Inter-hospital transports of critically ill patients in Southeast Netherlands, Heinsberg (GER) and Aachen (GER)

Which data is available for research within the EUMIC study?

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Abstract

Background: The hospital landscape is evolving towards less primary health care facilities and more centralised tertiary hospitals leading to an increase in inter-hospital transports (IHT). As an academic collection and analysis of transport data is missing in the Euregio Meuse-Rhine (EMR), the cross-border project Euregional Mobile Intensive Care (EUMIC) has been initiated in 2015.

Objectives: This study performs foundational research and evaluates already collected data from the EUMIC study. It analyses which data is available for further research and how IHTs are undertaken in the study region of Southeast Netherlands and the Districts of Aachen and Heinsberg in Germany. Therefore, operation times of IHTs, data about the requested urgency of transports, reasons for IHTs in general as well as for delays of IHTs, the occurrence of adverse events, patient outcomes 24 hours after admission in the receiving hospital and data about the transferring and receiving hospitals are analysed.

Materials and methods: A quantitative analysis of survey data from the EUMIC study and operation time protocols has been performed and complemented by the distribution of standardised questionnaires to professionals in the study region. The EUMIC database includes data of all Mobile Intensive Care Unit (MICU) transports carried out in Southeast Netherlands as well as data of intensive care ambulance and standard ambulance transports (which are accompanied by a physician) in the Districts of Aachen and Heinsberg since April 2015.

Results: In total, data on 255 IHTs was analysed. 151 cases took place in Southeast Netherlands, 54 cases in the District of Aachen and 50 cases in the District of Heinsberg. The two main reasons for transfer were treatment in expertise centre (64.3% of all IHTs) and planned interventions (31.3%). 24 hours after the transport 59.6% of all patients were reported to be alive. 44 adverse events have been registered in 31 IHTs (12.2%). Total operation times as well as patient handover period times differed significantly per region and transport unit. The most common reasons for delay of IHTs were waiting times for medical records or CDs with x-ray pictures or because the patient was still being treated.

Conclusions: The IHTs registered in the EUMIC database only represent a minor proportion of all IHTs, which are usually performed in the EMR. However, the data provides a large amount of information about IHTs for further research. Therefore, the data collection should be implemented in all regions of the EMR.
Inter-hospital transports of critically ill patients gain in importance and frequency for various reasons. In the Euregio Meuse-Rhine the Euregional Mobile Intensive Care project has been initiated to assess differences in IHTs performed by different transport systems in order to improve quality and efficiency of IHTs. Within this study the data available in the EUMIC project are analysed concerning the execution of IHTs, evaluated in terms of usability and recommendations are provided for further research.
Background

Inter-hospital transports

Hospitals and health centres become more and more specialised, leading to a centralisation of advanced health care services [1,2]. In particular, the transport of a patient from a primary health care facility to a secondary or tertiary care hospital in rural areas is frequently necessary to provide comprehensive patient care [2]. Reasons for IHTs are diverse and range from the unavailability of bed capacity to a lack of a tertiary department or equipment needed for further diagnostics or treatment [3]. IHT are so-called secondary transports as the patient is already receiving medical treatment and is transferred to another medical facility for additional treatment. In contrast, primary ambulance missions include bringing a patient from the scene of the emergency to the next suitable hospital, where an initial stabilisation and first or definite treatment can take place [1].

IHTs differ based on their modality and urgency. For long distance transfers, the transport might be air-based. Additionally, MICUs have been installed adjacent to care institutions in different areas as adequate transport vehicles for intensive care transports. These vehicles are designed for the purpose of transporting patients under intensive care unit (ICU) conditions and provide the required space as well as appropriate ICU equipment. The transport teams consist of trained staff members experienced in critical care medicine [3]. Nevertheless, most transports are carried out by the local rescue service driving standard ambulances equipped for pre-hospital emergency situations with paramedics or emergency medical services (EMS) physicians accompanying the transport [3].

