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Diagnosis, outcome and factors of predicting mortality of patients with abdominal trauma injury in resource-limited areas: Case of Lubumbashi in Democratic Republic of Congo

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Abstract
Introduction: *There has been a global increase in the incidence of abdominal trauma in surgical patients and abdominal trauma is a major public health problem for all nations and all socioeconomic strata. Abdominal trauma have a poor prognosis in the absence of prompt diagnosis and adequate management. We carried out this study with the objective of insisting on the clinical diagnosis in a settings with limited-resources, and highlighting the mortality factors.*
Patients and Methods: *This was a cross-sectional descriptive study carried out in surgical emergency department of Lubumbashi university hospital. We reviewed prospectively medical records of patients who had laparotomy or not after abdominal trauma. It had involved 93 patients with abdominal trauma. Statistical analyzes were performed using Epi info 7.2.2.6 software and IBM SPSS 25 software.*
Results*: A total of 93 patients with abdominal trauma were collected and treated by our surgical squad. Hypotension was present 20.43% and was severe in 2.15%. Index choc was greater than 0.9 in 62.36%. Hypothermia was present in 17 patients (18.27%) and only 3 patients (3.22%) had fever. In all, 89.24% of patients had tachypnea while bradycardia was noted in 4patients (4.30%) opposite to 52patients (55.19%) with tachycardia. Hypoxemia was noted in 63 patients (67.74%). 62 patients (66.66%) had a bulging Douglas con digital rectal examination, of which 42(67.74%) were sensitive and 20(32.26) non-sensitive. The trans-parietal puncture was performed in 23 patients (24.73%) and the peritoneal lavage puncture in 38 patients (40.86%). Echography was performed only in 17(18.28%) patients no scanner nor E-Fast was performed for diagnosis. Thus four factors were associated with a poor outcome, because the "p-value" was statistically significant (p value ≤0.05): these were index shock (p=0.00) pulse oxygen saturation (p=0.00), amount of fluid effused in the abdominal cavity (p=0.00) and the liver rupture (p=0.00).*
Conclusion*: Excess mortality in trauma abdominal patients in Lubumbashi has identified two major risk factors which can help developing accurate targeted strategies.*
Keywords: *Factors of Mortality, abdominal trauma, poor outcome, peritoneal lavage puncture*

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I. Introduction

Trauma is the leading cause of morbidity and mortality in younger populations worldwide [1, 2]. It is estimated that by the year 2020, 8.1 million people will die yearly as a result of injuries, and road traffic accidents (RTA) will be the third-most common cause of disabilities globally and the second-most common cause in developing countries [3]. Trauma is the main cause of morbidity and mortality worldwide [4,5] and is still the most frequent cause of death in the first four decades of life[6].

Abdominal trauma is one of the most common injuries among injuries caused mainly due to road traffic accidents. The rapid increase in motor vehicles and its aftermath has caused rapid increase in the number of victims to blunt abdominal trauma (BAT). Motor vehicle accidents account for 75%–80% of BAT [7]. Abdominal trauma is traditionally classified as either blunt or penetrating. Penetrating abdominal trauma can usually be diagnosed easily and reliably, whereas blunt abdominal trauma is often missed because clinical signs are less obvious. [1] Blunt abdominal injuries predominate in rural areas, while penetrating ones are more frequent in urban settings [8].

In South Africa, approximately 50,000 mortalities related to injuries were reported, with the majority relating to violence and RTAs [9].

To diagnose penetrating abdominal is usually easy and reliable but blunt abdominal trauma is a real challenge even for experienced trauma and general surgeons as some injuries may not manifest during the initial assessment and treatment period. This made worse in a resource-constrained setting like ours where advanced diagnostic armamentaria such as focused assessment sonography for trauma (FAST), computed tomography (CT) scan and laparoscopy are not readily available in many centers.

There has been a paradigm shift from routine operative to selective non-operative management (SNOM) of both blunt and penetrating injuries over the years. The present maxim for penetrating injury is that "not everybody with a hole in the abdomen needs exploration" unlike before when routine laparotomies were required in all patients [10, 11].

