos dos cursos de medicina e enfermagem, orientados pelos coordenadores do projeto. Utilizamos o software* itreg *(ECO Sistemas-RJ/SBAIT) como ferramenta de banco de dados. Vários "filtros" de qualidade foram propostos no intuito de selecionar os casos a serem revistos no processo de controle de qualidade.* ***Resultados:*** *entre março e novembro de 2014, foram inseridos no* itreg *dados de 1344 vítimas de trauma. Cerca de 87% foram vítimas de trauma fechado, 59,6% apresentaram RTS>7,0 e, 67%, ISS<9. Os registros foram completos em 292 casos, que foram selecionados para a revisãono programa de qualidade. Os filtros de auditoria mais frequentemente anotadosforam a laparotomia após quatro horas da admissão e a drenagem dos hematomas subdurais agudos após quatro horas da admissão. Identificamos vários pontos a serem desenvolvidos, como o controle da "supertriagem" de doentes, a necessidade de diminuição do número de exames de imagem negativos, o desenvolvimento de protocolos para passagem de acessos venosos centrais e tratamento de trauma craniencefálico grave.* ***Conclusão:*** *o Registro de Trauma traz uma visão clara dos pontos a serem melhorados no atendimento ao traumatizado, contudo, há características específicas na implantação desta ferramenta.*

Descritores: *Traumatismo Múltiplo. Ferimentos e Lesões. Índices de Gravidade do Trauma. Registros Médicos. Controle de Qualidade.*

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Risk factors for mortality in blunt abdominal trauma with surgical approach

Fatores de risco para óbito no trauma abdominal fechado com abordagem cirúrgica

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A B S T R A C T

Objective: identify risk factors for mortality in patients who underwent laparotomy after blunt abdominal trauma. **Methods:** retrospective study, case-control, which were reviewed medical records of blunt trauma victims patients undergoing laparotomy, from March 2013 to January 2015, and compared the result of the deaths group with the group healed. **Results:** of 86 patients, 63% were healed, 36% died, and one patient was excluded from the study. Both groups had similar epidemiology and trauma mechanism, predominantly young adults males, automobilistic accident. Most cases that evolved to death had hemodynamic instability as laparotomy indication - 61% against 38% in the other group (p=0.02). The presence of solid organ injury was larger in the group of deaths - 80% *versus* 48% (p=0.001) and 61% of them had other associated abdominal injury compared to 25% in the other group (p=0.01). Of the patients who died 96% had other serious injuries associated (p=0.0003). Patients requiring damage control surgery had a higher mortality rate (p=0.0099). Only one of 18 patients with isolated hollow organ lesion evolved to death (p=0.0001). The mean injury score of TRISS of cured (91.70%) was significantly higher than that of deaths (46.3%) (p=0.002). **Conclusion:** the risk factors for mortality were hemodynamic instability as an indication for laparotomy, presence of solid organ injury, multiple intra-abdominal injuries, need for damage control surgery, serious injury association and low index of trauma score.

Key words: Multiple Trauma. Abdominal Injuries. Wounds and Injuries. Risk Factors.

INTRODUCTION

The management of blunt abdominal trauma (BAT) is challenging, intra-abdominal injuries are less obvious and the indications for laparotomy are not as clear as in penetrating trauma[1]. Currently, conservative treatment is the gold standard for solid organ injuries in hemodynamically stable patients. The suspected or confirmed hollow organs injury requires surgery[2].

Accurate and timely diagnosis of blunt intra-abdominal injury is a common dilemma. The accuracy of the physical examination has been questioned by many, while others have suggested that the best method of diagnosis is done through serial tests performed by an experienced surgeon[3]. The abdomen is the third most affected region in blunt trauma and major traumatic injury may not be recognized quickly enough and it becomes a cause of preventable death[4].

In order to minimize the mortality in cases of abdominal trauma, risk factors for mortality must be identified and systematically studied. In recent years, risk factors including gender, the time interval between injury and abdominal surgery, shock upon admission and head trauma were revealed[5].

There is a lack of data in the literature related to blunt abdominal trauma that required laparotomy. The aim of our study was to identify risk factors associated with mortality in patients who underwent laparotomy after blunt abdominal trauma.

METHODS

This is a retrospective study of patients victims of blunt abdominal trauma that required emergency laparotomy in the *Hospital do Trabalhador* (HT), considered a teaching hospital and a reference in training human resources for healthcare[6]. It was selected all BAT victims undergone surgery (laparotomy) from March 2013 to January 2015, identified from the hospital surgery database. This study was aproved by the Ethics Committee of the *Hospital do Trabalhador* under the protocol number 44364215.6.0000.5225.

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All patients victims of penetrating trauma were excluded. It was carried out an analytic, case-control study comparing the group that was healed and the group that died, comparing the epidemiologic aspects, trauma mechanism, intra-operative findings, extra-abdominal injuries, laparotomy indications, trauma scores (Trauma and Injury Severity Score – TRISS), need for damage control surgery, reoperation and the outcomes. The data were collected, checked and submitted to statistical analysis. It was used the averages, standard deviation for the statistical analysis – chi-square test for categorical variables and the t-Studend test for numerical variables. It was considered p<0,05 as statistically significant.

RESULTS

A total of 86 patients were selected for the study. Of these, 54 obtained hospital discharge (63%), 31 have evolved to death (36%) and one patient was transferred and excluded from the study. Regarding the epidemiology, described in table 1, the age of the patients ranged from three to 82 years (average 32.72 years ± 15,93), with 66 male (77%). In both groups the majority of patients were male, healed with 42 men and 12 women and 24 men against seven women in the group of deaths, and majority in the fourth decade of life. The main mechanism of trauma for both groups was automobile accident (83% vs. 87% and p=0,84) – including patients victims of motor vehicle collision (cars, pickup trucks, trucks), motorcycle crashes and auto pedestrian collisions. Others mechanisms of injury found: falls from a height (3 *vs.* 4 and p=0,08) and direct blunt abdominal trauma in six healed patients and in none of those who died (6 *vs.* 0 and p=0,027). The average hospital stay in the group of deaths was 4,6 days (±6,71), significantly (p<0.05) lower than those patients who were discharged, who remain hospitalized on average 19 days (±23,6) (p=0,000791).

The main indication for surgical approach in non-survivors was hemodynamic instability - 61% vs. 38% (OR 2.4; CI95% 1.005-6.1 and p=0,02). In patients who have obtained hospital discharge, changes in computed tomography (CT) were the main indication for laparotomy (50% *vs.* 31% and p=0,47) – the main finding was free fluid in the abdominal cavity without solid organ injuries (70% of CT). Other CT findings were the presence of solid organ injury and pneumoperitoneum (Table 2). Abdominal pain and signs of peritonitis were not indications for surgical intervention in any patient from the deaths group, but were indicative in 9% of patients healed (OR, 0.03; 95% CI, 0.005 – 16 and p=0,04).

Solid organ injury was higher in the death group – 80% *vs.* 48% (OR 4.4; CI95% 1.599-13.48 and p=0,001), and 61% of these had another intra abdominal injury associated against 25% of the group of healed (OR 3.0; CI95%, 1.18-7.816 and p=0,01). All six patients with isolated bladder injury were healed (OR 0; CI95% 0-13.5 and p=0,02), 11 patients in this group had only bowel injury and only one among the 18 patients with isolated hollow organ injury (duodenum, small bowel, colon and bladder) evolved to death (OR 0.07; CI95% 0.003-0.4 and p=0,0001).

Of patients who died, 96% had severe extra abdominal injuries associated (head trauma, severe chest trauma, fracture of pelvis or femur, spine fracture in any segment), while in the healed group this figure represented 51% (OR 7.3; CI95% 2.132-33.49 and p=0,0003). The result was also statistically significant when the TRISS was compared between groups, the healed group had an average of 91,7% and the death 46,3% (p=0,002).

There was a significant difference (p<0,05) in outcome when compared the need for damage control surgery – 34% of patients required laparostomy in the first surgery, 45% of these have evolved to hospital discharge and 55% died (OR 3.3; CI95% 1.29-8.72 and p=0,0099) (Table 3).

DISCUSSION

The majority of the patients are young males and automobilist accident was the most common mechanism

Table 1 - Demographic Characteristics.