IHTs can be performed as an immediate emergency transport or as a scheduled transport. The decision to transport a patient to another hospital or another medical facility is usually made by the referring physician in cooperation with the physician responsible in the receiving hospital [4]. The decision to transfer a patient is mainly based on the patient’s critical condition and need of additional treatment such as a medical intervention (for example surgery) [5]. Decision-making concerning the most appropriate transport system can be challenging and is done by weighing the risks and benefits for the patient [4] through assessment of the patient’s status and available transport systems, considering issues such as the weather circumstances and distance to the receiving hospital [6]. The physicians have to distinguish between emergency patients in need of immediate further diagnostics or treatment, only available in another hospital, and those where a scheduled transport is justified [7]. Hecker & Schramm [4] clarify that the urgency of the patient to receive further medical treatment as well as the current medical state of an
intensive care patient are crucial factors for the decision to be made between an emergency IHT and a non-emergency IHT. As opposed to emergency transports, non-emergency transports can be planned in a sufficient time span. This decision-making process is also applicable to other critical patients, who are not (yet) in need of intensive care [5]. It is essential not to underestimate the risks and difficulties of transporting a critical patient as a patient’s safety might be compromised through an IHT [1]. The majority of all IHTs have to be accompanied by a properly trained physician to ensure qualified intensive care (IC) treatment for critically ill patients, as these patients are at a severe risk of deterioration during transport [7]. Therefore, IHTs need to be as well prepared as possible, and a patient needs to be stabilised sufficiently before transportation [5]. For this purpose, pre-departure check lists have been created for regional patient transfers in the United Kingdom [8]. Difficulties which may arise during transports of critically ill patients include adverse events [9], which can be caused by technical problems [1], communication or other team-related problems or the involvement of insufficiently educated personnel [10]. Further, the natural course of disease of the patient can cause numerous problems such as life-threatening cardiovascular or respiratory events [9]. However, there are no valid triage criteria and quality characteristics of IHTs for evaluation purposes. Adverse events are difficult to compare as international definitions differ widely [9,11]. Literature assessing the total operation times (from beginning to the end of transport) or waiting times during IHTs could not be found. Therefore, coherent quality assessment and improvement strategies for IHTs are found to be missing.

The qualification of the accompanying team members differs internationally. Whether a physician accompanies the IHT depends on the patient’s status as well as on the organisation structure of the local EMS. One important aspect is whether a nurse-based / paramedic system or physician-based EMS system is in place [3]. In the Netherlands, seven MICU systems were introduced in 2009 by a federal regulation to ensure high-quality transport of critically ill and IC patients in case of scheduled IHT [12]. A MICU is staffed by an ambulance driver, an IC nurse and an IC physician [11]. One of the seven MICU systems is located in Maastricht, carrying out transports for 10 hospitals in the regions North and South Limburg and Southeast Brabant, which form one MICU region Maastricht. The same 10 ICU collaborate closely within the network Intensive Care Unit Zuid Oost Nederland (ICUZON) [11,13]. In Germany, patients in need of an immediate IHT are transferred by the regular EMS system (ambulance and emergency physician). Patients whose transport can be scheduled in advance are transferred by an appropriately staffed and equipped vehicle. Either a standard ambulance, an ambulance with advanced equipment and staff or an intensive care transport vehicle [Intensivtransportwagen]
(ITW) will be provided [4], depending on the patient’s needs. In the newest law for rescue service provision in North Rhine-Westphalia, it is not clearly defined how intensive care transports have to be carried out. The law only states that vehicles should be equipped and staffed appropriately [14]. In both the Netherlands and Germany the problem occurs that physicians who are accompanying an IHT are not available for their regular duties (at the hospital or the EMS) during the time course of the transport [15].

**Euregional EUMIC study**

This research is part of the study ‘Quality and efficacy of inter-clinical critical care transport in the Euregio Meuse-Rhine’ (QUIT EMR trial), which officially started in April 2015. The trial belongs to the cross-border project EUMIC. EUMIC is a long-term research project of Maastricht University Medical Centre (MUMC+), which has been initiated within the scope of Euregio Meuse-Rhine In Case of Crisis (EMRIC), the cross-border cooperation structure of (public) organisations in the areas of fire fighting, emergency medical services and civil protection. The goal of EUMIC is to organise inter-hospital transports in the EMR more efficiently and with high quality standards. EUMIC intensifies cross-border cooperation between ambulance personnel as well as specialised transport teams, which are trained and equipped for intensive care transfers [16]. Within the QUIT EMR trial, transport systems with different standards are compared in terms of adverse events and the necessity for medical interventions during the transport. Additionally, morbidity and mortality rates 24 hours after completion of the transport are registered. The main objective of EUMIC is to investigate whether the differences between transportation vehicles and teams affect the quality of transports and thereby patient outcomes. Another objective is to predefine certain patient and transport team and vehicle characteristics, which should be checked before a possible IHT takes place in order to perform the most appropriate transport (either an emergency transport with a standard ambulance, an IC ambulance or a scheduled transport with a high level of personnel and equipment) [16].
**Study region**

This study focuses on Dutch and German IHT in the region of the EMR, which is a region that has been active in cross-border cooperation in the fields of public health and safety for more than four decades [17]. Within the EUMIC study, several emergency services within the EMR expressed their interest to participate, namely South Limburg (NL), North Limburg (NL), Southeast Brabant (NL), District of Heinsberg (GER), District of Aachen (GER), the City of Aachen (GER) and the region of Liège (BE). However, relevant data has only been collected by the ambulance services in three regions\(^1\) [18]. Therefore, the study region consists of the ICUZON region Southeast Netherlands (Limburg and Southeast Brabant) and the Districts of Aachen and Heinsberg in Germany (Figure 1).