Focussed assessment sonography in trauma (FAST) has largely replaced the diagnostic peritoneal lavage to diagnose intraperitoneal bleed in most of the cases [12]. Although an easy to perform and reliable technique, FAST has some inherent limitations in obese patients, patients with ileus, operator dependent, limitations in grading the injury and evaluation of bowel/vascular injuries. It can also miss up to one fourth of the abdominal injuries [13].

CT is the gold standard investigation in evaluation of abdominal trauma with its multiplanar capability and rapid acquisition. It can clearly delineate the grade of injury, presence of bowel injury, presence of diaphragmatic or vascular injury and better assessment of retroperitoneal structures [14, 15].

It is estimated that approximately one-third of all trauma patients have abdominal injuries. These injuries require careful triaging for appropriate intervention because approximately 25% of such injuries require surgery [16].

In our previous publication, we found in Lubumbashi a mortality of abdominal trauma of 23.66% [**17**].

The aims of our study is to highlight the importance of clinical aspects and the peritoneal lavage puncture in the diagnosis of abdominal trauma, to determine the outcome and reveal the factors of poor outcome of abdominal trauma in resource-limited areas like our city of Lubumbashi in democratic republic of Congo.

II. Materials And Methods

We have carried out a longitudinal descriptive study, with prospective data collection over a four-year period, from January 2018 to December 2021. We thus collected a total of 93 patients followed with abdominal trauma treated in Lubumbashi in two university hospitals in Lubumbashi.

We used SPSS software version 25.0 (IBM SPSS Inc, statistics for Windows NY; Chicago, IL, USA) to perform statistical data analysis. For categorical variables, data were summarized in proportions and frequency tables. For continuous variables, we used ranges, medians and inter-quartile ranges (IQRs) to summarize the data. We computed *P*-values for categorical variables using chi-square (X^2) and Fisher's exact tests in accordance with the size of the dataset. We used an independent Student's t-test for continuous variables. We determined the variables associated with the outcome using logistic regression. A *P*-value of < 0.05 was considered to be significant.

The multivariate logistic regression analysis was performed for the predictors of in hospital mortality after adjusting for the potential relevant variables (rupture of liver, spleen, meso damage, non- application of damage control).

III. Results

Table 1: Clinical characters

Type of abdominal trauma	**N = 93**	**Percent**	**Statistical parameters**
Closed abdominal trauma	62	66.67	
Opened abdominal trauma	31	33.33	
Heart rate (beat per minute)			**Mean**
< 60	4	4.30	101.63
[60 - 100]	37	39.78	**Standard deviation**
> 100	52	55.19	6.31
Respiratory rate (Cycles per minutes)			**Mean**
< 16	0	0	30.31
[16 - 24]	10	10.76	**Standard deviation**
> 24	83	89.24	11.44
Systolic blood pressure(mmhg)			**Median**
< 60	2	2.15	99.22
[60 - 90]	19	20.43	**Standard deviation**
> 90	72	77.41	12.02
Shock index			**Mean**
< 0.7	10	10.75	1.03
[0.7 – 0.9]	25	26.88	**Standard deviation**
> 0.9	58	62.36	0.24
Temperature			
Hyopthermia(<36)	17	18.27	
Normal (36<T^0<37.5)	73	78.49	
Fever (> 37.5)	3	3.22	
Hemodynamic state			
Stable	53	56.98	
Unstable	40	43.02	
Pulsed oxygen saturation (%)			
< 95	63	67.74	
> 95	30	32.26	
Abdominal defense			
Yes	49	52.69	
no	44	47.31	
Abdominal bloating			
Yes	48	51.61	
No	45	48.39	
Coldness of extremities			
Yes	24	25.81	
No	58	62.37	
Unspecified	11	11.83	
Bulging of the Douglas			
Yes	62	66.66	
No	31	33.34	
Douglas sensitivity			
No	34	36.56	
Yes	59	63.44	
Punctures			
Trans-parietal puncture	23	24.73	
Peritoneal lavage punctures	38	40.86	
No puncture	22	34.41	
ISS score(Injury severity score)			**Means**
<9	0	0	13.7
9<ISS<16	48	51.61	
>=16	45	48.39	

