Discussion

Chapter 10. Summary and future perspective

Summary and future perspective

Between 2006 and 2010 Task Force Uruzgan, as part of the ISAF mission, conducted military operations in a hostile environment. This thesis describes the multifactorial influences of armed conflicts; from the direct consequences for combat casualties, to the impact they have on their comrades, medical personnel and family members.
The aim of this thesis is to evaluate quality of care (QOC) of the Dutch armed forces (DAF) and the quality of life (QOL) of injured Dutch service members. Therefore, the thesis focuses on the incidence and characteristics of battle casualties (BCs) in North Atlantic Treaty Organization (NATO) coalition forces and secondly it compares these international data with the DAF and historical data. It further focuses on (1) QOC in the pre-hospital phase during the armed conflict in Uruzgan, and (2) the initial in-hospital (in-theatre hospitalized) phase. The military surgeon plays a vital role in the initial care of wounded service members and should be ready for this demanding task. Finally, this thesis focuses on the QOL of a BC, divided in (1) the role of social support, (2) outcome, and (3) post deployment reintegration.

In **Chapter 1** the armed conflicts of the last century and the recent conflicts are addressed. It illustrates the important improvements and adaptations in body-armour and personal protective equipment, that resulted in a different anatomical distribution of wounds, and the impact that combat events have on service members. This chapter provides a perspective on combat casualties from Afghanistan. This perspective focuses on the short and long term effects of injuries sustained by service members, but also on the impact of these injuries and their consequences on their comrades and their social network.

Incidence and epidemiology of battle casualties

Part 1 evaluates the incidence and types of battle casualties of NATO coalition forces and compares these international results with the DAF. It provides insight in demographics, offers opportunities to optimize quality of care of BCs, and describes the impact of explosive devices on the DAF.

Chapter 2 is a systematic review evaluating the incidences and characteristics of battle casualties from NATO coalition partners in Iraq and Afghanistan. This review is based on all available cohort studies of battlefield injuries of coalition forces from Iraq and Afghanistan. Eight published articles, encompassing a total of 19,750 battle casualties, were systematically analysed to achieve a summated outcome. These studies were rated on the level of evidence provided, according to criteria of the Centre for Evidence Based Medicine in Oxford. The methodological quality of observational comparative studies was assessed by the modified Newcastle-Ottawa scale. There was heterogeneity between the included studies, with major differences in inclusion and exclusion criteria, introducing bias. The overall distribution in mechanisms of injury was 18% gunshot wounds, 72% explosions and 10% other. The overall anatomical distribution of wounds was head and neck 31%, truncal 27%, extremity 39% and 3% other. The mechanisms of injury and anatomical distribution of wounds observed by NATO coalition partners in Iraq and Afghanistan differ from previous campaigns. Improved explosive devices (IEDs) became the major threat in these armed conflicts. We recommend that a NATO wide registry system should be implemented with a track and follow up system in order to further improve the quality of care and registration of casualties on the battlefield. Further research is necessary to

develop more effective protective equipment and body armour, with special focus for head and neck and extremity protection.

Chapter 3 is the first documented report on wounding patterns and mechanisms of injuries of battle casualties treated at the Dutch role 2 enhanced medical treatment facility (MTF) at Multi-National Base Tarin Kowt, Uruzgan, Afghanistan. A total of 2,736 patients were admitted, of which 60 % (N = 1,635) were classified as 'disease non-battle casualties' and 40 % (N = 1,101) as 'battle casualties'. The battle casualties sustained 1,617 combat wounds, resulting in 1.6 wounds per battle casualty. These injuries were predominately caused by explosions (55 %) and gunshots (35 %). The wounding patterns were as follows: head and neck (21%), thorax (13%), abdomen (14%), upper extremity (20%), and lower extremity (33%). These figures resemble the patterns as recorded by coalition partners, but differ from previous conflicts: a greater proportion of head and neck wounds and a lower proportion of truncal wounds. The pre-hospital phase seems to be the most substantial opportunity to improve outcomes for BCs, with improvements in body armour and life & limb saving medical skills as spear points.