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\(^1\) Data for other study regions are limited to a few IHT cases per region and are therefore not regarded as a useful extension of this study.
Objectives

Even though EMSs in the EMR are very experienced concerning IHTs of critically ill patients, an academic collection and analysis of transport data has not been executed before the EUMIC study. This explorative study uses already collected data from the EUMIC study. Its goal is to indicate which issues might be important for future analyses as a good system performance and clinical evidence are essential for high quality patient care. The main objective of this study is to evaluate which IHT data are available within the EUMIC study and which continuous data will be available in the future to facilitate further analyses. Consequently, this study is undertaken as foundational research and it is only one building block of further analyses of IHTs in the EMR within and beyond the EUMIC study.

This research complements the objectives of the EUMIC study by analysing differences between scheduled and emergency IHTs in the border region of the Netherlands and Germany. Subject to this study are ground-based IHT, which are accompanied by a physician in the German regions as well as MICU transports in the Southeast Netherlands region. Transports between hospitals within each country are studied, but also the occurrence of transports across the national borders in the EMR is examined. It is discussed whether hospitals call for an emergency transport, even though the patient may not be prepared and ready for transport in order to investigate whether the process of IHTs could be improved. For this purpose, operation times (duration) of the transports and problems encountered by the EMS or MICU teams are assessed. In addition, it is evaluated whether planned interventions in the receiving hospital were performed in a timely manner. Finally, a scheme for transfer relations and patient flows between the hospitals in the study region and the accompanying regions is created.
Research questions
The following research questions formed the basis for this study, starting with an overarching question. All research questions refer to the EUMIC study and additional gathered data via questionnaires.

Which data is available in the EUMIC dataset about IHTs in the Dutch-German border region of the ICUZON Southeast Netherlands and the Districts of Heinsberg and Aachen?

1) What are reasons for transfer of critically ill patients?
2) In which proportion of cases was the requested urgency for the arrival of the transport team and the beginning of the IHT accomplished?
3) How much time do transport teams in the EMR spend in preparation for and / or waiting in the transferring hospital before the transport actually begins?
   ▪ What are reasons for a delay?
   ▪ Which problems do transport teams encounter when taking over a patient for transport?
4) Is there evidence of a difference in the occurrence of adverse events during IHTs by MICU teams and by less equipped teams and vehicles in the study region?
5) How long are transport vehicles and teams occupied and therefore not available for other emergencies / transports?
6) What is the patient outcome 24 hours after transport?
   ▪ Which of the planned intervention(s) in the receiving hospital have actually been conducted?
7) What is the special pattern of patient transports within the region (in terms of patient flows between the hospitals)?

The overarching research question was chosen as the main objective of the study is to evaluate the availability of data within the EUMIC study. Therefore, detailed sub-questions were formulated after screening the database for useful data categories to allow an in-depth analysis of the EUMIC data.
Methods
A mixed-methods study design has been used for this exploratory research to answer all research questions and meet the objectives of this study. The research consists of a quantitative analysis of survey data and operation time protocols. The latter is complemented by the use of standardised questionnaires, involving mostly quantitative and a few qualitative questions filled in by professionals working in the field. All analyses described below were performed using SPSS (Statistical Package for Social Science version 21 by IBM). These methods were chosen as the quantitative analysis gives a detailed overview of the data available in the EUMIC study. The use of questionnaires complements this analysis and additionally includes professional opinions.

Survey and questionnaire data
Data collection and registration in the EUMIC study
In the EUMIC study, all IHTs of critically ill adult patients (18 years old and older) are registered in the study region. All transports carried out in the study region between 1st April 2015 and 30th June 2016 (15 months) are included in this research. These include IHTs which were performed between hospitals in one region but also supra-regional / trans-regional and cross-border IHTs. Helicopter transports are excluded, only ground-based transports are registered. For the region Southeast-Netherlands, all MICU transports (which are dispatched by the dispatch centre in Maastricht) are recorded in the EUMIC database. For the Districts of Heinsberg and Aachen, IHTs, which are accompanied by a physician (either emergency physician from the local EMS or an escorting physician from the transferring hospital), are registered in the EUMIC database. The sample size was therefore dependent on the data provided by the EUMIC database.