Table 2: Paraclinical exams

Hemoglobin (g/dl)	**N (93)**	**Percentage**	**Statistical parameters**
Day 0			**Means**
< 10	42	45.17	9.69
> 10	51	54.84	
Not realized	0	0	
Day 3			**Means**
< 10	12	12.90	10.78
> 10	55	59.13	
Not realized	26	27.95	
Day 5			**Means**
< 10	6	6.45	11.28
> 10	58	62.36	

Not realized	29	31.18	
Day 10			**Means**
< 10	1	1.07	11.91
> 10	61	65.59	
Not realized	31	33.33	
Echography			
No	76	81.72	
Yes	17	18.28	
Blank abdominal X-Ray			
Yes	4	4.40	
No	89	95.69	
CT Scan			
Yes	0	0	
No	93	100	

Determinants of mortality in bivariate analysis

The bivariate tables looking for the mortality factors showed the followings results:

The time to treatment was 2.64±1.399 for the deceased versus 3.46±6.64 for the survivors, the association was not significant (p=0.550); *The association between the non-application of the damage control surgery* and mortality was statistically not significant (p=0.565). The road traffic accident remains the most incriminated cause in the abdominal trauma with 58 patients out of 93(62.4%) of the cases, among which 15 deaths (25.9%) but the statistical association is not significant (p=0.541). *Liver damage* was found in 26 of the 93 patients who took part in the study, of whom 13 died (50%) and 13 others survived (50%); The difference was significant (p=0.00). Rupture of the spleen was found in 33 of 93 patients who took part in the study, of whom 4 died. Of all the 22 deaths, 4 are attributable to damage to the spleen but the statistical difference is not significant (p=0.074). *Mesenteric lesions* were found in 23 patients, of whom 4 (17.4%) died. But the statistical association is not significant (p=0.574).

Others factors studied in bivariate analyses was Age, amount of fluid effused in the abdominal cavity, index shock and operating time (Table 3).

Table 3: Determinants of mortality in bivariate analysis

Issue		**Operating time (minutes)**	**Amount of blood shed in the abdominal cavity**	**Age**	**Shock Index**
Death	Mean	127.95	2145.45	30.55	1.2538
	Standard deviation	89.863	902.762	13.355	0.45133
	Mean	112.50	2350.00	28.00	1.2400
	Minimum	10	500	4	0.60
	Maximum	360	3500	68	2.60
	N	22	22	22	22
Survival	Mean	113.54	1157.25	28.23	0.9644
	Standard deviation	45.084	552.686	14.030	0.27102
	Median	110.00	1100.00	29.00	0.9600
	Minimum	50	100	1	0.30
	Maximum	260	3000	67	1.80
	N	69	69	71	71
Total	Mean	117.18	1396.15	28.77	1.0304
	Standard deviation	59.365	775.859	13.837	0.34087
	Median	110.00	1200.00	28.00	1.0000
	Minimum	10	100	1	0.30
	Maximum	360	3500	68	2.60
	N	91	91	93	93
p		**0,328**	**0,00**	**0,495**	**0,00**

A significant association was found between death and the shock index (p=0.00) and amount of blood shed in the abdominal cavity (p=0.00).