Variables	Healed (n = 54)	Death (n = 31)
Male	42	24
Female	12	7
Age*	32.4	33.2
Age >55 years	5	3
Mechanism of injury		
Automobile accident	45	27
Direct abdominal trauma	3	4
Fall	6	0

Source: Hospital do Trabalhador *database.* **Mean age*

of trauma. In this study both groups, healed and death, had similar epidemiology in agreement with the literature, mostly young adult males[3,7]. This result is also found at the *Hospital de Pronto Socorro de Porto Alegre* by Espino *et al*.[8] in Porto Alegre and in Santa Catarina by Kruel *et al*.[9], they evaluated cases of abdominal trauma undergone laparotomy. It is known that age over 55 years old is a worse prognostic variable in trauma[10,11], but in our study this was not found. Automobilist and motorcycles accidents were the most common mechanisms of trauma, but these were not related to the mortality. Farrath *et al*. pointed a higher incidence of abdominal lesions in victims of car crash, while victims of same level fall had a lower incidence[4]. We observed a negative association between direct abdominal trauma, such as aggression and falls, and deaths. These are low energy mechanisms of injury, therefore with less extra-abdominal related lesions, providing lower severity in the overall view of the patient.

Table 2 - Indication for laparotomy, injuries found.

Variables	Healed (n=54)	Death (n=31)	P
Indication for laparotomy			
Hemodynamic instability	21	19	0.47
Abdominal pain	5	0	0.058
CT*	26	9	0.47
CT			
Free fluid without solid organ injury	23	7	0.62
Pneumoperitoneum	3	2	0.1
Isolated solid organ injury	7	6	0.27
Without CT	21	15	0.39
Intraoperative findings			
Absense of injury	6	5	0.14
Isolated solid organs injury	12	9	0.27
Multiple solid organ injuries	8	7	0.19
Isolated bladder injury	6	0	0.07
Isolated intestine injury	11	1	0.15
Associated injuries†			
Yes	30	28	
No	24	3	0.0009
TRISS	91.7%	46.3%	0.002
Need for DCL‡	13	16	0.0099
Days of hospitalization			
Average	19	12	0.0007

Source: Hospital do Trabalhador *database.*
*‡ Damage control laparotomy; †Associated injuries: Head trauma,thoracic trauma, spine fracture (any segment), fracture of pelvis or femur; *Computed tomography as surgical indication: pneumoperitoneum or free fluid intra abdominal without hemodynamic instability or significant abdominal pain.*

Table 3 - Factors that influence the prognosis of blunt abdominal trauma victims with surgical approach.

Risk Factors (OR)	Good prognostic factors (OR)
Important associated injuries† (7,3)	Isolated hollow organ injury intraoperatively* (0,007)
Solid organ injury (4,4)	Abdominal pain or signs of peritonitis as indication for laparotomy
Need for damage control laparotomy (3,3)	
Multiple intra abdominal injuries (3,0)	Direct abdominal trauma
Lower TRISS‡	Hemodynamic instability as indication for laparotomy (2,4)

Source: Hospital do Trabalhador *database.*
OR: Odds Ratio*; *Bladder or intestine injury; †Important associated injuries: Head trauma, thoracic trauma, spine fracture (any segment), fracture of pelvis or femur; ‡Trauma and Injury Severity Score.*

In this study patients who did not survived have had a lower hospital stay time than patients who were discharged from hospital. Patients undergone exploratory laparotomies after blunt abdominal trauma die sooner because they are critically injured reflecting shorter hospital stay.

In the assessment of patients with suspected abdominal trauma the most common clinical presentation is the presence of hemorrhagic shock without apparent cause and the leading cause of death is the hypovolemic shock[12,13]. The treatment for patients with hemodynamic instability and obvious signs of abdominal trauma is immediate surgical exploration[12]. We verified that patients victims of blunt abdominal trauma who go to laparotomy unstable have 2.4 times higher risk of death than those without circulatory changes, being a risk factor for mortality. According to Gad *et al*. hemodynamically unstable patients with abdominal lesions or suspected lesions that required abdominal laparotomy have a mortality rate higher than 56%, especially those with systolic blood pressure below 60mmHg[11]. These patients therefore require fast and efficient handling in the prehospital and initial care, as well as greater attention in the postoperative period, since the aggressive surgical approach in patients with signs of shock should be maintained.

Patients with clinical signs of intra-abdominal injury - pain and signs of peritonitis - as an indication for surgery have a significant correlation with discharge. In general, patients with hollow viscera injury without major bleeding. Jones *et al*. have demonstrated that patients with no immediate indication for surgery and capable of monitoring with serial physical examination, that required intervention after blunt trauma showed signs or symptoms of injury within nine hours, and the vast majority in the first 60 minutes after arrival the emergency room[14]. We can conclude that when present, changes in physical examination on the patient are reliable explanations for intervention as well as better prognosis sign for the patient. The absence of these signals, however, does not exclude intra-abdominal injury[15].

Most of the deaths in this study are related to multiple intra-abdominal injuries, predominantly solid organ injury, and 80% of deaths had another intra-abdominal injury associated, most other solid organ injury. These findings are in agreement with the study by Hildebrand *et al*., which evaluated a series of 342 blunt abdominal trauma undergoing laparotomy, and all patients who evolved to death had hepatic or splenic injury, even if in the smallest degree of severity[16]. Blunt abdominal trauma with multiple solid organ injury has higher mortality, greater need of ICU and days of hospitalization, and increased need for blood transfusions, which is in agreement with our study. The presence of any solid organ injury during surgery increases the risk of death by 4.4 times. The gold standard for treatment of solid organ injury is conservative and usually those in need of surgery have more severe injuries, which confer higher mortality.

We verified that isolated hollow viscera injury is a factor of good prognosis after blunt abdominal trauma. Even if the mandatory conduct in suspected hollow viscera injury is surgical intervention, the absence of other concomitant intra-abdominal injuries in trauma is consistent with a significantly lower risk of mortality. Although rare in blunt trauma the diagnosis and rapid management of patients with hollow viscera injuries remain compelling, a delay of more than 24 hours intervention is associated with higher mortality than those with immediate repair[17,18].

There is a statistically significant difference between bladder isolated injury among groups studied in this sample. No patient who died had isolated bladder injury. A study of bladder injuries showed that those that required surgical repair of other abdominal organs beyond the bladder were at higher risk of mortality, especially elderly patients[19]. It is recommended that intraperitoneal bladder injury have immediate surgical repair and the extraperitoneal lesions will be reparied if a laparotomy is necessary to treat other abdominal injuries. Uncomplicated extraperitoneal bladder lesions can be managed with bladder catheter[20].

Extra-abdominal injuries add morbidity and mortality in blunt trauma, head trauma is a typically related factor as a cause of mortality in multiple trauma patients with blunt abdominal trauma[21,22]. Extra-abdominal injuries and their complications are the leading cause of late mortality in patients with multiple trauma who underwent laparotomy, as reported by Hildebrand *et al*.[16] and Mohamed *et al*.[21]. Our study showed similar results, almost all deaths had potentially serious injuries associated with 7.3 times the risk of death. The results of our study confirm findings in the literature, indicating that the combination of abdominal, thoracic, pelvic or head injuries are associated with increased risk of adverse outcome.

Trauma score Injury Severity Score (ISS) greater than 35 was a factor related to mortality in blunt traumas with surgical indication by Fernandez *et al*.[23]. In our study we used the Trauma and Injury Severity Score (TRISS) based on the ISS and Revisited Trauma Score (RTS). Low TRISS also proved to be a risk factor for death in surgical patients after blunt abdominal trauma in our study. Despite of being a retrospective analysis of the likelihood of survival, TRISS index allow evaluation of the quality of the service provided by the trauma centers. This study can be used as source for this assessment in this group of patients.

In face of the need to promote the rapid control of hemorrhage and contamination caused by trauma and to ensure the adequate resuscitation is performed damage control laparotomy (DCL). The aim of the DCL, at first, is to preserve the life of the individual, allowing time for intensive treatment to restore their physiology, thus allowing the definitive surgical repair of injuries in a second time. Stalhschmidt *et al*. found that damage control surgery is indeed a measure that increases the survival rate of severely injured patients only if those patients have stabilization of

their physiological parameters within the first 24 hours, if it does not occur, mortality rates remain high[24]. Independent factors affecting the survival of these patients include: Glasgow coma scale lower than eight and a base excess lower than 13.9mEq/L[5]. In our study the need for damage control laparotomy is a major risk factor for death after blunt abdominal trauma. They are more severe patients who it was chosen for an immediate approach due to greater risk injuries and a scheduled reoperation when improvement of physiological parameters. The mortality found in our study was 36%, lower than in studies with similar samples between 38.3 and 41.9%[16,21]. These studies however considered only patients with ISS greater than 18 and excluded patients with negative laparotomy. Our study aimed to find risk factors for bad and good prognosis for the group of patients victims of blunt abdominal trauma undergone exploratory laparotomy. Although we have a good number of subjects, it was a small sample to define with precision all the risk factors.