All data within the EUMIC study are gathered in a web-based database. This database consists of six different sub-sections, of which the physician or another transport team member fills in four sections in a questionnaire. For the full EUMIC questionnaire, please see Appendix 1. Part 1 covers general demographics / characteristics including amongst others time of alarm, transport unit, transferring and receiving hospital, patient characteristics such as sex and year of birth, as well as the reason for transfer and the requested urgency of the transport (indicating an emergency or scheduled IHT). In addition, it is asked whether any medical intervention is planned in the next 24 hours, which could be a reason for the transfer. In part 2, the patient status at the intake of the call for the patient transfer is documented as well as the status at the arrival of the transport team and lastly, at the end of the transport. These are mainly medical
data. Part 3 indicates whether any interventions during the transport took place. In part 4, the physician has to document any adverse advents occurring during the IHT. These can be technical errors such as problems with the ambulance, stretcher, ventilator, infusion pump, defibrillator, suction unit or the monitoring system. Other adverse events could be stated under patient / treatment / team related events such as low oxygen saturation (< 90%), blood pressure changes (mean blood pressure < 60 or systolic blood pressure < 80), new tachycardia (> 120/min), new bradycardia (< 40/min), ventricular fibrillation (VF), ventricular tachycardia (VT), asystole, pulseless electrical activity (PEA), unintended extubation, loss of intravenous (IV) access or arterial line, medical related complications or communication related complications. Furthermore, for all adverse events, a free text field allows the physician or transport member to enter any other complications which occurred during transport. In addition to the data of the transport team, data about operation times (alarm time, start of the transport team, arrival of the transport team at the transferring hospital, start of the transport, time of arrival at the receiving hospital, time until / of readiness of the transport team and vehicle for another transport and end of transport) are registered by a research assistant by using the radio alarm system’s data of the responsible dispatch centre (part 5; see also Figure 5). This data is matched with all other information related to the respective patient transfer. 24 hours after the transport has taken place, a research assistant collects the necessary follow-up data (similar to parts 1-4) by calling the receiving hospital. Medical data about the patient status are requested, as well as information about interventions which took place as planned or may not have been performed (part 6).

Additional data collection
In cases where data about operation times (part 5 EUMIC database) were missing, the dispatch centres of the Districts Aachen and Heinsberg were approached to fill in the missing data. Data on emergency IHTs performed by standard ambulances in Limburg are not included in the EUMIC data. In the Netherlands, rescue operations are categorised into A1 (absolutely urgent), A2 (urgent) and B (less urgent) operations [19]; IHTs can fall under all of these categories. Therefore, additional data on the emergency IHTs could not be provided by the dispatch centre in Maastricht as the data collection would have required extensive efforts by the dispatch centre data analysts. However, all MICU transports of the ICUZON Southeast Netherlands are included in the EUMIC database. Notwithstanding that data from the German regions and the ICUZON Southeast-Netherlands differ in terms of the transport unit which performed the IHT, the research proceeded as it shall serve as a first indication study for EUMIC which data is available and useful for analyses later on.
Personal communication with one expert per transport unit and region took place in order to receive sufficient information about the transport units’ equipment and procedures.

**Data collection via questionnaires**

As less data were available in the EUMIC database than anticipated, additional questionnaires were distributed to professionals working in the three study regions in June 2016. A cover letter and consent form was provided together with the questionnaire explaining the research objectives and the use of the study results by EUMIC (see Appendix 2). The full questionnaire is provided in Appendix 3. The anonymous brief questionnaire covers demographic information about the participants (e.g. the respondents’ work place and occupation) as well as experiences and encountered problems before or during patient handovers and IHTs. The questionnaire was newly created and the questions were informed by a literature review and by questions used in the EUMIC database. Its purpose is to provide additional information for this research in line with the EUMIC study. The questionnaire was designed in such a way that no conclusion could be drawn on individuals that are subject to the questionnaire, neither professionals nor patients. Therefore, no linkage between cases of the web-based database and the questionnaire data is possible, but data can only be matched according to the demographic variables identified in each of the two datasets. Questions were asked retrospectively for the period of the last twelve months in order to reach more professionals than would have been possible with prospective questionnaires on IHTs taking place within the study time. Furthermore, the retrospectively collected data are understood to represent and complement the EUMIC data which have been collected in a similar time frame. The questionnaire was handed out in German and Dutch in order to ensure a good understanding of the questionnaire and to reach a higher response rate.