Table 4: Determinants of mortality in multivariate logistics regression analysis

Parameter estimation								
Issue[a]	B	Standard Error	Wald	Degree of freedom	"p value"	Odds ratio	95 % confidence interval for Odds ratio	
							Lower bound	Upper bound
Constants	-1.714	.630	7.397	1	.007			
[Mesenteric lesions=death]	-.109	.895	.015	1	.904	.897	.155	5.186
[Mesenteric lesions=survival]	0[b]			0				
[Liver_rupture= décès]	**1.719**	**.681**	**6.362**	**1**	**.012**	**5.578**	**1.467**	**21.213**
[Liver_rupture=survival]	0[b]			0				
[Spleen_rupture=death]	-.786	.752	1.092	1	.296	.455	.104	1.991
[Speen_rupture=survival]	0[b]			0				
[Damage control surgery=death]	**.330**	**.599**	**.303**	**1**	**.582**	**1.391**	**.430**	**4.496**
[Damage_control= survival]	0[b]			0				

After multinominal statistical analysis, two factors proved to be determinants in the mortality of patients with abdominal trauma, these are hepatic rupture and the non-application of control damage, although the association was not significant.

IV. Discussion

Complete blood count is important in all patients of BAT. The presence of massive hemorrhage may be obvious from hemodynamic parameters, and an abnormal hematocrit value merely confirms the diagnosis. Normal hemoglobin and hematocrit results do not rule out significant hemorrhage. Transfusion is usually recommended for patients who have relatively normal hematocrit results (i.e., >30%) but have evidence of clinical shock, serious injuries (e.g., open-book pelvic fracture), or significant ongoing blood loss. Hemodynamic instability in an adult despite the administration of 2 L of fluid over a period of 30 minutes indicates ongoing blood loss and is an indication for immediate blood transfusion. Platelet transfusions is used to treat patients with thrombocytopenia (i.e., platelet count < 50,000/μL) and ongoing hemorrhage [**19**].

Diagnosis

In developed countries, the creation and performance of pre-hospital medicine, thanks to the Emergency Medical Assistance Service (SAMU), revolutionized trauma patients care [**6**]; which is quite the opposite of developing countries where these services are not yet established today, such as our country DR Congo, my country where this study was carried out [**20**].

Many emergency services acquired ultrasound machines. Thus, several attempts at standardization have led to the development of a protocol: FAST (Focussed Abdominal Sonography for Trauma patients) [**21**]. This is a protocol for coding emergency ultrasound for trauma patients, especially abdominal, in a synthetic, oriented and simple way. In the 2000s, in the United States, it is believed to have replaced peritoneal lavage in the diagnosis of hemoperitoneum. Since then it has continued to be promoted and is now taught as part of Advanced Trauma Life Support on the North American continent (North American Trauma Management Protocol). In the mid-2000s, the chest assessment for pneumothorax and hemothorax has been added to the traditional FAST examination, resulting in the acronym EFAST (Extended FAST), "extended FAST" to the pleura [**22, 23**]. Ultrasound using the EFAST technique has played a central role in this management [**24**].

In black Africa particularly, the management of chest and abdomen trauma remains a real challenge. In this context, puncture lavage of the peritoneum (PLP) is often the first resort in a suspected intra-abdominal lesion [**25**]. Very few studies have been published on ultrasound scans performed in emergency rooms in a resource-limited medical environment. Muller et al. in Congo agreed in 2015 that the introduction of FAST ultrasound was possible and necessary [**26**]. All this justifies that the management of our patients with abdominal trauma is based on careful clinical examination and PLP. In our series, only 18.28% of patients have done abdominal echography and E-fast is not yet applied in our hospital for various reasons such as the lack of personnel trained in surgery for this practice, the absence of the imaging team during on-call duty, the additional coast of this examination at unsubsidized patients. its realization necessitating a displacement of the patient towards another pavilion in the hospital and often conditioned by the payment of the expenses.

In our series, the low rate of completion of ultrasound, failure to perform an x-ray of the abdomen without preparation, and CT scan is justified by the fact that before a vital emergency, and the positivity of the

transparietal peritoneal puncture; these examinations, which sometimes lengthen the time taken to take charge, seemed. Ultrasound is very specific for detecting the presence of intraperitoneal effusion, which has enabled it to replace peritoneal lavage in most hospitals However, it is not quickly and systematically available urgently in our services.

