Chapter 10
General discussion
Since the first introduction of physician staffed helicopter emergency medical services (P-HEMS) in the Netherlands, there has been debate on the additional value of the advanced therapeutic options a P-HEMS can provide. A lot of research has been done into the survival benefit and cost-efficiency of P-HEMS care. It has been proven to increase the odds for survival for the severely injured and the moderately injured patient whilst keeping the costs per Quality Adjusted Life Year below the accepted threshold. However P-HEMS care is a high-visibility and resource-consuming expense and therefore subject to public debate, forcing the field to continuously review their work. Prehospital trauma systems are therefore constantly evolving. Examples within the Dutch system are for instance the institution of regionalized trauma care, implementation of ambulance protocols or the implementation of trauma registries. However proper P-HEMS care depends on continuous training, education, skill improvement, monitoring and research. Trauma care is integrated care and according to the national guidelines one of the success factors in trauma care is the quality of the collaboration between different health care providers in the chain. One of the next steps to improve Dutch prehospital trauma care through research is to try to address the collaboration and optimize the dispatch and cancellation of both P-HEMS and EMS.

In order to do so, this thesis addresses early trauma care for the severely injured patient. We focus on both prehospital trauma care provided by emergency medical services (EMS) and P-HEMS as well as in hospital care by trauma teams. When trying to optimize the deployment of the P-HEMS, primary question that arises is how one can identify which patient is in need of care by P-HEMS? Though in trying to answer this question, more questions arises. This because prehospital trauma care is subject to so many different variables and in its current form is a relatively new fledged type of care. Before trying to identify a patient in need of care by the P-HEMS, we first need to gain more insight into the factors at play, prior to structure and protocol prehospital trauma care. This because we are not simply looking at patient factors but also situational factors, creating a unique situation for every trauma dispatch. A dispatch is not just dependent on solely measuring the vital parameters or looking at the injuries sustained. It also has to do with the assessment of a layperson on-scene, the content of the distress call to the dispatch center (DC), the interpretation of this information by the dispatch operator, the usage or non-usage of a (protocolled) dispatch program and the subsequent deployment of different types of EMS. Furthermore the prehospital logistics, the locations of the accident, the distance to the nearest trauma center, the availability of EMS and P-HEMS and the weather are of influence. Moreover the assessment of the EMS nurse at the scene plays an important role, as does the exposure of the EMS nurse to severely injured patients or the communication between DC and EMS and P-HEMS and consequently the information handed over to the P-HEMS. Furthermore the interpretation of the hectic of the situation, the time spent in the prehospital setting and the skills of the EMS nurse to secure the ABCD are of influence. When reading this enumeration one can understand that it is difficult to provide a structured answer to the first research question which is applicable to every prehospital trauma patient. In order to elucidate some of the factors at play, we focused on assessing
what factors are major contributors in the decisions making process, how can we influence these and what are shortcomings in current practice.

A factor that is perceived to be of great influence on the outcome of a trauma patient is the time spent in the prehospital setting. It is difficult to solely address the factor time on trauma patient outcome. This is reflected in the heterogeneity of the included studies included in Chapter 2. In this chapter we review the duration of several prehospital intervals on trauma patient outcome. However, various types of patients groups, mechanisms of trauma, types of prehospital trauma care or trauma scores are clustered and analyzed, disregarding there independent effect on mortality. Through carefully reviewing the data we conclude that for undifferentiated trauma patients shorter response time and transport time may have a positive influence on mortality. However longer on-scene-times of EMS and P-HEMS may increase odds of survival. The same goes for increased total prehospital time, probably due to the relatively large proportion of on-scene time in total prehospital time. This leads us to believe that not merely time but prehospital interventions performed and the type/ level of care are a major contributors on trauma patient outcome. P-HEMS provide a more extensive type of care in the prehospital setting, though this may lengthen prehospital time intervals. Lessons that one may learn is not to stress to much with regard to the factor time, but focus more on the deployment of the appropriate type of care. Though, swiftness of transport does seem beneficial for patients suffering traumatic brain injury or hypotensive patients suffering penetrating trauma.