The questionnaire handed to EMS professionals consists of nine overarching closed-ended questions, namely multiple choice questions and Likert scales, with several sub-questions and one additional field for free text. Fixed-alternative or closed-end questions have shown to facilitate the process of standardising and analysing the questionnaire. Moreover, it can be assumed that respondents are more willing to answer such questions [20]. Likert scales were used to determine the incidence of certain problems which may have occurred during these processes. The Likert scales ranked from ‘never’ to ‘always’ on a 5-point scale [20]. The multiple-choice questions were used to gather demographic respondent characteristics as well as information about the number and processes of IHTs and patient handovers the respondent was part of in the last twelve months. In the free text fields, participants were supposed to provide information on any other issue they encountered which was not mentioned in the
questionnaire. After designing a draft questionnaire, it was peer-reviewed by professionals in the field (IC nurse, paramedic and emergency physician) and adapted according to their feedback.

In the Dutch study region of Southeast Netherlands, the questionnaire was handed to 19 employees of the MICU team Maastricht. Additionally, it was sent to all medical directors of IC units in the Southeast Netherlands of ICUZON10. In the District of Heinsberg, the questionnaire was distributed to the entire ambulance personnel in the region and the emergency physicians of the EMS. In the District of Aachen, the questionnaire was provided to the personnel and emergency physicians, who staff the IC ambulance. Therefore, the sample size was not clearly defined beforehand because as many professionals as possible were contacted in the three regions. The questionnaire was distributed using print-outs and emails in case print-outs were not practicable. An online-tool was not used as it was perceived to entail a risk of misuse and as it was assumed that fewer professionals would respond to an online-based survey. A total of eight completed questionnaires were returned from the ICUZON Southeast Netherlands, eight from the District of Aachen and 62 from the District of Heinsberg.

Data analysis

Data on the urgency of IHTs, operation times, adverse events and the transferring and receiving hospitals were used from the EUMIC database. Data from the web-based database and dispatch centres were merged and statistically analysed, as well as the questionnaire answers. Potential differences in the duration of transport teams’ occupation (time from alert until end of the transport) between acute emergency and planned IHTs were determined using independent t-test. The t-test was used to compare both transport data and operation time data. Statistical significance was tested using Anova. Further data from the database and the questionnaires were analysed in frequencies and descriptive numbers (either per cent or total numbers) and statistical significance was tested using Chi-square tests. Statistically significant for all tests was defined as a p value \( \leq 0.05 \). Further, findings of the EUMIC survey data and the questionnaire data were compared.

Certain IHTs had been alerted one day before the actual IHT took place; consequently, there are cases in the database for which the total transport time exceeds twenty hours. The time between the alarm and the point in time when the transport team actually starts driving was therefore disregarded when calculating the total transport time. Instead, for this purpose, the point in time when the transport team actively starts the transport (time of departure at hospital or ambulance station) was chosen as the starting time. For calculating the time a transport team
spends in the transferring hospital for the patient handover interval, the time between arrival at the transferring hospital and departure from the transferring hospital was analysed.

Moreover, inter-hospital relations in the EMR have been investigated resulting in a map showing the different patient flows of IHTs in the region. In seven cases, the same hospital was stated as transferring and as receiving hospital; these cases were therefore disregarded for the analysis of the hospital relations.

**Validity and Reliability**

In order to ensure validity and reliability of the study, all data from the EUMIC study was included covering three different regions in two countries. Data was considered within a time frame of fifteen months. Sensitivity analysis was performed when analysing and comparing similar variables and data from the EUMIC study and the questionnaire answers. Respondents of the EMS were more representative than the data from physicians. Much more EUMIC data from the Dutch MICU region was available than for the two German regions. However, the additionally provided questionnaire was mostly answered by EMS staff in the District of Heinsberg (79.5% of all respondents) while only 10.8% of all respondents from the ICUZON and also from the District of Aachen answered the questionnaire. This provides a more representative view of the professionals in the District of Heinsberg than from the other two regions.

**Results**

Within the EUMIC study by end of June 2016, 331 IHTs were registered in total (Figure 2).
Of these, 56 IHTs were excluded because they were incomplete and did not contain a minimum amount of useful data or any of the variables of interest to the EUMIC study (exclusion was performed by the study coordinator). Further, 20 IHTs were excluded for this study as these cases did not fulfil a minimum number of 20 cases per region, therefore, one case for North Limburg and 19 cases for Southeast Brabant (other IHTs, not performed by the MICU) were excluded. From the remaining 255 IHTs, 54 IHTs were registered in the District of Aachen, 50 in the District of Heinsberg and 151 in the ICUZON Southeast Netherlands. All 255 cases were included in the analysis, even though certain data were missing. Cases with missing operation times could still be used for the analysis of other data such as the occurrence of adverse events.
EUMIC data analysis

From the 151 registered IHTs for the ICUZON Southeast Netherlands, 149 were performed with the MICU and two patients were transported with an IC ambulance. This occurs when the MICU ambulance is not available (Strauch, U. 2016, oral communication, 5th of July). In the District of Aachen, 54 transports took place, of which 52 were performed with an IC ambulance, one with a standard ambulance and one with an ITW. In the District of Heinsberg 50 cases were registered, of which 28 were performed with an IC ambulance, 21 with a standard ambulance and one with an ITW.