In conclusion, the groups of healed and death showed no significant statistical difference in epidemiology and mechanism of injury. From this study, we can say that risk factors for death to blunt abdominal trauma who require laparotomy include: hemodynamic instability as an indication for laparotomy, presence of solid organ injury, multiple intra-abdominal injuries, necessity of damage control laparotomy, severe injury associated as head trauma, severe chest trauma, pelvic or femoral fractures, and low trauma index. Among the good prognostic factors we noticed a tendency to factors such as direct abdominal trauma, pain or peritonitis as surgical indication and the finding of isolated hollow viscera injury during surgery (bladder or small intestine).

R E S U M O

Objetivo: *identificar fatores de risco para óbito em pacientes submetidos à laparotomia exploradora após trauma abdominal contuso.* ***Métodos:*** *estudo retrospectivo, caso-controle, no qual foram revisados prontuários dos pacientes vítimas de trauma contuso submetidos à laparotomia. Foram avaliados: variáveis epidemiológicas, mecanismo de trauma, lesões anatômicas das vísceras abdominais, lesões associadas, necessidade de operação para controle de danos reoperação e desfecho.* ***Resultados:*** *dos 86 pacientes, 63% foram curados, 36% foram a óbito e um paciente foi excluído do estudo. Ambos os grupos possuíam epidemiologia e mecanismo de trauma semelhantes, predominantemente adultos jovens do sexo masculino, vítimas de acidente automobilístico. A maioria dos casos que evoluíram a óbito teve instabilidade hemodinâmica como indicação de laparotomia – 61% contra 38% do outro grupo. A presença de lesão de víscera maciça foi maior no grupo óbitos – 80%* vs. *48%, e 61% destes tinham outra lesão abdominal associada contra 25% dos curados. Dos pacientes que faleceram, 96% apresentavam lesões graves associadas. Pacientes que necessitaram de cirurgia de controle de danos tiveram maior taxa de mortalidade. Apenas um de 18 pacientes com lesão de víscera oca isolada evoluiu a óbito. A média do escore de trauma TRISS dos curados (91,7%) foi significativamente maior do que a dos óbitos (46,3%).* ***Conclusão:*** *os fatores de risco para óbito encontrados para vítimas de trauma abdominal fechado que necessitam de laparotomia exploradora são: instabilidade hemodinâmica como indicação para laparotomia, presença de lesão de víscera maciça, múltiplas lesões intra-abdominais, necessidade de cirurgia de controle de danos, lesões graves associadas e índice de trauma baixo.*

Descritores: *Traumatismo Múltiplo. Traumatismos Abdominais. Ferimentos e Lesões. Fatores de Risco.*

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Implementation of the trauma registry as a tool for quality improvement in trauma care in a brazilian hospital: the first 12 months

Implantação de registro de trauma como ferramenta para melhorar a qualidade do atendimento a traumatizados: os primeiros 12 meses

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ABSTRACT

Objective: to analyze the implementation of a trauma registry in a university teaching hospital delivering care under the unified health system (SUS), and its ability to identify points for improvement in the quality of care provided. **Methods:** the data collection group comprised students from medicine and nursing courses who were holders of FAPESP scholarships (technical training 1) or otherwise, overseen by the coordinators of the project. The *itreg* (ECO Sistemas-RJ/SBAIT) software was used as the database tool. Several quality "filters" were proposed to select those cases for review in the quality control process. **Results:** data for 1344 trauma patients were input to the *itreg* database between March and November 2014. Around 87.0% of cases were blunt trauma patients, 59.6% had RTS>7.0 and 67% ISS<9. Full records were available for 292 cases, which were selected for review in the quality program. The auditing filters most frequently registered were laparotomy four hours after admission and drainage of acute subdural hematomas four hours after admission. Several points for improvement were flagged, such as control of overtriage of patients, the need to reduce the number of negative imaging exams, the development of protocols for achieving central venous access, and management of major TBI. **Conclusion:** the trauma registry provides a clear picture of the points to be improved in trauma patient care, however, there are specific peculiarities for implementing this tool in the Brazilian milieu.

Key word: Multiple Trauma. Wounds and Injuries. Trauma Severity Indices. Medical Records. Quality Control.

INTRODUCTION

In 2013, 151,683 trauma patients died in Brazil, amounting to a rate of approximately 415 deaths per day or 17 per hour[1]. There was a 21% increase in mortality due to external causes between 2003 and 2013, accounting for 12.9% of all deaths registered in Brazil[1]. This represents the third most frequent cause of death among Brazilians and, in the population aged 5-39 years, is the leading cause of death in Brazil.Given that trauma predominantly affects younger individuals, it is a cause which most consumes years of productive life.Based on these figures, it can be inferred that trauma is a major burden of society[2].

On the 8th of July 2013, the Ministry of Health approved the project "Line of Attention to Trauma", which lays out clear objectives to change this scenario[3]. Under the project, several measures are proposed to improve care, including the implementation of quality control programs in trauma patient care (PQAT), defined as methods and processes created to continuously monitor the diagnosis, management and evolution of trauma patients[4,5]. The PQAT avails of several different tools, such as trauma registries (TR). morbimortality meetings, investigation of avoidable deaths, development of filters for auditing, morbimortality review committees, cycle outcomes and quality process metrics, among others[5-9]

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The TR is a database which holds specific characteristics of trauma cases, including demographic and epidemiological data, trauma mechanism, pre-hospital care information, diagnostic procedures, treatment administered, patient evolution and costs[5,9-11]. These registries must store information on traumatic injuries, classify them, define their severity and group the information for individual and collective analyses.

The study hypothesis is that the Trauma Registry (TR) is a useful and cost effective tool for identifying specific points to be addressed in a patient trauma care quality improvement process. However, implementation of this system within a hospital that predominantly treats users from the Unified Health System (SUS) poses certain challenges, particularly related to the absence of a local culture for data collection.Few hospitals in Brazil have this experience.

The objective of this study was to analyse the process of implementing a Trauma Registry in a university teaching hospital delivering care predominantly to SUS users, and its ability to identify issues and their impact on improving quality of the process.

METHODS

The study was submitted to the Research Ethics Committee of the Irmandade da Santa Casa de São Paulo Hospital and approved under decision number 656.666.

The software used for the collection and storage of data was *itreg,* developed by *ECO - Empresa de Consultoria e Organização em Sistemas e Editoração Ltda.*, in conjunction with the Brazilian Society of Integrated Care for the Trauma Patient (SBAIT).The *itreg* uses the internet and a site only accessible by authorized users holding the password. Besides the data entry screens, there are pre-established dashboards which allow a clear assessment of the most important points for assessing the quality of trauma patient care in real time.

Briefly, the *itreg* stores data pertaining to patient identification, trauma mechanism, pre-hospital care, transport, initial care, complementary exams (laboratory and imaging), injuries diagnosed, severity of sample (trauma scales), treatment administered, complications, hospital discharge, quality filters (national and international) and ICD, among others. Stratification of severity is performed based on calculation of the following scales: Glasgow coma scale (GCS)[12], Revised Trauma Score (RTS)[13], Abbreviated Injury Scale (AIS-1990)[14], Injury Severity Score (ISS)[15], NISS, NTRISS[16] TRISS[17].

Data collection was carried out by the Trauma Study Group (GET), formed by students from medicine and nursing courses of the School of Medical Sciences of *Santa Casa de São Paulo*. First, a ten hours theoretical-practical training course on data collection for trauma patients was given. A pilot study was then conducted in which data were collected for all trauma patients admitted to the emergency room of the Central Emergency Service of the *Irmandade da Santa Casa de Misericórdia de São Paulo Hospital* over a period spanning three months, commencing in March 2014. After assessing the quality of the data and refining the process, definitive data collection was started for an initial period of 12 months.