To improve prehospital trauma care and dispatch the P-HEMS more adequate is seems important to identify patient in need of care by an P-HEMS team early in the process. To investigate this and review other factors of influence on prehospital trauma care the DENIM (a Delphi-procedure on the identification of prehospital trauma patients in need of care by Mobile Medical Teams (P-HEMS)) was performed. This study reveals communication to be of utmost importance (Chapters 6 and 7). To further address this topic we looked into the current status of prehospital communication and handovers between all EMS and the dispatch center in Chapter 3. Tape-recordings of communication between the ambulance, DC and the helicopter for trauma related dispatches were transcribed and analyzed. It showed that in only 17% of all dispatches a complete situational report was handed over, either using the ABCD-methodology (5%), the Situation-Background-Assessment-Recommendation technique (9%) or the Mechanism-Injuries-Signs -Treatment method (2%). All other handovers were incomplete. EMS on scene are responsible for a direct and clear situational report. Based on this information, the P-HEMS physician is responsible to ensure him- or herself if continuation of P-HEMS dispatch is necessary or if the mission can safely be aborted. Therefore the handover is essential for the quality and continuity of care. A structured communication format can add to this, currently several different acronyms exits to aid EMS in their handover. Though this study shows limited usage of the current models. Furthermore the DENIM (Chapter 6 and 7) shows a national consensus on that, simply reporting “ABCD-stable” is insufficient to make an educated decision and likewise there is consensus among all professions in the field of prehospital trauma care on the need for a
new and structured model for handover. This will aid to standardize prehospital handovers, so more patient and situational information is provided, to increase joined decision-making and increase quality of care and improve patient’s outcome. Another conclusion from chapter 4 is that the implementation of the new P-HEMS model already enhances the flow of information. Going through the cancellation model enforces the EMS nurse to provide the P-HEMS physician with more detailed information. In Chapter 4 we review the implementation of this cancel model. To prevent high levels under triage, the Dutch trauma system handles a low activation threshold for the primary P-HEMS dispatch. Therefore it is important that attempts to reduce over- and under triage focus on the second point in triage, when EMS nurses on-scene make a first professional assessment of the situation. Based on this information a decision needs to be made to either continue or cancel the P-HEMS dispatch. In P-HEMS care, over triage causes increased costs, additional safety risks to the flight crew and shortage of P-HEMS care for higher acuity emergencies. The American Colleges of surgeons have deemed 5-10% under triage acceptable with maximum 50% over triage. Due to previously reported high cancelation rates of the P-HEMS of the Lifeliner One and low predictability for major trauma a new cancellation model for P-HEMS was designed. We identified prehospital parameters that were significant in the identification of majors trauma patients in order to design a safe triage model for cancelling unnecessary P-HEMS dispatches. Chapter 4 shows that implementation of the new cancel model yielded a high level a off accuracy for identifying a major trauma patient. The sensitivity of the new model is 0.898 (CI:0.817 to 0.945), the specificity 0.72 (CI:0.625-0.799). The positive predictive value is 0.738 (CI:0.648 to 0.812) and the negative predictive value 0.889 (CI:0.802 to 0.9840). Generating a under triage percentage of 10.2% and an over triage percentage 28%. Two cohorts before and after implementation of the cancellation model were compared. Results show that the mean age was significantly older for the recent cohort than for the former cohort. Furthermore the ISS significantly increased, this could implicate better prehospital triage for the severely injured to receive P-HEMS care. The number of acute interventions significantly increased, whereas number of patients admitted to an ICU decreased. Moreover mortality rates were comparable. The new model makes sure the most severely injured patients receive lifesaving care whilst reducing unjustified P-HEMS dispatches. This study furthermore provides us with insight into the prehospital triage of patient to different trauma centers. Fifty-three percent of all patients was transported to a level 1 trauma center, when looking at the major trauma patients this was 74%. The remaining 26% were mostly transported to level 2 but also level 3 trauma centers.

