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Types of injuries among Polish soldiers and civilian staff in the 7th, 8th, 9th and 10th rotation of the Afghan stabilization mission

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Summary

Background: The Afghan military theatre is specifically marked by guerilla operations and massive use of IEDs (improvised explosive devices) that pose new types of threats for their victims. At the same time, the relevant literature contains only a single, fragmentary analysis on injuries suffered by soldiers serving in the Afghan mission.

Material/Methods: This is a review of medical reports of the Polish Military Contingent deployed within Operation Enduring Freedom, from 1 January 2010 to 31 December 2011; the analysis includes all cases of combat and non-combat injuries in terms of their causes.

Results: In the period under analysis, 380 Polish soldiers were reported injured; 87.1% of cases were combat and 12.9% non-combat injuries. The structure of injuries caused as a result of IED explosions was dominated by multiple limb injuries, associated most frequently with severe body cavities/spine injuries. In the case of other incidents, both combat and non-combat, the predominant consequences were single and, most commonly, less severe injuries. The average number of injuries suffered from IED attacks (3.37) was significantly higher than the number of injuries from other attacks (1.16), and higher than the number of non-combat injuries (1.43).

Conclusions: IED attacks pose a serious medical problem, considering their high number and the severity of injuries they cause.

key words: **injuries • combat • non-combat • casualties • ISAF Operation • IED**

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Background

The International Security Assistance Force (ISAF) in Afghanistan has been among one of the most difficult military missions performed by military forces of democratic states during the last 50 years. While the death toll (both those killed in battle or dead due to injuries) constitutes approximately 10% of all casualties, as compared to 24% of those killed during the Vietnam War or 25% during the Korean War [1]. Many wounds are severe injuries that often lead to post-traumatic stress disorder [2]. Operations that have been conducted during recent years, mainly within the scope of stabilization missions, have commonly resulted in limb injuries, which account for 75% of all combat wounds [3,4]. This is the result of very frequent bombings in which the body may be injured with fragments, and which, considering a good level of protection of the head and the torso (helmet, mandatory bulletproof jacket), primarily strike the limbs. During recent years combat in Afghanistan has been marked by attacks against infantry mine-resistant ambush-protected vehicles (MRAPs) with IED booby traps with a particularly strong indirect hit, often exceeding 100 kg of TNT [5–7]. Open fractures are frequently accompanied with burns [8] and poly-traumas [9].

Soldiers who take part in ISAF missions most frequently suffer from injuries during the summer, mainly as a result of a greater intensification of combat, and hence an increased number of patrol activities. Soldiers suffer both combat and non-combat injuries [9–15]. The latter take place during individual and/or organized sports and recreational activities, specialized training, and as a result of accidents in military transport (car, planes, helicopters). Fitness training is the cause of injuries among 6–18% of soldiers [12,16,17].

Traffic accidents take place both during combat and non-combat missions. A significant number of such traffic accidents are due to bad road conditions [16,18,19]. Among other non-combat injuries are burns and frostbite. Moreover, Afghan wildlife includes several species of venomous snakes, crustacea and spiders [20].

Material and Methods

We reviewed medical files of the Polish Military Contingent (PMC) in Afghanistan, for the period from 1 January 2010 to 31 December 2011 (rotations: 7–10), at the disposal of the Operational Command of the Polish Armed Forces.

We have taken reviewed all cases of injuries suffered by soldiers, excluding auxiliary services and civilian staff. Injuries have been divided into combat and non-combat. The former category included all cases in which injuries were suffered during battle: field patrols, response to attacks both in the base and in the field, and operations actively counteracting the enemy. All other injuries were typified as non-combat.

Wounds caused by injuries were then divided in terms of body organs/areas. The consequences of injuries have been broken down into lethal cases, severe injuries and light injuries. We defined lethal injuries as those causing immediate or delayed death from wounds suffered. Severe injuries were defined as the one which cause a health disorder lasting longer than 7 days and which result in inability to perform active service during that time.

With the use of STATISTICA software, we have proceeded to the analysis, in the form of descriptive statistics, and to the test of significant differences between average results (continuous variables, Student's t test, ANOVA) and of differences between data sets with interval variability (chi-squared test). The significance level was defined as $p<0.01$.