During this period, the Quality in Trauma Patient Care Project (PQAT) was implemented within the Emergency Service of the ISCMSP, based on the information from the Trauma Registry (TR).First, meetings were held involving all the attending physicians from the surgical team of the emergency service to present the project and take suggestions to be incorporated into the program. Meetings were also held with the resident doctors from the Surgical Department, showing how the program operates. After these preliminary definitions, the PQAT was officially deployed and run using the following tools: **Routine discussion meetings (RD) -** These meetings were held monthly on the 2nd Tuesday of each month, with discussions centered mainly on routines for patient care. Those wishing to provide input were also invited to take part. A number of matters were tabled and included in an agenda for future discussions; **Morbidity and mortality meetings (MM) –** MM meetings were split into two parts.TR reports are presented first, along with the key numbers and indicators. The next topic is the review of cases pre-selected based on the quality filters of the TR. Auditing filters are variables which are more frequently associated with breaches of protocol or failed care. This calls for thorough case by case review, in a bid to identify the underlying circumstances that led to these occurrences. This process is carried out by an independent auditor (not involved with care of the patient), who reports at the morbidity and mortality meetings of the group. The case reporter makes pertinent comments at this time. Based on this discussion, the points to be addressed by the PQAT are identified. This meeting is confidential in order to protect the parties involved in the discussion of the clinical case. **PQAT Reports –** Based on the ideas raised at RD and MM meetings, a report is produced, which is reviewed by the Director of the Emergency Service and by the other participants.Following approval, this report is sent to those interested (attending physicians, resident doctors, nurses, managers, etc.) via the internet as required. Upon conclusion of the project, the group intends to produce a manual containing all the reports discussed in order to assist in the PQAT of other interested institutions. **Continued education –** Drawing on the points discussed at the previous meetings, an issue is chosen for weekly review.As decided by the attending doctors, an article is sent by email to all participants for review of the subject and updating of the team. Depending on the topic, a specific meeting to define the protocol is decided and scheduled.

In the present study, the process of implementing the TR as a whole was analyzed, including the obstacles

encountered and solutions found.An assessment of the data collected was carried out in an effort to identify key points on which trauma patient care can be improved by specific interventions and training of the group. The preliminary phase of the PQAT was also evaluated, specifically the problems observed and the proposed solutions to remedy them.

RESULTS

Data collected

As of 24/11/2014, data for 1344 trauma patients had been input to *itreg*. Around 87% were blunt trauma patients, among which the most common mechanisms were falls from the same level (17.3%), followed by falls from height (16.1%), motorcyclists (15.6%) and being struck by a vehicle (15.2%).

Analysis of sample severity revealed that the vast majority of patients (89.1%), at admission, had a Glasgow coma scale score of 13-15 while only 7.6% had systolic arterial pressure under 100mmHg.The sample was characterized by the large number of patients (59.6%) with RTS>7.0 (without significant physiological changes) and ISS<9 (67%) (without serious injuries) (Figure 1).

From these records, 292 were reviewed and completed, forming the sample for the assessment of the quality control variables. Figure 2 shows patient destination following assessment. The majority of those admitted remained within the emergency service, either in a ward bed, emergency room bed or semi-intensive care unit. Only 21 out of the 292 closed files were admitted directly (<24 hours) to intensive care. Among patients with closed files, the most common treatments administered were thoracic drainage (12%), laparotomies (6.8%) and conservative management of limb fractures (5.8%).

The most frequent complications were respiratory failure and hemodynamic shock.Iatrogenic pneumothorax was noted in seven out of the 292 patients with closed files (Figure 3). Twenty-seven patients died, representing 9.2% of closed files.The most common causes of death were traumatic brain injury (11) and hemorrhage (5).

The auditing filters most frequently identified were laparotomy four hours after admission (3.4%), commencement of nonoperative management for injuries to the liver, spleen, kidney and/or pancreas (2%), and drainage of acute subdural hematomas four hours after admission (1.7%) (Figure 4). Lethality was highest for RTS scores <2 and for ISS scores >25 (Figure 5).

Figure 1 - *Severity of the sample.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

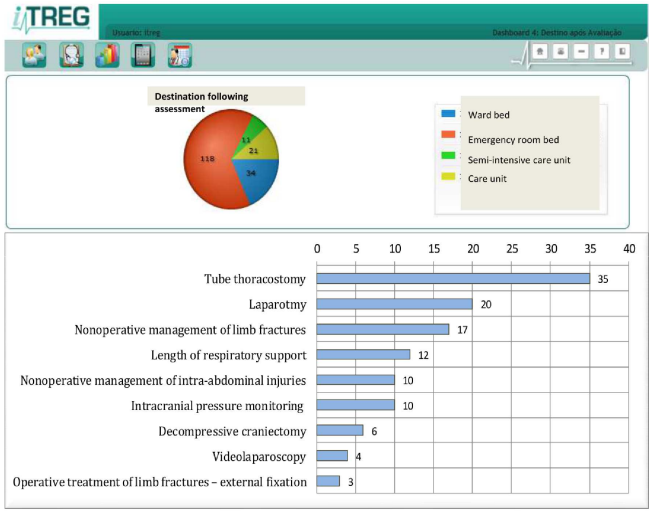

Figure 2 - *Destination after initial assessment and most frequently administered treatment options in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

DISCUSSION

There is no question that TR yield valuable information[4,5,18]. In the context of quality control and trauma care, the outcome and the costswould be more accurately assessed. The main challenge might be implementing the TR, particularly in settings without a culture of data collection and quality control processes[19-22].

Analysis of TR implementation

The pilot project brought many obstacles to light. The first of these was identifying and locating trauma patient amid the flow of patients through the emergency room,

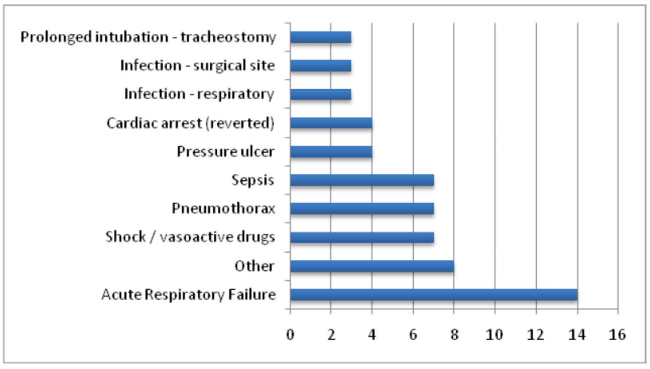

Figure 3 - *Most frequent complications observed in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

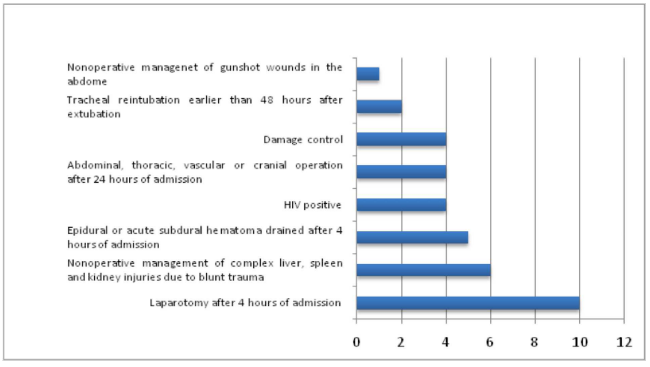

Figure 4 - *Auditing filters for trauma observed in 292 patients with closed files.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

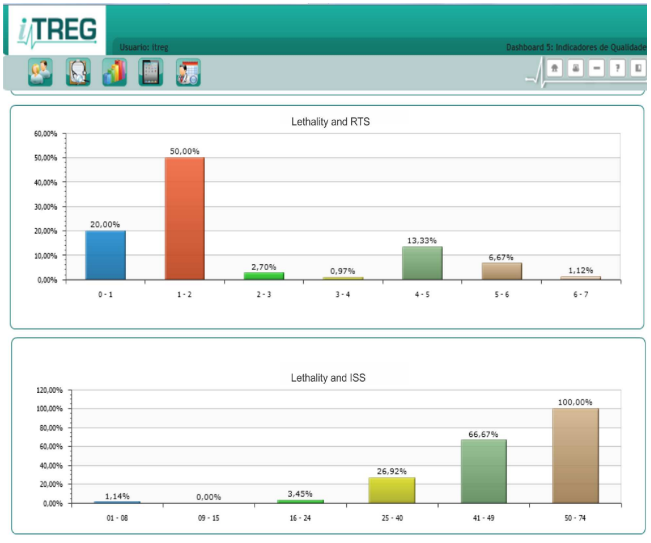

Figure 5 - *Distribution of lethality (within 30 days) according to RTS and ISS severity scales.*

Source: Emergency Service of the Irmandade da Santa Casa de Misericórdia de São Paulo *Hospital.*

whose occupancy averages 100-120 clinical and surgical cases (despite having "only" 62 beds).

The entry point of trauma patients is via the Emergency Room at "Trauma Room 1". Depending on the case, the patient may be referred to undergo complementary exams, or transferred to the ward, intensive care and/or surgical center. Since there are often no beds available initially, patients may remain on gurneys for a period. The space within the PSC where patients are placed temporarily varies according to demand and availability, and changes throughout the day, precluding attempts to list the patients. Given that the service handles an average of 20-30 trauma patients daily, besides other PSC patients, locating a particular patient amidst this volume became problematic.