But CT provides important information for adequate management of trauma patients and has become the cornerstone for early diagnosis. However, good clinical assessment such as implementation of clinical prediction rule has been suggested to reduce unnecessary CT examination in trauma patients [**27**].

In regions with limited resources such as Lubumbashi, peritoneal lavage puncture remains the key element for establishing the diagnosis of post-traumatic peritoneal effusion. Reason why the transparietal puncture and/re the peritoneal washing puncture was performed in all our patients with blunt abdominal; which thus represented a rate of 24.73% and 40.86%.

CT scan were not performed in our patients. . This simple and inexpensive gesture retains great efficiency, especially in our environments where access to the paraclinical imaging assessments remains a serious problem given the self-care of the population. In the Vignon *et al.* [**28**], the transparietal peritoneal puncture confirmed the diagnosis in 58.3% of the cases. In the Abri's study highest diagnostic method used for patients with abdominal penetrating trauma was DPL (diagnose puncture lavage), this method were used in 82 cases (59.9%) and DPL and CT scans was used combined in 31 cases (22.6%) [**29**]. Also, all of the patients were evaluated by FAST exam like in our study. The non-specificity of the clinical signs often made it essential to carry out systematic biological examinations, rhesus grouping, hemoglobin and hematocrit levels.

Clinical examinations

Patients usually present with abdominal pain, nausea, vomiting [**30**] as the main symptoms and the severity is proportional to the degree of injury [**31**]. Tenderness, guarding, hematuria, hematemesis are the main signs of abdominal trauma. Seat belt sign is usually a sign of major intraabdominal injury and identification of one should prompt the clinician to consider operative management in this group of patients [**32**] BAT patients can be classified as either hemodynamically stable or hemodynamically unstable based on their hemodynamic status at presentation. Patients with systolic blood pressure above 90mmhg and a pulse rate below 110beats per minute are considered to be stable whereas patients with deranged hemodynamic status are said to be hemodynamically unstable [**33**].

Diagnosis of blunt abdominal trauma is mainly clinical, through history taking and physical examination.

On our clinical examinations, monitoring of the vital signs of patients is of capital importance to us. 52 patients (55.19%) had tachycardia (>100beats/min), the average heart rate was 101.63±6.31 (beats/min) while the study of Adelin found an average of 95.55±15.14 with extremis of 61 and 152 [**34**]; tachycardia being a sign of hemorrhage that may be in the compensation phase, is of great semiological value in an abdominal trauma patient.

Low systolic blood pressure, less than 90 mmHg is a critical value that can reflect blood depletion in a trauma patient. But taken in isolation, it is not of great value. Reason for which one uses the differential which, pinched is of great semiological value in the hemorrhagic shock but also and especially the index of shock. Shock Index (SI), defined by the ratio of heart rate to systolic blood pressure, has been advocated to better risk-stratify patients for increased transfusion requirements and early mortality [**35**].

We found that 19 patients (20.43%) had systolic blood pressure below 90mmHg and 2 (2.15%) had systolic blood pressure below 60mmHg; compared to the shock index, 58 patients(62,36%) had an index shock greater than 0.9, **:** Isolated vital signs (for example, heart rate or systolic blood pressure) have been shown unreliable in the assessment of hypovolemic shock.

Up to the best of our knowledge, there are only few reports that describe the incidence and the outcome of abdominal trauma from our region.

In our study, we recorded a death rate of 23.66%. Wanting to study the factors associated with mortality, we analyzed different variables of clinical significance according to the outcome. No significant association according to the outcome for the delay of care (p=0.550). Musau *et al.*[**36**] from Nigeria reported an overall mortality of 12.5% among abdominal injury patients. Another prospective study on blunt abdominal trauma observed an overall mortality of 26% and half of these patients died of multiple organ failure secondary to sepsis. In comparison to other studies, the overall mortality in our cohort group was very high (2.4%); A total of 86 (8.3%) patients died in the study cohort, of whom 62 (6%) patients died within the first 24 h of hospital admission in Arumugam's serie [**37**].