Of all 255 transports, 82.0% were alerted during the early day (08:00-17:00), 12.2% during the evening (17:00-23:00) and 5.9% during the night (23:00-08:00). Separating the IHTs per region showed that 70.4% of all IHT in the District of Aachen were alerted during the day, 86.1% in the ICUZON and 82.0% in the District of Heinsberg. 14.8% of all transports in the District of Aachen were asked for in the evening, 9.9% in the ICUZON and 16.0% in the District of Heinsberg. During the night, 14.8% of all transports in the District of Aachen were alerted, 4.0% in the ICUZON and 2.0% in the District of Heinsberg. The numbers of transports requested during the night differed significantly between the locations (p=0.015) while those during the day did not.

In 51.8% of all IHTs, the requested urgency of transport was > 120 minutes. 26.7% were requested within 30-120 minutes and in 21.6% the requested urgency was within 30 minutes. 84.8% of the transports with a requested urgency > 120 minutes took place in the ICUZON Southeast Netherlands (11.4% for Aachen and 3.8% for Heinsberg). 41.8% of all cases with a requested urgency < 30 minutes took place in the District of Aachen while 52.7% of those were performed in the District of Heinsberg. Only 5.5% (three cases) in the Dutch region were requested in this short timeframe. In two of these cases, the transport team actually arrived within the timeframe of 30 minutes. In a different case, the timeframe of 30-120 minutes was not obtained. In the region of Heinsberg, all transports with a requested urgency < 30 minutes and between 30-120 minutes were accomplished within the requested time (45 registered cases). The transport teams in Aachen did not accomplish the requested urgency of < 30 minutes in three cases (13%), but were able to perform all requested transports within 30-120 minutes in time. The following reason was stated by the transport teams in the database why they did not reach the transferring hospital in time: the driving distance from the city of Aachen to the city of Simmerath (both located in the District of Aachen) is approximately 50 kilometres, which requires more than 30 minutes of driving time.
The following reasons for transfer were provided in the EUMIC database: follow-up treatment needed, no ICU or IMC bed available, return to patient’s home region, or treatment in an expertise centre needed. Any other potential reason could be added by the transport teams.

**Figure 3 - Reasons for transfer (in % of all IHTs)**

By far the most frequent reason stated for IHTs was the requirement of the patient to receive treatment in an expertise centre, occurring in 64.3% (164 out of the 255 cases) (Figure 3). Within this category, the cases were split into several medical specialties the patient required to be treated in: 8.6% of all patients were brought to cardio vascular surgery, 8.2% to neurosurgery, 10.6% to a different ICU, 6.7% of all patients needed general surgery, and 13.3% of all patients were in need of the cardiology department. For 16.9%, which were categorised under ‘treatment in expertise centre’, other special departments or procedures were stated such as the need for a pulmonary department (for ventilation or weaning), for an extracorporeal membrane oxygenation (ECMO), for certain surgeries (lung, liver or heart transplantation, vascular surgery), for diseases of the ear, nose and throat or for immunology.

One of the major reasons for transferring a patient is a scheduled medical intervention in the receiving hospital. In the data, in 43.9% (112 cases) of all IHTs an intervention was planned to be performed within the next 24 hours. The interventions are categorised into those which needed an assist device, any planned operation, a percutaneous transluminal coronary angioplasty intervention (PTCA) or a transjugular intrahepatic portosystemic shunt (TIPPS) procedure. Transport teams could also add other planned interventions in a free text field.
Amongst others, the following (reasons for) planned interventions were stated: aneurysm, diagnostics, dialysis, endoscopy, tracheotomy, lysis, cerebral embolism, weaning and ECMO. Furthermore, interventions such as operations and lung transplantation were mentioned.

The distribution and execution of the planned interventions per defined category can be seen in Figure 4. Out of the 112 cases, where an intervention within the next 24 hours was planned, in 35 cases (31.3%), the intervention was indeed executed. In 23 cases (20.5%), the planned intervention was not performed at all. For the remaining 54 cases (48.2%), it is unclear whether the intervention took place as this data was not stated in the database. 25.9% of the planned interventions were registered by the District of Aachen, of which follow-up data is missing. Therefore, reasons for missing data about the execution of the remaining 22.3% of planned interventions cannot be reconstructed.