This was exacerbated by the fact that only one GET member was present per shift (12-hour night shift) where covering all these locations at once proved impossible. The members of the GET were often not in the trauma room at the time of patient arrival. The most obvious alternative was to ask administrative clerks and or resident doctors to advise GET members upon entry of a trauma patient, but this often did not take place, compromising admissions data collection.

In an effort to complete the necessary information, data was drawn from patient medical charts. One of the major points was identified during the initial phase: the information needed for quality control of trauma care was missing from medical charts. This relates mainly to data on respiratory rate and Glasgow coma scale, needed to calculate the trauma measures and probability of survival. In some cases, the description of the clinical decision-making process in the charts was unclear, which hampered the GET team members who had problems completing the TR.

The situations above led to another problem: some files were "opened" by scholarship holders but not closed (i.e. not completed with all the necessary data) prior to patient discharge from the hospital. This resulted in a very large number of "open" files, which contained only information collected at admission plus exams ordered, yet not including exam results, injuries diagnosed and treatment proposed nor details of complications and deaths. Without this data, setting up a quality program would not be possible. The *itreg* revealed this problem, showing a large number of open files together with a low rate of injuries and complications.

The existence of a learning curve for data collection was clear. The GET comprised medical students in their second or third yearand nursing students in their fourth year of the course. All had an evident learning curve. During the pilot project period, numerous basic doubts were brought up at the meetings and all learned from the experience. The main limitations were difficulty understanding the written annotations in the medical charts, treatment procedures, clinical outcomes and grading

anatomical injuries using the AIS-90 table.

These issues were discussed at the GET meetings and those of PQAT members. The primary objective was to set-up an information system to alert the GET upon entry of a trauma patient to the trauma room, and to facilitate the process of finding the trauma patients still in the central emergency room and those who had been transferred to other units of the hospital. To this end, the following steps were taken: a) The residents responsible for attending the trauma patients were made aware that if no GET member was present upon admission of a trauma patient then a member should be alerted; b) A group was set-up on the *WhatsApp* application called *Trauma alert*. The most qualified residents on the shift sent a daily alert to GET members detailing the trauma patients undergoing follow-up and/or operated in the last 12 hours, along with their diagnosis, registration and procedures performed; c) A table of patients admitted to hospital and followed by the GET was created and made available on the "cloud" using the spreadsheet application and updated daily by GET members. This listing served less to locate the patient bed but more to inform whether the patient had left the hospital; d) A log book registering all trauma patients included in the *itreg* during each shift was introduced. A photograph of the log book page was sent daily by the shift leader to the *WhatsApp* group GET it and served as a control for patients input into the program; e) GET members were tasked with starting their shift by doing a "round" of all the trauma patients present in the PSC, done together with the group of residents and assistants taking over the shift, thereby guiding objectives; f) A subgroup of the GET responsible for the daily visit to the hospitalized patients was set–up. This subgroup was called "horizontal" as its work times were spread over the five working days of the week to allow linear follow up. Because they had the afternoons free, nurses and nursing students were chosen for this task. This was an important point, since it established a "trauma visit" which involved not only the scholarship holders but also the group researchers.

Another solution found to help optimize the closure of files was to schedule "closure meetings", held weekly at a dedicated time outside shifts or other commitments. Based on the information drawn from medical charts, the data on the *itreg* was reviewed and incomplete fields filled out up to the time of patient exit. The presence of a more experienced researcher was found to be fundamental to ensure the information entered into *itreg* was truly reliable. Interpreting the medical chart is often challenging for students, calling for more clinical experience.

Despite all these resources, it was noted that gaps existed in the shift roster, reducing the number of patients input into *itreg*. Since there were a number of scholarships unused because they were different types, a request for reallocation of the available funds to TT1 type scholarships was made. A further 15 TT1 scholarships were approved and another selection process began. Since then, the GET has scholarship holders carrying out data collection during the night shift (12 hours) seven days a week, while coverage is 24 hours at weekends and there is also the afternoon group (horizontal group) during week days.

In Brazil, the vast majority of trauma patients are first attended in hospitals under the *SUS*.The financial difficulties faced by some of these institutions are well known.Most of the hospitals cannot afford to hire (through public admissions procedures) specialized personnel solely to collect data. Resources are generally allocated to other areas, particularly in healthcare delivery.

Nevertheless, there are numerous benefits of quality control in trauma care, the "heart" of which is the information collected and stored in the TR. It is important to grasp the concept that quality control is not a means to punish people but a tool for protecting them. Once the initial obstacles have been overcome, the analysis of the data becomes the main tool for improving the service. We believe that when results improve, the rate of complications will fall, also promoting shorter hospital stays, lower costs with intensive therapy, nutritional support and antimicrobials, among a series of other advantages.

Many challenges were faced during the implementation of the project as a whole. We provided a detailed description of the most important points in order to help pave the way for other researchers and hospital managers who choose to pursue this path. These obstacles go far beyond mere tailoring of the software for use in Brazil, but also involve the training of an inexperienced group to carry out a relatively complex procedure. Once all the elements have been put in place, the challenge is to keep the group together and working smoothly, since many individuals are having to work together as a team, giving rise to specific problems.

The TR originated in the developed trauma systems from North America, which spread quickly to Europe. The culture of quality control is directly linked to improvements in performance on many fronts, including financial.Centers that fail to submit their data to regulatory agencies do not receive funding.This does not occur in Brazil, which may be one of the reasons explaining the low number of services with active TR.

There is a major difference between the model proposed in the present study and that observed in centers with TR experience. At more developed trauma centers, data collection is done professionally. There is the role of Trauma Nurse, with specific training and paid solely for working on TR[7]. This professional has access to the medical charts containing information on treatment and feeds this data into the TR retrospectively. The present project also differs in another respect. If this professional model had been implemented instead, invaluable information on pre-hospital care and admission would have been lost, since this data often goes unrecorded in medical charts.One of the insights gleaned from implementing this program in the hospital was the need to create tools to improve the

filling out of information in medical charts. Until this need is addressed, a system of "prospective collection" has been introduced, requiring the efforts of a large group of people.

Regarding the data collected, there is much to be done to achieve complete analysis. Ideally, all the open records should be "closed" when the patient leaves the hospital. This proved impossible under the current conditions, generating information which does not lend itself to scientific interpretation. Current efforts are focused on attempting to reduce the number of open files through the closure meetings outlined earlier.

However, a number of key points have been identified in this initial assessment. A large number of trauma patients treated by the service were found to have no major injuries. Only a small percentage of patients presented serious injuries and remained hospitalized after initial assessment. This phenomenon is known as "overtriage" and occurs when mild cases are referred to advanced trauma centers (tertiary, quaternary and/or university teaching hospitals), when they could be treated in secondary hospitals. The consequences are clear and exacerbated in an emergency service with a high volume of patients such as ours: patients, even devoid of serious injuries, require professionals for care, and also for ordering and scheduling complementary exams. This diverts some of the team to a group of trauma patients without major injuries, whilst other more serious cases need their assistance; gurneys and physical space are occupied in the emergency service until all the teams have gone over the patient and exam results again; there is high demand for use of imaging methods, such as X-ray, ultrasound and tomography. The patient flow of the service is negatively impacted by a large number of exams testing negative.

The occurrence of a high rate of negative exams may be due to several factors:the cause of this phenomenon may be related to failure to follow protocols for ordering exams, which may indicate the need for targeted actions in the quality program for group training; the protocols for ordering exams are flawed and should be revised. This is because some protocols allow a high rate of negative exams.In trauma, many severe injuries can be present in asymptomatic patients and an active search can lead to negative exams; these exams overload the group of professionals that attend trauma patients and also the equipment available, causing the problems cited above.

The most frequent complications observed were systemic in nature: respiratory failure and shock requiring vasoactive drugs. Local complications were less common. These complications are likely related to the systemic inflammatory response secondary to trauma (first hit) or to an infectious insult (second hit). Other important points for deployment in the quality program were the presence of iatrogenic pneumothorax and pressure ulcers. Both of these complications can be addressed by the application of protocols to reduce their occurrence through education and preventive measures. As observed in most casuistics, traumatic brain injury was the most common cause of death, followed by hemorrhaging. Likewise, specific protocols can be developed and applied to target these problems.