Results

During the mission of the PMC in the period under analysis, various injuries were reported among 380 soldiers – 87.1% were combat injuries and 12.9% were non-combat injuries. Injuries suffered by 291 soldiers (76.6%) resulted in inability for service which lasted longer than 7 days, and 190 (50.0%) wounded soldiers needed to be evacuated out of the country for medical reasons. The number of dead on the battlefield or as a result of injuries suffered, before medical evacuation, rose to 18 soldiers. Moreover, 2 soldiers died in the country: 1 case of death remained unexplained, while the other was the result of an unfavorable outcome of a chronic disease that manifested itself during the mission. A detailed breakdown of those losses during specific years of the mission is presented in Table 1.

In the period under analysis, 125 battle incidents (75.3% of incidents) were recorded, causing injuries (including lethal ones) among 331 soldiers. In total, 1,107 individual injuries were diagnosed (2.91 per 1 soldier on average; SD 1.57). Multiple injuries were diagnosed among 254 soldiers, while individual injuries were diagnosed among 77. The most common cause of combat injuries were attacks

Table 1. A detailed breakdown of casualties during four subsequent rotations of the PMC, in service in 2010-2011, as compared to the overall contingent headcount (shown in brackets, in percentage)

No. of each rotation/ time of service	Contingent headcount	Victims		Fallen		Injured		Injured evacuated out of the country	
I/1.01.2010–30.06.2010	2600	143	(5.5%)	6	(0.23%)	137	(5.27%)	59	(2.27%)
II/1.07.2010–31.12.2010	2600	48	(1.85%)	2	(0.07%)	46	(1.77%)	53	(2.04%)
III/1.01.2011–30.06.2011	2600	125	(4.81%)	4	(0.15%)	121	(4.65%)	68	(2.62%)
IV/1.07.2011–31.12.2011	2494	64	(2.57%)	6	(0.24%)	58	(2.33%)	10	(0.4%)
Total	**10294**	**380**	**(3.69%)**	**18**	**(0.17%)**	**362**	**(3.52%)**	**190**	**(1.85%)**

Table 2. The breakdown of attacks launched against the PMC during each rotation.

No. of each rotation/ time of service	Type of attack				
	MRAP gunfire	IED attacks	Heavy weaponry	Guns	Indirect gunfire
I/1.01.2010–30.06.2010	1	17	6	7	1
II/1.07.2010–31.12.2010	1	13	3	5	0
III/1.01.2011–30.06.2011	0	31	2	6	2
IV/1.07.2011–31.12.2011	0	26	1	2	1
Total	**2**	**87**	**12**	**20**	**4**

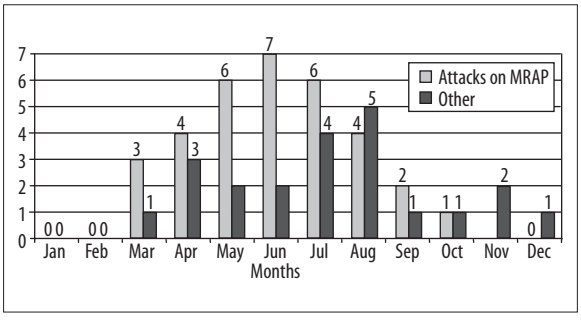

Figure 1A. Number of incidents leading to combat injuries in 2010.

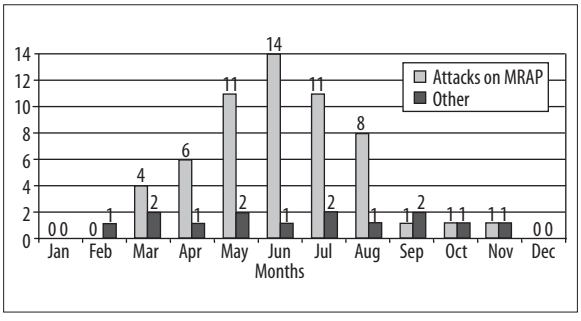

Figure 1B. Number of incidents leading to combat injuries in 2011.

against MRAPs launched with IEDs (87/125–69.6%) or those from bazookas (2/125–1.6%). In total, they resulted in 995 injuries (average: 3.37, SD 1.46).