Out of the 255 transported patients, 152 patients (59.6%) were reported to be alive 24 hours after admission in the receiving hospital. Three patients (1.2%) had died within the 24 hours after the transport took place. For the remaining 100 patients (39.2%), it is not known whether they were alive or dead 24 hours after the IHT as this data is missing in the database. There was no significant difference found in mortality between the ICUZON region and the District of Heinsberg. As follow-up data from the District of Aachen is missing, the data does not include patients from this region.
In 12.2% (31 IHTs) of all transports, 44 adverse events have been reported. In three cases it was not stated whether adverse events had or had not occurred. Out of the 252 cases, in 25 IHTs adverse events (80.6% of all IHTs with adverse events) were reported in the ICUZON Southeast Netherlands. The Districts of Heinsberg and Aachen each registered three IHTs (9.7%) with adverse events. For the Dutch region, the 25 IHTs, during which adverse events occurred, account for 16.8% of all registered IHTs. Numbers are respectively 5.6% for the District of Aachen and 6.1% for the District of Heinsberg. The difference between the regions has been proven to be statistically significant (p=0.034). Within all MICU transports, in 24 IHTs (16.1%) adverse events occurred, within all IC ambulance transports 5 IHTs (6.1%) with adverse events were registered and within all standard ambulance IHTs two transports (9.5%) with adverse events have been reported. The differences in occurrence of adverse events between the transport units were not found to be statistically significant. The adverse events in the database were divided into technical errors and team related events. The following 11 technical errors were recorded: on two occasions there was a technical error with the ambulance itself: a non-functioning air conditioning and a stuck brake of the stretcher (although this would belong to the category of technical errors with the stretcher). The latter was described as resolved after 15 minutes without further implications for the patient. Further, in three IHTs a problem with the stretcher was reported (defect electrical cord and syringe pump as well as non-sufficient oxygen delivery. All three problems were solved directly, either by using different equipment or by reparation. Three technical errors with the ventilation system were reported, one technical defect (equipment was replaced) and two times the alarm of the ventilation machine could not be stopped; therefore, the mode of ventilation was changed in one case. Negative outcomes for the patients were not reported. No technical problems with the infusion pump, defibrillator or suction unit have been reported. During one IHT, a problem with the monitoring system occurred, however, it was solved quickly. Other technical errors that have been described by the transport teams include rebuilding the stretcher for a heavy patient and waiting time of two hours because of a fire in the receiving hospital. The delay did not result in any negative outcome for the patients. 33 patient or team related adverse events were registered. In three cases, a communication related complication occurred (ICU was not informed about the time of arrival of the transport team, an oxygen bottle was not opened and long x-ray waiting time). A lower oxygen saturation of the patient < 90% was reported in 11 cases (4.3%) of all cases resulting in an immediate change in oxygen provision or ventilation. However, in three cases, the patients were not able to reach a higher oxygen level by the end of the transport. A change in blood pressure was reported in nine patients (either the mean blood pressure was < 60 mmHg
or the systolic blood pressure was < 80 mmHg) but the pressure was normalized at the end of the transport in all cases. Two patients were reported to have an emerging high heart rate (heart frequency > 120 beats per minute) but it was treatable by the crew. No case was registered with a heart frequency of 40 beats per minute or lower. A VF or VT was reported for two patients as well as an asystole or PEA, which was registered for two patients. All four patients had recovered by the end of the transport. Three losses of IV accesses or arterial lines were reported. In one patient a medication-related complication was registered as side effects occurred. Overall, in 3.9% of all IHT (10 IHTs), one technical event was registered while in 4.7% (12 IHTs) one treatment or patient related adverse event was reported. In 3.1% (8 IHTs) more than one treatment or patient related event occurred and in 0.4% (1 IHT) a technical and a patient or team related adverse event was registered. Four adverse events were reported for one MICU transport, which is the highest number of adverse events within one IHT registered.

Analysis of operation times

There are different time intervals during an IHT, which can be seen in Figure 5. The different points in time are registered by the dispatch centre and were available via the EUMIC database and additional data by the dispatch centres. The time intervals of interest for this study were the total operation times and the patient handover time at the transferring hospital.

![Time intervals during IHTs](image)

Total operation times, the time from starting the transport until the end of transport, ranged from 0:47 to 11:13 hours (mean 3:09 hours, SD 1:45). Table 1 shows the descriptive numbers per region and per transport unit. For the District of Aachen, the minimum time needed was 1:08 hours, for the ICUZON it was 1:11 hours and for the District of Heinsberg it was 0:47 hours. The maximum length differed between 5:11 hours (Heinsberg), 5:53 hours (Aachen) and

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11:13 hours in Southeast Netherlands. Several transports in the ICUZON had long total operation times when for example transporting a patient to Groningen in the North of the Netherlands (see Appendix 4). Table 1 shows detailed times for the total operation times per region and per transport unit; in both analyses, the differences between the groups were found to be significant (p < 0.001).