The evaluation of the quality filters in the TR revealed that some of these situations were clearly more frequent, such as subdural hematoma drainage four hours after admission. Each of these cases was reviewed to identify the issues that contributed to delays in surgical procedures or to ascertain whether failures in the process took place. Employing the TR for its primary purpose, namely, to identify key points where the quality program can be most effective, produced important results. One of the most effective ways of improving quality was the identification of cases for review at the closed MM meetings. The TR was pivotal in flagging those cases associated with points to be improved in the process. This appeared to be one of the greatest benefits of implementing the TR.

Concerted efforts to maintain the quality of care delivered to trauma patients have been made for years in the institution. The PQAT served to organize and standardize this process. The engagement of the group of professionals hired is variable and hinges wholly on personal motivation. However, many physicians hired to practice in emergency services have time available only for healthcare assistance. Extra meetings and continued education were not envisaged, which can sometimes pose a problem. Attendance at routine discussion and MM meetings depends on this variable. In order to raise the knowledge level of the group on the PQAT, reports were made available to the attending physicians of the service by email. We feel that, within a mature quality program, all professionals involved in trauma patient care should have a remunerated dedicated period every week to participate in the PQAT, which also includes continued education.

Another positive aspect observed at the meetings for defining routines is the involvement of various professionals including those from different medical specialties. This forms a task force which, working together, is better able to resolve problems and pursue action on different fronts.For example, at a meeting to define transfusion protocols, there was involvement from not only the general surgeon but also blood bank professionals, hematologists, the nursing area, transport, anesthesiologists and intensivists, among others. Consequently, the protocol becomes more widely disseminated outside the specific area, facilitating its application. At morbidity and mortality meetings, this multi-disciplinary approach was maintained in the medical chart review process. Suggestions for enhancing the process were made to the group as a whole and not only the professionals that handled the cases. All the specialties and professionals involved are kept abreast from an educational standpoint.

The *Itreg* was developed by ECO in conjunction with SBAIT based on the San Diego trauma registry (CA).

Tailoring to meet Brazilian needs was overseen by a working group from the SBAIT that drew on services with greater experience in data collection in Brazil, with the wider goal of devising a Brazilian Trauma Registry (Brazil TR). The Brazil TR can provide an overview of the characteristics of trauma on a national scale hitherto never seen. The possibility of benchmarking would allow more effective self-assessment, contributing to an improvement in the quality of trauma patient care. In the present study, this software was applied in a pioneering program which, allied with an appropriate quality program, proved highly effective in evidencing the needs for improvements in the service. Moreover, application of the *itreg* software makes the creation of the Brazil TR feasible.

It is noteworthy that the mere implementation of the quality program has led to clear changes in the registering of information. The fact that professionals are aware there is documentation and observation of events has had an extremely positive effect. The trauma registry and trauma care quality improvement program have proven fundamental and vital tools for hospitals responsible for handling this special patient group.

R E S U M O

Objetivo: *analisar a implantação de registro de trauma em hospital universitário com atendimento ao SUS, bem como, sua capacidade em identificar pontos para melhorada qualidade no atendimento.* ***Métodos:*** *o grupo de coleta de dados foi composto por alunos dos cursos de medicina e enfermagem, orientados pelos coordenadores do projeto. Utilizamos o software* itreg *(ECO Sistemas-RJ/SBAIT) como ferramenta de banco de dados. Vários "filtros" de qualidade foram propostos no intuito de selecionar os casos a serem revistos no processo de controle de qualidade.* ***Resultados:*** *entre março e novembro de 2014, foram inseridos no* itreg *dados de 1344 vítimas de trauma. Cerca de 87% foram vítimas de trauma fechado, 59,6% apresentaram RTS>7,0 e, 67%, ISS<9. Os registros foram completos em 292 casos, que foram selecionados para a revisãono programa de qualidade. Os filtros de auditoria mais frequentemente anotadosforam a laparotomia após quatro horas da admissão e a drenagem dos hematomas subdurais agudos após quatro horas da admissão. Identificamos vários pontos a serem desenvolvidos, como o controle da "supertriagem" de doentes, a necessidade de diminuição do número de exames de imagem negativos, o desenvolvimento de protocolos para passagem de acessos venosos centrais e tratamento de trauma craniencefálico grave.* ***Conclusão:*** *o Registro de Trauma traz uma visão clara dos pontos a serem melhorados no atendimento ao traumatizado, contudo, há características específicas na implantação desta ferramenta.*

Descritores: *Traumatismo Múltiplo. Ferimentos e Lesões. Índices de Gravidade do Trauma. Registros Médicos. Controle de Qualidade.*

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Curbing Inflammation in hemorrhagic trauma: a review

"Curbing Inflammation" e hemorragia por trauma: uma revisão

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A B S T R A C T

Trauma is one of the world's leading causes of death within the first 40 years of life and thus a significant health problem. Trauma accounts for nearly a third of the lost years of productive life before 65 years of age and is associated with infection, hemorrhagic shock, reperfusion syndrome, and inflammation. The control of hemorrhage, coagulopathy, optimal use of blood products, balancing hypo and hyperperfusion, and hemostatic resuscitation improve survival in cases of trauma with massive hemorrhage. This review discusses inflammation in the context of trauma-associated hemorrhagic shock. When one considers the known immunomodulatory effects of traumatic injury, allogeneic blood transfusion, and the overlap between patient populations, it is surprising that so few studies have assessed their combined effects on immune function. We also discuss the relative benefits of curbing inflammation rather than attempting to prevent it.

Key words: Wounds and Injuries. Traumatology. Multiple Trauma. Blood Transfusion. Inflammation Mediators. Immunologic Factors .

INTRODUCTION

Trauma is a leading cause of death within the first 40 years of age around the world and one of the most significant health problems. It accounts for nearly a third of the lost years of productive life before 65 years of age[1]. Our ability to keep trauma patients alive leads to a clinical syndrome known as multiple organ dysfunction (MODS) after multiple traumas. This syndrome is associated with infection, hemorrhagic shock, reperfusion syndrome, and an inflammatory response[2]. The control of hemorrhage, coagulopathy, optimal use of blood products, balancing hypo and hyperperfusion, and hemostatic resuscitation improve survival in cases of trauma with massive hemorrhage[3]; however, many survivors develop organ dysfunction and sepsis due to a systemic response to traumatic aggression and treatment[4].

This review aims to present concepts of inflammation in the context of trauma-related hemorrhagic shock. We were motivated by the International Journal of Inflammation proposed special issue on "Curbing Inflammation 2013" and by Jackman superb review of immune modulation in transfused trauma patients[5]. When we consider the known immunomodulatory effects of traumatic injury, allogeneic blood transfusion, and the overlap between patient populations, it is surprising to find so few studies of their combined effects on immune function. In addition, the curbing inflammation overlaps the "preventing" leading to a speculative exercise.

Definitions of inflammatory reaction syndromes

The exaggerated inflammatory response is regulated by a rapid anti-inflammatory response to acute phase proteins; this is known as compensatory anti-inflammatory response syndrome (CARS). Elevation of these acute-phase proteins is a nonspecific response to infection, inflammation, and tissue damage, and its primary function is to restore homeostasis and increase the chance of survival[6,7].

This anti-inflammatory response leads to immunosuppression, which according to its magnitude, can lead to life-threatening sepsis. Systemic inflammatory response syndrome (SIRS) and CARS occur simultaneously in an antagonistic response syndrome known as the mixed antagonistic reaction, contributing to the occurrence of infection, sepsis, and MODS, which is a progressive and potentially reversible condition involving physiological dysfunction of two or more organs or systems. A diagnosis of MODS is based on its severity, as judged by several indices of cardiovascular, respiratory, renal, and liver dysfunction. The most widely used indices for evaluation of organ dysfunction are the MODS score and the sequential organ failure assessment.

Ciesla *et al.*[8] recognize another condition called post-injury MODS, an inflammatory disorder that affects approximately 25% of severely traumatized patients. MODS has a complex etiology associated with patient-specific factors and treatment[9].

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Endogenous loss of hemostasis occurs very early after trauma. This condition has been called "acute traumatic coagulopathy" (ATC). Approximately 25–30% of all patients with severe trauma are admitted with some degree of coagulopathy and are particularly susceptible to MODS, infection, and death[10]. ATC is a multifactorial condition caused by bleeding-induced shock, tissue injury related to formation of the thrombin complex, and thrombomodulin activation of anticoagulation and fibrinolysis[11].

The allogeneic blood transfusion as a predictor of an increased inflammatory response and post-traumatic infection. This reaction is probably related to contaminating leukocytes and inflammatory mediators in the red blood cell bags and immunosuppression caused by hemorrhagic shock[12]. Wafaisade *et al.*[13] found a dose-dependent relationship between massive transfusion and post-traumatic risk of infection was doubled in patients who received ten or more units of packed red blood cells. The physiopathological association between hemorrhagic trauma, coagulation, and inflammation is presented in figure 1.