Chapter 5 provides us with a detailed protocol of the DENIM. In search for the answer to our primary research question; which acute trauma patient is in need of care by a P-HEMS a three round national digital Delphi study was initiated. Both steering committee as well as the respondent all had their occupational background within the field of pre- or in hospital trauma care such as P-HEMS physicians and nurses, trauma surgeons, EMS paramedics, emergency medical operators in the DC. Chapter 6 reveals the first results from the DENIM study. A large group of respondent completed all three rounds. For the first DENIM round, the main question asked was; which trauma patient would benefit by the advanced care
of P-HEMS? The first round was used to generate discussion and yield argumentation on the topic. The answers were used to identify topics of interest leading to statements that were presented in the subsequent round. From the first round we could conclude that it was difficult to identify what patient would benefit by the care of a P-HEMS. It appears that the identification of the major trauma patient is problematic. Moreover prehospital communication on parameters, such as vital signs, for major trauma patients is often sparse and inadequate. Therefore the second and third DENIM rounds further looked into the prehospital communication, mode and content of the prehospital communication. This because it was thought that when prehospital communication becomes more clear the P-HEMS dispatch can be evaluated more adequately, which in turn would allow use for better assessment and/or adjustment in dispatch criteria that may improves prehospital trauma care.

For the second round topics were evaluating factors influencing prehospital communication, critical information for proper handover, factors influencing collaboration and how these can be influenced from a training/educational perspective. From answers on the second questionnaire we converged to the third round, which was aimed at exactly establishing the content of a prehospital handover. Chapter 7 provides us with an extensive overview of the DENIM communication tool for prehospital trauma handover. The purpose of this study was improving prehospital communication generating consensus on the exact content of a minimal adequate prehospital handover for a trauma patient. The tool comprises of a set of ten parameters and may help to aid EMS and P-HEMS to structure the handover and provide each other with the essential information to create appropriate situational awareness.

The final part of this thesis focuses on the in hospital trauma care for the severely injured. Chapter 8 reviews the implementation of a recently introduced two-tiered trauma team activation system. To improve in hospital triage the trauma team activation system was changed from a single tiered system mainly based on high energy trauma, to a two-tiered system. This system is based on specific criteria concerning patients vitals, mechanism of injury and type of injuries the patient sustained. A divide is made in the dispatch of a complete trauma team (CTT) or a selective trauma team (STT). The CTT comprise of a more extensive team then the STT. The division was made done to minimize over triage and to allocate resources more properly whilst making sure that the severely injured patients are identified and receive the appropriate care. It appeared that the new system identifies those patients in need of care by the CTT adequately with an under triage percentage of 7%, and over triage 29%. The patients were grouped into correct CTT, over triage, correct STT and under triage. We compared all groups for in hospital mortality, 30-day mortality, length of stay, Intensive care admission (ICU) and the duration of ICU admission and found no differences across the groups. When reviewing the additional examinations requested per team, an almost 1:4 ratio was seen in the total number of requests (resp. STT vs CTT), this was the same for the additional radiological requests. Implicating higher costs for the CTT. Furthermore the implementation of the new model has led to improvement of pre-to in hospital communication. The implementation of the new trauma team response system.
in just one of the many changes this level one trauma center has gone through. In Chapter 9 we aim to assess how the outcome of the trauma patient population was influenced over time by the maturation of trauma care in our level I Trauma center, VU University medical center. A cohort comparison study between June 2004 - July 2005 and the year 2014 shows that even though patients increase in mean age, the mortality rate decreased by 7.0% and with a Z-score of 4.25 the observed survival was significantly higher than the predicted survival in favor of the 2014 cohort. This is implicating improved trauma care in our hospital.

In conclusion for proper dispatch and cancellation of P-HEMS early identification of the major trauma patient, a patient in need of care by P-HEMS is important. Identification of this patient however seems difficult due to no prehospital trauma patient and situation being identical and many variables are at play. It is furthermore challenging because prehospital communication and reporting on parameters is very spares. Recently, many improvements have been made in the documentation of prehospital parameters in ambulance reports and national databases, though this documentation is often done in hindsight and not in the acute moment when several EMS are trying to figure out the most appropriate dispatch of what resources. Focus on optimizing prehospital communication and information flow will therefore provide us with a better understanding of the prehospital setting. This thesis provides a evidence based tool to improve the communication between all EMS for trauma patients. Providing a structured format with a set of ten parameters which each prehospital trauma handover should entail. This thesis furthermore provides a validation of a new cancellation model which aids in safely cancelling P-HEMS dispatches. Identifying the most severely injured whilst reducing unjustified P-HEMS dispatches and maintaining low mortality rates.