Chapter 4 represents an in-depth analysis of all Dutch battle casualties during our participation in the ISAF mission as lead nation (2006-2010) in Southern Afghanistan. The trauma registry query resulted in 199 Dutch battle casualties. The case fatality rate was 9.5%, the percentage killed in action was 16.5%, and the percentage died of wounds was 1.1%. The wounding patterns were as follows: head and neck (32%), thorax (8%), abdomen (13%), upper extremity (18%) and lower extremity (30%). The mean AIS and ISS were 3 and 11 in the wounded in action group. Explosive devices accounted for almost 85% of the casualties. This study shows roughly the same windows of opportunity as found in chapter 3, but also stresses the need for a prospective registration in a standardized data collection system that encompasses all echelons of the medical support organization. Collaboration of the Dutch armed forces in the US trauma registry (DoDTR) or integration in the Dutch national trauma registry seem good opportunities for achieving this aim.

Quality of Care

Part 2 evaluates (1) the self perceived QOC in the pre-hospital phase during the armed conflict in Uruzgan, and (2) the initial in-theatre hospital phase, with special emphasis on QOC in the pre-hospital phase as experienced by the "direct circle" around BCs and the psychological impact on deployed surgeons and anesthesiologists.

Chapter 5 assesses "the direct circle" around battle casualties. An online survey was conducted amongst medics, nurses, tactical commanders and enablers (n=200) deployed to Southern Afghanistan (2009-2010) in three Marine companies. Eighty seven percent of the eligible Dutch medics, nurses and tactical commanders participated in this survey. Most (14/16) medics and nurses scored their pre-deployment training as sufficient, the overall self-perceived QOC score was above average (7.8). There were no significant differences regarding rank, gender, age and military task using the impact of event scale and post deployment reintegration scale (PDRS). The only exceptions were the work negative, family positive, and personal positive subscales in the PDRS, where there was a significant difference ($p<0.05$) with the Canadian norm values. The post-traumatic stress disorder rate in the deployed Marine companies was low. Further

(prospective) research is necessary to identify predisposing, but preventable high stress factors and for composition of a "waterproof" aftercare program (e.g. fully integral TRiM) as initial warning instrument for the need of more specialist (mental) health care.

Chapter 6 extends our evaluation of the medical support organization (MSO). The experiences of Dutch military surgeons and anesthesiologists that deployed to South Afghanistan provided an opportunity to evaluate pre-deployment training and preparation of our military medical specialists. An online survey was conducted amongst all surgeons and anesthesiologists (n=40) that deployed to the role 2 MTF in Uruzgan and / or the role 3 MTF at Kandahar Airfield between February 2006 and November 2010. Most (35/40) participants reported high levels of self-perceived preparedness prior to their deployment. All (40/40) surgeons and anesthesiologists described a positive influence of their deployment on their professional skills and 33/40 described a positive effect on their personal development. Knowledge of maxillofacial, ophthalmic, neurological, urological, gynecological, vascular and thoracic surgery scored below average. Impact on their mental health and social support network was reported as negative by 11/40 participants, 24/40 reported a neutral and 5/40 a positive effect. Eighteen (surgeons 7/22, anesthesiologists 11/18) felt the need to meet an independent professional coach (defined here as peer to peer) to talk about their experiences at some point after deployment, 22/40 did not feel this need at any point in the post-deployment phase. A focused pre-deployment training program to prepare Dutch surgeons and anesthesiologists for combat surgery is currently lacking. These results emphasize the need for a standardized pre-deployment medical training, despite high levels of perceived preparedness. Also, the high mental and psychological impact of their experiences on the deployed surgeons and anesthesiologists warrants further assessment.

Chapter 7 compares the surgical workload at the role 2 MTF with resident surgical training and the surgical exposure during deployment. In the studied period 1,427 casualties (including 336 pediatric cases), required 2,319 surgical procedures. Graduating chief residents did an average of 1,444 cases, including 165 laparotomies, 19 major vessel repairs, 28 amputations, and 153 fracture stabilizations during their residency. Residents had limited exposure to injuries requiring a thoracotomy, craniotomy, nephrectomy, IVC repair and repair of external genital trauma. The injuries treated at the Dutch Role 2 MTF were often severe. Exposure to pediatric cases was much higher than reported in other combat hospitals in Iraq and in Afghanistan.
The current civilian resident training does not provide in the minimally required competences of a military surgeon, because it is not focused on military deployment. In order to prepare specialists for the typical challenges of a military (medical) deployment, a specified program of training is required and a organizational structure should be introduced. The recognition of military surgery as a subspecialty within general (trauma) surgery, with a dedicated training curriculum, in the Netherlands should be considered. The introduction of a North Atlantic Treaty Organization Military and Disaster surgery standard could attribute to achieve this aim.