Severe trauma and hemorrhagic shock activate the host immune response, leading to SIRS, MODS, and death. The accepted "two-hit" theory[14] (Figure 2), suggests major trauma (the "ûrst hit"), activates or "primes" the immune response, rendering patients susceptible to a subsequent "second hit" such as delayed hemorrhage, hypoxia, ischemia/ reperfusion, massive ûuid resuscitation, operative intervention, or infection, leading to an uncontrolled inûammatory response and MODS. According this theory, the "first hit" is the opportunity to actively curb inflammation in order to avoid the "second hit".

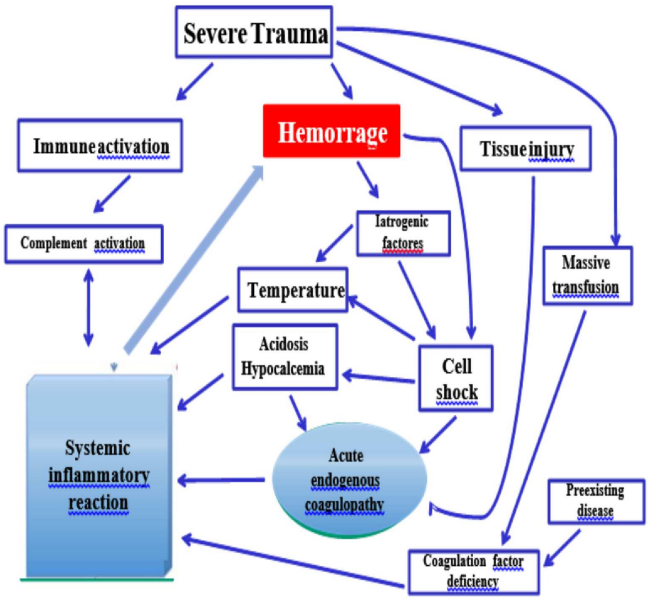

Figure 1 - *The physiopathological association between hemorrhagic trauma, coagulation, and inflammation.*

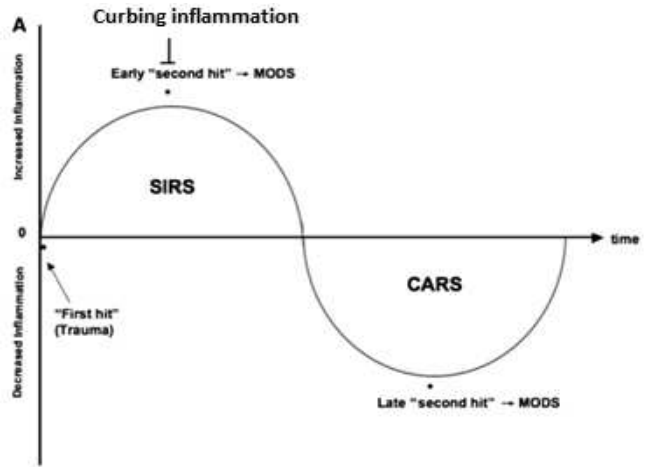

Figure 2 - *The "two-hit" theory (adapted from Sailhamer, 2008)[14].*

Biomarkers

Activation of the inflammatory response and the subsequent risk of sepsis and organic dysfunction are dependent on individual factors and the magnitude of the traumatic injury. The base deficit (BD) is found early in poorly perfused trauma patients and is a predictor of mortality regardless of organ dysfunction[15]. Mutschler *et al.* demonstrated the importance of BD in the classification of hemorrhagic shock and identification patients who need early blood transfusion[16].

Namas *et al.* suggested that the magnitude of inflammatory biomarkers differs in patients with similar injuries[17], suggesting those with a propensity to inflammation and infection should be identified early. This study concluded that the biomarkers involved in the first 24 hours of inflammatory trauma are interleukin (IL)-7, IL-4, IL-2, IL-13, IL-5, and IL-1â. These mediators remained high during the first seven days in comparison to patients who did not develop an infection.

Gouel-Cheron *et al.* demonstrated that IL-6 and HLA-DR, when measured early, are significant predictors of sepsis. A decline in HLA-DR expression on the monocyte surface[18] is an important biomarker of a decrease or even inactivation of monocyte production of inflammatory cytokines. The role of cytokines in the pathophysiological and physiological response to tissue damage in trauma, and a many inflammatory markers have emerged as predictors.

Pathophysiology

Severe injury induces an inflammatory response followed by another anti-inflammatory (CARS) reaction which creates a transient immunosuppression state. This state is believed to be directly related to a predisposition to nosocomial infections in patients who survived to the initial resuscitation.

The inflammatory response after trauma involves interaction of the hemostatic system, inflammation, and endocrine and neurological responses, compounded initially by the injury caused by hypoperfusion and reperfusion. The endothelium activated by exposure to inflammatory cytokines becomes more porous, allowing the migration of tissue injury mediators to the intercellular space. The inflammatory response to severe trauma is associated with a reduced ability to fight infection, sepsis, and allows a greater inflammatory response.

The vascular endothelium is an important participant in the pathophysiology of ATC. Tissue damage and the endothelial lesion, especially in the area of injury, start the clotting process after exposure to subendothelial collagen type III and tissue factor. These factors bind to von Willebrand factor, platelets, and activated factor VII. Finally, the "tissue factor/activated factor VII" complex activates coagulation proteases in the plasma, resulting in the formation of thrombin and fibrin[10].

Activation of the coagulation proteases leads to inflammation through cell surface membrane receptors. Platelet degradation releases lysophospholipids, which enhance the immune response by activating neutrophils and endothelial adhesion. In addition, monocytes express tissue factor and can adhere to platelets. Activation of endothelial thrombomodulin-protein C and the competitive binding of protein S to C4b protein can lead to changes in the anticoagulation pathways[10].

It is unclear why only some trauma patients, even those with the same demographic characteristics and trauma severity, develop a hyperinflammatory reaction and post-traumatic infection. The exacerbated response results in a second lesion known as a "second hit", making patients more susceptible to infection[17].

Curbing hemorrhagic shock inflammation

Mortality from trauma has decreased in recent decades due to improvements in prehospital care, the development of trauma systems, the use of Damage Control tactics and developments in fluid resuscitation, diagnosis, and treatment of coagulopathy associated with trauma. The strategies employed during and after the initial resuscitation phase are designed to prevent MOD after initial resuscitation, through modulation of the inflammatory response and stimulation of immunity.

Immunomodulation

Several attempts have been made to reduce, curb, or even avoid an exaggerated inflammatory response. Strategies including activation of neutrophils, the use of antioxidants in ameliorating free-radical damage, and hydrocortisone have not yielded significant results. Many immunomodulatory measures, such as the use of immunoglobulins and interferon (IFN), have been shown to improve parameters that indicate inflammation. However, they did not alter infection and mortality rates. Administration of immunoglobulins may normalize IgG concentrations that are reduced after traumatic aggression and thus produce a better response by the host to antigen presentation. Douzinas *et al*. performed a prospective, randomized, double-blind trial and proposed the use of intravenous immunoglobulin as prophylaxis for infection and sepsis after trauma[19]. They observed no reduction in mortality, but there was a decrease in the incidence of pneumonia, especially when associated with immunoglobulin antibiotic. Glinz *et al*. performed a similar study and concluded that immunoglobulin administration did not reduce the occurrence of sepsis, but did reduce pneumonia in hospitalized trauma patients[20].

The post-traumatic inflammatory response appears to be associated with a decrease in antigen presentation capacity and a dysfunction of macrophages. The suppression of macrophage function by reducing HLA-DR expression is related to increased mortality in severe trauma. In addition, IFN-ã is a cytokine with many positive effects including up-regulation of monocyte class II and HLA-DR, and the production of various inflammatory mediators. IFN-ã enhances antigen presentation to lymphocytes by inducing HLA-DR expression on monocytes, which is associated with a reduction in infection and mortality rates[21]. Therefore, to reverse the detrimental suppression of adaptive immunity, restoration of IFN-ã-dependent pathways with exogenous IFN seems an appropriate avenue to explore[22].

Immunonutrition

Immunonutrition refers to the addition of specific nutrients in specialized therapy (parenteral, enteral or both) to improve immunological function and reduce inflammation and complications associated with sepsis. The post-trauma stress and treatment related to the hyper-inflammatory reaction, with increased energy expenditure and catabolism, often cause a negative protein balance. Release of certain cytokines, albumin, and pre-albumin loss, and an increase in acute phase proteins are associated with the inflammatory phase followed by an anti-inflammatory response and immune paralysis. Nutritional therapy should be introduced early, at least within the first 48 hours after injury or preferably within 24 hours, if the patient is hemodynamically stable, even with administration of vasoactive drugs.