The second group of injuries (36/125–28.8%) were mainly caused by gunfire, either from small arms, hand grenades or indirect hits (chips, fragments of wooden, steel or concrete structures, ricochets). Moreover, the group included 4 relatively rare cases of incidents classified as accidents, such as falling from the transporter during escape from gunfire, entanglement of limbs into the transporter revolving turret, and a traffic accident. As the outcomes of those types of incidents were similar to consequences of indirect hits, they were analyzed jointly. In total these caused 42 injuries among 36 soldiers (1.16 per 1 soldier on average; SD 0.38). The breakdown of types of attacks launched against the PMC during each rotation is presented in Table 2. The statistical analysis showed significantly more frequent IED-type attacks during the 3rd and 4th rotations as compared to other incidents.

The attacks launched against the PMC during the following months were different in their frequency and nature; most took place in spring and summer months, and during subsequent PMC rotations the number of IED attacks rose considerably. A detailed breakdown of types and timing of attacks against the PMC by months is presented in Figure 1.

There were 41 non-combat incidents recorded (24.7% of incidents). There were 49 casualties in a total of 70 individual injuries (1.43 individual injuries per 1 soldier on average, SD 0.71). The number of those incidents remained relatively stable across rotations and specific months of service. Among the causes of non-combat injuries are: injuries of the osteomuscular system, traumatic amputations, self-inflicted gunshots, burns suffered during sports activities and specialized training (including 1 involving war games), and accidents (including traffic accidents). The details of these incidents are presented in Table 3.

The difference between the average number of combat injuries suffered as a result of attacks against MRAPs was significantly higher than in the group of other combat injuries and in the category of non-combat injuries ($p<0.001$).

The analysis of bodily injuries made on the basis of medical files showed that the most frequent cases resulting from battle incidents were limb injuries, followed by face and facial bone injuries, injuries to the organs of hearing, balance and sight, and body cavities and craniocerebral injuries. In a great majority of cases, these were multiple injuries affecting more than 1 body area or more than 1 internal organ. Relatively frequent cases of paired body areas/paired organs injuries were also reported.

Non-combat incidents resulted most frequently in relatively light injuries, injuries of the osteoarticular system and muscles, traumatic amputations of single fingers, and spine injuries such as spondylolisthesis or disk compression fractures.

We observed a significant differentiation of combat injuries in terms of attack modalities – those against infantry forces moving in MRAPs, launched with IEDs or with bazookas significantly more often caused multiple injuries, including multi-organ ones, than attacks against infantry stationed in the base or acting in the open theatre.

IED attacks against MRAPs frequently caused multiple limb injuries, including multiple fractures of 1 bone and/or multiple fractures (often including open ones) in 1 limb,

Table 3. A comparison of types of incidents causing non-combat injuries among PMC soldiers in each rotation.

No. of each rotation/ time of service	Type of event			
	Specialized training	Sport and recreational activities	Traffic accident	Fall from height
I/1.01.2010–30.06.2010	1	8	0	2
II/1.07.2010–31.12.2010	3	6	0	1
III/1.01.2011–30.06.2011	2	8	2	0
IV/1.07.2011–31.12.2011	2	7	0	1
Total	**8**	**27**	**2**	**4**

Table 4. The breakdown of combat and non-combat injuries suffered by the PMC soldiers in 2010–2011.

Location/type of injury	Combat injury		Non-combat injury	
	As a result of the attack against MRAP	As a result of other attacks		
Limb bones fractures/including open fractures	501/179	12	33	546
Contusion/muscle disruption	142	8	23	173
Injury leading to limb/body part amputation	36	2	2	40
Disruption of limb vessels/without amputation	12	1	1	14
Spine injury	34	3	7	44
Eye injury	31	4	2	37
Acoustic injury/disruption of the tympanic membrane	21	2	0	23
Face wounds	42	1	0	43
Facial skeleton injuries	24	1	0	25
Craniocerebral injuries	34	2	0	36
Thoracic injury	19	3	1	23
Abdominal injury	19	1	0	20
Pelvis/genitourinary organs injuries	19	0	0	19
Burns	61	2	1	64
Total	**995**	**42**	**70**	**1107**

together with injuries to the body cavity, pelvis, spine or head. The injuries of the abdominal cavity most often appeared together with the impairment of spleen, liver or kidneys. Pelvis fractures were often linked with the disruption of the bladder and/or urethra. Head injuries were mainly craniocerebral injuries, often manifested together with the impairment of organs of hearing, balance and sight. In particular, cases of orbit-penetrating wounds, together with eyeball opening or foreign body in the eye were quite frequently reported. Registered ear wounds were often acoustic injuries and/or disruptions of the tympanic membrane, while those of thoracic organs were most frequently burns of the upper respiratory tract, 1- or 2-sided pneumothorax, lung contusion/crush, and disruption of the great vessels. Spine injuries were mainly disk compression fractures, spondylolisthesis or disk elements fractures. The most injury-sensitive areas were cervical, cervical-thoracic and thoracolumbar. In the sample under study, spine injuries were most often reported at the Th12 and L1 junction, which is due to the fact that during IED mine attack, soldiers were inside the combat vehicle, in the sitting position. The second most frequent area of injuries was the cervical segment