Quality of life

Part 3 focuses on the QOL of a BC, divided in (1) role of social support, (2) outcome, and (3) post deployment reintegration.

Chapter 8 evaluates the 5-year follow up of Dutch battle casualties. The survey contained 6 main topics: (1) participants general background, (2) the Impact of Event Scale-Revised (IES-R), (3) the Post deployment reintegration scale (PDRS), (4) the Symptom Checklist 90 (SCL-90-R), (5) Quality of Life (QOL) using the EuroQol-6D (EQ-6D) and Short form health survey (SF)-36, and (6) the modified Trimbos questionnaire for Costs associated with Psychiatric Illness (TIC-P). Thirty eight percent of the eligible BCs participated in this survey. The, significantly different ($p<0.05$), mean IES was respectively in the BC group 15.9, CG1 5.1, and CG2 3.7. The PDRS showed a significantly different ($p<0.05$) outcome in the work negative, family negative and personal negative subscale. The mean SCL-90 of the BC group was significantly higher than that in the control groups ($p<0.05$). The mean costs of direct medical consumption was respectively in the BC group € 486.80, CG1 €162.90, and CG 2 €166.10.
The QOL, the impact of events, and the distress levels were significantly different when comparing the BC group with the control groups. Care consumption was three times higher in the BCs. The results of this analysis are meant to provide novel insight into management and long-term outcomes of BCs. The association of traumatic stress and distress levels with QOL, provides an opportunity and advocates for aggressive interventions to manage these raised stress levels, in order to improve the QOL. Future analyses could help to identify modifiable factors that, hopefully, will improve outcomes among all BCs.

In **Chapter 9,** a systematic analysis of the complete MSO of the Dutch Armed Forces regarding repatriated service members from Afghanistan (July 2003-January 2014) was performed. Musculoskeletal injuries were the main cause (63%, 141/223) for repatriation, and IEDs the major (67%, 60/89) mechanism of injury in the BC group. The mean time between injury and arrival in the Netherlands was 8 days, and this was limited to 3.6 days in case of polytrauma casualties (ISS>15). Sixty percent of all medical evacuations were DNBIs, and these service members also were significantly older compared to the BCs. In our opinion the repatriation time frame was relatively long before receiving definitive treatment; 48-72 hours for arrival in a role 4 medical treatment facility (out of theatre) for definitive surgical care seems feasible. Further research is necessary to identify delay factors and possible improvements in the MSO, also the assess the relation between shorter evacuation timeframes and beneficial outcome for a BC.

Conclusions and future directions

This dissertation focuses on recent experiences in armed conflicts. Uruzgan, Afghanistan, saw four years of involvement of the Dutch Armed Forces in fighting insurgents and nation building.
Armed conflicts are part of our history. Triaging and treating wounded service members in the early days of battlefield medical care was primarily aimed at returning them to the frontline. In those days soldiers who were severely wounded had a dismal prognosis. Chances of surviving significant blood loss, penetrating torso trauma and infections were miserably low. However, in history, military medicine induced numerous practical adaptations to existing medical practices and started many innovations. Famous war surgeons like Paré[1] (1510-1590) and Larrey[2] (1766-1842) are remembered for their contributions to military medicine that

found rendition in civilian medical care. The Dutch military physician Mathijsen[3] (1805-1878) is believed to be the inventor of the Plaster of Paris. Armed conflicts are still part of today's world. Conflicts in Iraq and Afghanistan and civil wars like in Libya, Syria, Gaza and Ukraine cause human suffering on a daily basis. War has changed over centuries and wars will continue to change. Therefore, military medicine will continuously have to familiarize itself with new developments. The clouding lines between soldiers and civilians, states and non-states, and the obscuring differences between war and politics have changed the battlefields. Frontlines hardly exist any longer. When looking at numbers (without a robust trauma registry from the earlier armed conflicts), battlefield statistics have changed over the last century. The number of military casualties and the amount of civilian victims, including infants, children and women, are nowadays different (regarding ratio military/ civilian casualties). The predominant mechanisms of injury are still explosions and gunshot wounds. Better personal protective equipment is likely to be an influential factor in the changing patterns of the anatomical distribution of those injuries.