The use of immune nutrients appears to benefit the most severely ill patients. The most used immune nutrients are glutamine, arginine, nucleotides, and omega-3 fatty acids. Glutamine is widely used because it specifically prevents bacterial translocation. However, Heyland *et al*. published a randomized, multicenter study in 2013 that concluded that the early use of glutamine in critically ill patients with organ dysfunction increased mortality[23]. Thus, despite evidence of the importance of nutrition therapy to protect severe trauma, additional studies are needed to verify its efficacy.

Antioxidants

Experimental evidence suggests replacement of rapidly depleted antioxidants in critically ill surgical patients decreases the risk of organ failure (especially adult respiratory distress syndrome), length of stay, and overall mortality[24]. Massive doses of vitamin C decrease microvascular leak and volume requirements after burn injuries[25], and lyophilised plasma reconstituted with vitamin C and water is better than fresh frozen plasma (FFP) for hemorrhage control, suppression of dysfunctional inûammation, and antioxidant capacity in complex multiple-injury porcine models[26,27]. It is unclear whether generic antioxidants or speciûc combinations of agents are necessary.

Acetylation

Acetylation is a method for modulating the immune response following trauma/hemorrhage and inflammatory second hit in animals and humans. The Sailhamer research group[28-30] suggested that hemorrhage induces an imbalance in histone acetyltransferase/histone deacetylase (HAT/HDAC) ratio. In that way, first hit correction of this imbalance with histone deacetylase inhibitors (HDACI) could improve survival. The tested agents were SAHA (suberoylanilide hydroxamic acid, HDACI) and Garcinol (HAT inhibitor).

Other measures

The measures described above are far from efficient. These studies and clinical practice have made it clear that the inflammatory response is present in all trauma patients. However, their responsiveness to anti-inflammatory therapy is extremely individualized.

Coagulation control

The CRASH 2 clinical trial, published in 2010, showed that tranexamic acid (ATX) significantly reduced mortality in bleeding trauma patients when administered within three hours of the traumatic event[31]. ATX is an antifibrinolytic similar to lysine; it interferes with plasminogen-fibrin binding, which is necessary for plasmin activation. The breakdown of fibrin by plasmin is the basis of fibrinolysis. Inhibiting degeneration of fibrin may increase survival by improving the stability of the clot and by limiting the inflammatory response caused by fibrin degradation products[32]. Cole *et al.* performed a prospective study of ATX and found a relationship between the drug and reduced organ failure rates in patients admitted in hemorrhagic shock[33]. By inhibiting the conversion of plasminogen to plasmin, ATC could modulate plasmin-mediated inûammation, neurotoxicity, and ûbrinolysis[34]. The interaction between coagulation and several immune pathways makes plasmin an appealing target.

An alternative to early detection of ATC and the need for blood transfusions and other blood products is the use of viscoelastic methods. These tests, in use since 1948, have the advantage of providing, with a minimum amount of blood, quick results in the mechanical and physical properties of clot development. In addition, they provide information on the need and contribution of red blood cells, platelets, and coagulation factors, making it the only method that allows rapid identification of the hyperfibrinolytic state. The viscoelastic tests (TEG®/ ROTEM®) have proven useful in guiding transfusion and reducing the use of blood components[35].

Trauma damage control

The use of antibiotic prophylaxis, starch avoidance for fluid resuscitation, and limited use of red-blood-cell transfusions are supported by several studies of patients with major trauma. The occurrence and severity of trauma-induced coagulopathy is largely due to tissue trauma and shock-induced hypoperfusion. Coagulopathy is amplified by factors such as hypothermia or dilution. Diagnosis and therapy of deranged coagulation should start as soon as possible. Routinely tested coagulation parameters are of limited diagnostic use. Treatment follows the concept of "damage control resuscitation". Infusion of large volumes should be avoided, and a mean arterial pressure of 65mmHg (with an eye to contraindications!) may be targeted[36]. Specific protocols for massive transfusion should be introduced and followed. Acidemia should be prevented and treated with appropriate shock therapy. Loss of body temperature should be avoided. Hypocalcemia <0.9mmol/ L should be prevented and may be treated. For actively bleeding patients, packed red blood cells may be given at haemoglobin <10g/dL (0.62mmol/L)[33]. If massive transfusion is performed with fresh frozen plasma, a ratio 1:2 to 1:1 of fresh frozen plasma/packed red blood cells should be achieved[37].

To treat hyperfibrinolysis after severe trauma, early use of ATX should be considered[36]. Fibrinogen should be substituted at levels <1.5g/L (4.41ìmol/L). Prothrombin complex concentrates may help to treat diffuse bleeding or to treat patients undergoing anticoagulant therapy. In acute bleeding, platelets may be transfused at a platelet count of <100,000/ìl. For diffuse bleeding or thrombocytopathic patients, desmopressin might be a therapeutic option. If a factor XIII (FXIII) measurement is not promptly available, a factor XIII blind-dose should be considered in severe ongoing bleeding. The use of recombinant activated coagulation factor VII (rFVIIa) may be considered if significant bleeding persists despite standard attempts to control bleeding and best practice use of blood components[37].

Gruen *et al.* are exploring speciûc treatments to curb the inûammatory response to hemorrhagic shock[22]. Even considering the molecular basis of disease, most studies have focused on isolated components or limited pathways of the complex immunological processes, without reproducible clinical beneûts. Because of the extensive redundancy and parallel eûciencies of the immune system, only a multipronged approach or a suûciently broadly

eûective treatment seems likely to have a measurable clinical beneût. The current options for curbing hemorrhagic trauma inflammation are presented in table 1.

CONCLUDING REMARKS

Considering the known overlapping effects of immunomodulatory traumatic injury and allogeneic blood transfusion, there is a surprising paucity of studies assessing their combined effects on immune function.

Activation of the inflammatory response and the risk for sepsis and organic dysfunction are dependent on individual factors and the magnitude of traumatic injury.

The magnitude of inflammatory biomarkers differs between patients with similar injuries, suggesting the need to quickly identify those with a propensity to inflammation and infection.

The inflammatory response after trauma involves the interaction of the hemostatic system, inflammation, and endocrine and neurological function, and is compounded by the injury caused by hypoperfusion and reperfusion.

It is unclear why only some trauma patients, even those with the same demographic characteristics and trauma severity, develop a hyper-inflammatory reaction and post-traumatic infection.

Mortality from trauma has decreased in recent decades due to improvements in prehospital care, the development of trauma systems, the use of Damage Control tactics and developments in fluid resuscitation, and diagnosis and treatment of coagulopathy associated with trauma.

Strategies during and after the initial resuscitation phase are designed to prevent MODS after initial resuscitation, mainly through modulation of the inflammatory response and immune stimulation.

Table 1 - Options for curbing hemorrhagic shock inflammation.

Curbing hemorrhagic shock inflammation
1. Immunomodulation: hydrocortisone, immunoglobulins and interferon
2. Immunonutrition: parenteral nutrition therapy
3. Antioxidants: High doses of vitamins C and A
4. Acetylation: SAHA (suberoylanilide hydroxamic acid, HDACI), or Garcinol (HAT inhibitor).
5. Coagulation control
6. Trauma damage control

R E S U M O

O Trauma é uma das principais causas de morte até 40 anos de idade em todo o mundo e, portanto, um significativo problema de saúde. Esta doença é ainda responsável por quase um terço dos anos perdidos de vida produtiva até os 65 anos de idade e esta associada com infecção, choque hemorrágico, síndrome de reperfusão e inflamação. O controle da hemorragia, coagulopatia, utilização dos produtos derivados do sangue, equilibrando hipo e hiperperfusão, e reanimação hemostática melhoraram a sobrevida em casos de trauma com hemorragia volumosa. Esta revisão discute a inflamação no contexto de choque hemorrágico associado ao trauma. Quando consideradosos efeitos imunomoduladores conhecidos da lesão traumática e transfusão de sangue alogênico em relação aos doentes, é surpreendente que tão poucos estudos avaliaram os seus efeitos combinados sobre a função imunológica. Discutimos também os benefícios relativos de reduzir a inflamação ao invés de tentar impedi-la.

Descritores: *Ferimentos e Traumatismos. Traumatologia. Lesões Múltiplas. Transfusão de Sangue. Mediadores da Inflamação. Imunomoduladores.*

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