– either in the upper part in the atlantooccipital junction, or in the lower part at the C7-Th1 junction. Almost all injuries were multiple – they affected 2 or more spine segments, including the aitch bone or more than 1 spine disk.

The structure of combat injuries other than those caused by IED attacks did not differ from non-combat injuries. The comparison of combat and non-combat injuries classified by organs/body areas is detailed in Table 4.

Discussion

Injuries suffered by the PMC soldiers were predominantly caused by IED attacks. Out of 125 battle incidents, IED attacks were recorded in 87 cases, causing severe and multiple injuries. This resulted in 87.1% of casualties due to combat injuries and 12.9% of non-combat injuries; 93.7% of injuries were due to enemy attack, of which 89.9% were due to IEDs. The idea of an IED use is not new at all. Mines were used extensively by Vietnamese guerillas [21] and mines were used by the Irish Republican Army (IRA) in the 1970s. Booby traps against British soldiers were set by Irish rebels with simple bombs, made with smuggled explosives and fertilizers. Igniters and remote detonation systems were constructed with simple electrical parts [22]. The real "renaissance" of the IED was seen during the second Iraq war, when their explosions caused injuries to 63% of soldiers. Western military forces were totally unprepared for such a threat. The majority of soldiers moved along roads in poorly armored vehicles such as HUMVEEs, becoming easy targets for IED attacks, and the number of losses started to grow rapidly.

The idea to combat Western military forces with IEDs was quickly transferred into the Afghanistan theatre. Since 2005, losses from explosions of booby traps rapidly increased, with the peak in 2010, when there were nearly 8000 explosions, accounting for 66% of all injuries [23].

Authors reporting on medical consequences of combat in Afghanistan state that most losses suffered by coalition forces are caused by explosive devices. Among Canadian soldiers killed in 2006–2008 in Afghanistan, 81% died in explosions [19]. Injuries caused by IED-type attacks are severe or very severe, resulting in internal bleeding, parenchymal organs contusions and brain injuries [19].

Limb injuries leading to amputations have been dominant and are a considerable issue in military medicine [24,25]. This is mainly due to the common use of personal protection measures such as highly protective Kevlar helmets and bulletproof jackets in Iraq Freedom and Enduring Freedom operations, which reduced the relative proportion of head and thoracic injuries. When the majority of injuries are caused by IED attacks, the main injury-sensitive body areas are the limbs and spine [25–29]. Limb bone fractures, including multiple ones, amounted to 50% of all injuries, and, together with muscular and articular injuries, amount to 64.9% of all injuries; after adding amputations and vessel or nerve injuries, the percentage rises to 69.8% (Table 4). This data confirms the findings of Owens et al. [29] that 3,575 combat-related limb injuries occurred among 1,281 soldiers, mainly hand and finger injuries [29]. This relatively smaller number of limb injuries per soldier may possibly result from the non-registration of such smaller wounds.

Moreover, there was a huge increase in open fracture cases. While in 2001–2006, both in Iraq and Afghanistan, 53% of non-combat injuries were contortions, sprains and overloads of the loco-motor system, and only 27% were open fractures [12], in our sample they amounted to 35.7% (Table 4).

Facial bone injuries are most commonly caused by explosions [30,31]. They account for 21%-26% of all injuries and are often multiple, affecting more than 1 bone. This paper, which is general in nature, does not include a detailed analysis of the results. However, we should stress that such injuries, caused in most cases by IED attacks (Table 4), were elements of multi-organ injuries. Nevertheless, the analysis of the data in Table 4 shows that, as in the report of Lew et al. [31], facial soft-tissue injuries are twice as frequent as bone injuries.

In their analysis of the initial stage of Operation Enduring Freedom, Peoples et al. [27] stated that the majority of combat injuries were caused by fragments (49%), mainly limb injuries (58%), while gunshot wounds were the main cause of death (57%). Serious head, thoracic and abdominal injuries were relatively rare (13%). Both in Iraq and Afghanistan operations, in the same period of time, injuries to the skeletomuscular system accounted for about half of all wounds. Gunshot wounds to the head or the thorax represented only 4.6% [5].