Experiences from these modern time conflicts have enormously contributed to changes in modern civilian (trauma) care. The Joint Trauma System (JTS) Clinical Practice Guidelines found their origin in military medicine[4] and are frequently implemented in customized or adjusted form in civilian protocols. The revival of the tourniquet and the use of so called massive transfusion protocols found their basis on the battlefields of Iraq and Afghanistan[5-7]. As said, military medicine needs to follow conflicts. It needs to adapt effectively to new threats and developments, like the introduction of Improvised Explosive Devices or "dirty" bombs. It needs to adjust its modus operandi constantly and swiftly. And, in recent years, military medicine did adapt, resulting in the lowest case fatality rates ever[8-12]. Military medicine covers a large area of interest, including battlefield related medical and surgical acute interventions, but also the physical and psychological wellbeing of service members during and after their deployment. Preferably there should be scientific evidence for interventions applied and consequently research in military medicine is essential. Detailed analyses can be converted into new doctrines, practices and management guidelines. However, for simple practical reasons like getting a victim's informed consent, it is difficult to do even basic prospective studies, let alone to conduct multicentre, randomised pre-hospital and clinical trials in actual areas of military operations. Many, if not all, published battlefield studies are therefore descriptive and or retrospective in nature. Hence, the obtainable levels of evidence are limited. Yet, if we want to further improve the quality of care for wounded service members, we need to find ways to overcome that gap between military and civilian medicine. Till then, we will have to learn as much as possible from recent experiences in war-zones and introduce these observations in doctrines and training courses. Knowledge of the management of war-zone injuries is also valuable in treating casualties from natural disasters or (terrorist) mass casualty situations[13]. Studying the changing anatomical distributions of war injuries might help in developing lifesaving materials and better protective equipment. To date, only a few prospective battlefield studies[14-16] (with a high level of evidence) have been conducted. The PRISMO study[17] of Eric Vermetten is a fine example of Dutch modern research, and might help us to disentangle factors of relevance in Post-Traumatic Stress Disorder. Attention for team interaction is crucial for this high stress environment. Crew resource management is more and more finding it's place in civilian and military medicine. This effective tool in teamwork should be exploited for maximal profit.

Overall, three themes are dominating this thesis: incidence and epidemiology of BCs, QOC and QOL. These three themes are the foundation for more research in the DAF. Optimizing the treatment of BCs goes beyond the MSO, early active involvement of "buddies", tactical commanders and family after a combat incident will be beneficial for everyone. A fully integral approach in the DAF is required. Military medicine is a continually evolving process, all efforts should be exerted for optimization. The integration of prospective studies will enhance the quality of lessons learned from each armed conflict. There is a strong analogy with disaster medicine and surgery. Collaboration of disaster and military medicine could possibly be useful. If the results reported in this dissertation could help to improve the quality of the Medical Support Organization, the training of medical and non-medical personnel, and the QOL of all involved by more than one percent, we have achieved our aim.

Many questions remain unanswered and clichés are once again applicable. Two are discussed below.

Civilian medicine is not similar to military medicine

Current civilian resident training does not provide in the minimally required competences of a military surgeon. This gap will only grow due to the ongoing "super "specialization and the loss of the true general surgeon. Not many surgeons will be exposed to, and capable of dealing with, ossal, vascular and truncal injuries. We should anticipate on this development.
There are several possible solutions discussed in this thesis: standardized courses, exchange/ fellowship programs, the deployment of surgical residents as part of their medical specialist training, staged classification of military surgeons, the introduction of a NATO military (and disaster) surgery standard and the recognition of military surgery as a subspecialty within general (trauma) surgery.
The changes in the way armed conflicts are fought, brought us to fourth-generation warfare. In the coming decades the distinction between a war theater and a civilian setting might blur even more, changing into fifth generation of warfare. This implies that new skills and competences should be integrated in military and civilian medicine.

Boots on the ground

Despite the evolving technical capabilities of modern mechanized or automated elements like drones, human "boots on the ground" will likely remain crucial in future armed conflicts. Therefore our efforts to improve the quality of medical care for wounded service members should never cease. The important role of co-combatants and a strong social support network cannot be overemphasized. Their early active involvement in the rehabilitation process will be beneficial for everyone.
As a former troop commander and sportsman, I strongly believe in the power of teamspirit and teamwork. Esprit de Corps and "train as you fight" are more than force multipliers, but a way of life. Recent collective participation of wounded service members in "Mud Masters" and "The Invictus Games" strengthens this assumption. Only as a team will we be able to meet the challenges.

Qua Patet Orbis

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