In view of our observations, depending on the operating time, deceased patients have on average a longer operating time that than those who survived (127.95±45.084 minutes vs 113.54±45.084 minutes), but the difference is not statistically significant (p=0.328).

No significant association between sex distribution and organ injuries was seen in the Musau's study and the main predictors of mortality in the current study were head injury (with high median AIS score of 4) and

need for blood transfusion; the former was associated with 5 times increase in the mortality whereas, the latter was associated with 3-fold increase in the mortality [**36**]. Some studies explored risk factors for fatalities in this sample of penetrating and blunt abdominal injuries. The strongest risk factor for all abdominal cases was delay before treatment; however, this is not a case for our study where we did not find a significant association between the time to treatment and the outcome. In all cases, the type of abdominal trauma, RTS, and comorbid injuries predicted higher among those with blunt injuries. Penetrating trauma had a much higher rate of fatality overall, and the type and site of penetration injury mattered a great deal. Gunshot wounds were associated with about eight times higher fatality rate than stab wounds, a pattern that is consistent with others' findings [**38, 39, 40**].

In Arumugam's study, Multivariate logistic regression analysis [**37**] showed that the main predictors of mortality were head injury (OR: 5.50. $P < 0.001$), need for blood transfusion (OR: 2.67, $P = 0.01$), ISS (OR: 1.12, $P < 0.001$), and serum lactate (OR: 1.04, $P = 0.02$). In comparison with our study, multivariate logistic regression retained two main predictors of mortality; it was hepatic rupture, which multiplies the risk of mortality by 6 (p=0.012 and OR= 5.57) and failure to apply damage control in highly unstable patients (OR=1.39) although in this second case the "p" value was not significant (p=0.59).

Working on severe trauma in intensive care in the city of Kinshasa, Nsiala carried out a multivariate analysis of the predictive factors of mortality and identified 4 of them which are age ≥ 65 years (adjusted OR : 3,23 ; 95 % IC : 1,1 - 9,0), Glasgow score ≤ 8 (adjusted OR : 3,52 ; 95 % IC : 3,5 – 1,3), pulsed oxygen saturation < 90% (adjusted OR : 3,52 ; 95 % IC : 1,3 – 10,7) and RTS score < 10 (adjusted OR : 4,16 ; 95 % IC : 1,2 – 65,2). The use of oro-tracheal intubation, and mechanical ventilation persisted as a beneficial factor. However we could not analyze many more parameters given the size of our small sample, a much larger sample could allow an in-depth analysis of these different parameters [**41**].

However, in **TANUI**'s study, Association between outcome and other variables like duration before presentation, age, associated injuries, hemodynamically stability, duration before surgery, number of involved organs and injury mechanism was tested and none were statistically significant (p>0.05) [**42**].

V. Conclusion

The peritoneal lavage puncture still retains a place of choice in the clinical diagnosis of abdominal trauma in setting with limited resources where E-FAST is not available.

The factors associated to poor outcome were hepatic rupture, amount of leaked fluid, high shock index and low pulse oxygen saturation. After multivariate logistic regression, two factors were retained as determinants of mortality in our environment, namely hepatic rupture and non-application of damage control.

Conflicts of interest

The authors do not declare any conflict of interest.

What is known about this subject?

- The mortality of abdominal trauma remains higher
- E-Fast is the reference examination for the diagnosis of abdominal trauma, although for some authors the CT Scan remains the reference in an equipped environment.

What does our study bring new?

- The importance of clinical examination and the peritoneal lavage puncture in the clinical diagnosis of abdominal trauma in an under –equipped environment where CT Scan and E-fast are terribly lacking
- The evolution of the hemoglobin level of patients with abdominal trauma from admission to discharge
- The factors associated with the mortality in our country are identify; Fours factors are associated with a fatale outcome, two of which were retained as the most decisive after logistic regression, namely liver rupture and non-application of damage control.

Author contributions

All authors contributed to the development of the article.

All had read and approved the final version before submission.

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