We have not found in the available literature any specific analyses on combat and non-combat injuries of the hearing/balance organs. The analysis of our own data (Table 4) shows that they are one of the most serious problems in the Afghan theatre, equal to ocular injuries. The former were 37, which accounts for 3.34% and 3.37% of all combat injuries, respectively. In the British contingent in service in Iraq in 2004–2005, they accounted for 10% of injuries, out of which ¾ were diagnosed as severe. One of every 3 injuries was accompanied by eyeball opening – disruptions, perforations, perforations with foreign bodies, enucleations and eviscerations. Intraocular foreign bodies were recorded in 17.5% of cases [32]. This paper does not include such detailed analysis; a more specific presentation of each body organ injured goes beyond the scope of this report and will be discussed in further analyses.

Facial, facial skeletal and ocular injuries are relatively frequent and result in final withdrawal of the soldier from the war theatre. Breeze et al. [30] stressed that while facial bone injuries account for 21% of all combat injuries, they are also the reason for 30% of medical evacuations, also relatively frequent in cases of ocular injuries (about 16%) [33].

A powerful explosion may cause serious parenchymal organ and lung injuries [5,26]. Serious pelvis and lower urinary track injuries are another element not registered until now on such a scale. Out of all fatalities, 77% suffered injuries in this area [18]. Explosions, which caused ¾ of casualties, also lead to injuries to the intestines, abdominal cavity parenchymal organs, abdominal cavity excavated viscera, heart and great abdominal and thoracic organs [18].

This analysis reports a relatively small number of spine injuries. However, the literature shows that spine injuries are quite frequent – these are serious and frequently multiple injuries that affect more than 1 spine segment [34,35]. This discrepancy

may be due to reporting and registering only serious injuries that cause pain ailments as well as motor disorders and neurological complications. The analysis of losses suffered in Iraq and Afghanistan operations in 2001–2009 by Possley et al. [34] found that about 15% of spine injuries, apart from osteoarticular pathologies, were additionally linked with such complications as the disruption of the pachymeninx of the spinal canal, damage to spinal cord vessels, damage of the spinal cord, and injuries of the abdominal cavity structures. In almost half of the cases, those injuries were caused by explosions, while others resulted from bullet/fragment penetration [34,35].

The number of reported non-combat injuries was relatively small. It is known that non-combat injuries may account for 31–36% of medical evacuations [16,28,36]. A cause-type structure of non-combat injuries was similar to that found in the literature; these were acoustic injuries caused by sports activities, specialized training, falls, and traffic accidents [16].

Combat injuries are significantly different from non-combat ones, as shown in this paper. In a significantly higher number of cases, they are multiple and more severe than non-combat injuries. Combat spine injuries, involving higher energy projectiles and blasts, more often require surgical intervention and cause heavier and more prolonged neurological deficits [35]. The analysis by Owens et al. of 3,102 soldiers wounded in the Afghan operation [28] found that combat injuries included multiple injuries, which is demonstrated by the ratio of 6,609 wounds suffered by 1,566 soldiers. The average of 4.22 wounds per 1 victim of combat is close to the data revealed in this paper on IED attacks.

An explosion next to a closed combat vehicle may bring other consequences resulting from elevated temperature and causing burns [37]. In the sample under analysis, they accounted for 5.8% of all injuries.

A bite by a venomous snake is another life-threatening incident. The venom has either hemotoxic properties (hemolysis, impairment of blood vessels, rhabdomyolysis, dermoneurosis) or neurotoxic ones (nerve impairment or paralysis, which in turn leads to cardiac and respiratory disorders resulting from respiratory nerve paralysis). Survey studies have shown that among 3,265 US soldiers deployed in Iraq/Afghanistan from January 2005 to May 2006, 9 suffered from snake bites (4.9 cases per 10,000 patients per month) [20]. The sample under study did not reveal any such cases.

Conclusions

1. Casualties of attacks against MRAPs most often suffer from severe and multiple injuries.
2. It should always be suspected that the victim of an IED attack could have suffered internal body cavity injuries.
3. Considering frequent cases of damaged ocular/acoustic and balance organs, routine protection of those organs should be introduced.
4. The number of non-combat injuries suffered by the PMC soldiers is relatively low.

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