Table 1 - Total operation times (in hours)

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aachen</td>
<td>41</td>
<td>2:12</td>
<td>0:57</td>
<td>1:54</td>
<td>2:30</td>
<td>1:08</td>
<td>5:53</td>
</tr>
<tr>
<td>Heinsberg</td>
<td>42</td>
<td>2:10</td>
<td>0:53</td>
<td>1:53</td>
<td>2:26</td>
<td>0:47</td>
<td>5:11</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>3:09</td>
<td>1:45</td>
<td>2:55</td>
<td>3:23</td>
<td>0:47</td>
<td>11:13</td>
</tr>
</tbody>
</table>

The patient handover time interval, which transport teams spend in the transferring hospital, measures the time from arrival at the transferring hospital, picking up the patient to starting to drive to the receiving hospital. The time frame ranged from 0:05 to 5:22 hours (mean 0:45 hours, SD 0:40). Detailed numbers per region and per transport unit can be seen in Table 2. The transports with a MICU or ITW showed a minimum time of 0:05 hours and maximum time of 5:22 hours, which was spent in the transferring hospital for the patient handover. Picking up a patient with a standard ambulance took at the most 0:55 hours. The maximum time spent with an IC ambulance in the transferring hospital was 1:21 hours. The differences between the groups were found to be significant (p < 0.001).

Table 2 – Patient handover times in the transferring hospital (in hours)

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient handover time in transferring hospital per region</td>
<td>128</td>
<td>3:45</td>
<td>1:54</td>
<td>3:25</td>
<td>4:05</td>
<td>1:11</td>
<td>11:13</td>
</tr>
<tr>
<td>Standard ambulance</td>
<td>66</td>
<td>2:19</td>
<td>0:56</td>
<td>2:05</td>
<td>2:33</td>
<td>1:08</td>
<td>5:53</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>1:57</td>
<td>1:06</td>
<td>1:23</td>
<td>2:30</td>
<td>0:47</td>
<td>5:11</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>3:09</td>
<td>1:45</td>
<td>2:55</td>
<td>3:23</td>
<td>0:47</td>
<td>11:13</td>
</tr>
</tbody>
</table>
### Special pattern of patient transport in the region

The EUMIC data shows that the two maximum care hospitals in the study region, namely MUMC+ in Maastricht and the University Hospital in the City of Aachen (UKA) received the majority of patients from all registered IHTs. Figure 6 shows the most frequent IHTs which took place in the research area; the thickness of the arrows represents the number of IHTs which were performed by each region. More detailed numbers on transferring and receiving hospitals in the EUMIC study can be found in Appendix 5.
Out of 248 cases, MUMC+ received 73 patients (29%) of all IHT patients and UKA received 64 patients (26%). However, MUMC+ also transferred patients to other hospitals in 16% (39 patients) of all IHTs while UKA did not transfer any patients according to the data set. MUMC+ did transfer four patients to hospitals in Germany. Within the District of Aachen, 21% (53 IHTs) of all IHTs started and 6% (16 IHTs) of patients were transported to hospitals in this region. 18% (45 IHTs) of all IHT started in the District of Heinsberg and in 3% (8 IHTs) of cases, the patient was transported to a hospital in the same District. One patient was transported into a homecare facility. 6% of all transports (16 patients) were transferred to other hospitals in Germany. For South Limburg, 21% (51 patients) were transferred to other hospitals (16% from MUMC+, 4% from the hospital in Heerlen and 1% from the hospital in Sittard). 35% (87 IHTs) of all IHTs were directed towards South Limburg (MUMC+ received 29%, the other two hospitals in the region each 7%). 3% (7 IHTs) were directed from and 16% (40 IHTs) were
transferred to the ICUZON including North Limburg and Southeast Brabant. The MICU Maastricht also transported patients from other hospitals in the Netherlands, which are not located in the ICUZON, in 3% (7 cases) of all IHTs. Further, the MICU Maastricht transferred one patient from a Belgian hospital towards MUMC+, but also one patient between two Belgian hospitals.

**Questionnaire analysis**
In total, 78 questionnaires were filled out by professionals in the field: 79.5% (62 persons) by EMS staff in the District of Heinsberg, 10.3% (8 persons) by staff of the IC ambulance in the District of Aachen and also 10.3% (8 persons) by MICU staff and medical directors of ICUs in Southeast Netherlands. Staff in Germany included paramedics of different educational level: Rettungssanitäter (15.4% of all professions), Rettungsassistenten (51.3%) and Notfallsanitäter\(^3\) (1.3%) as well as emergency physicians (16.7%) and clinicians (3.9%). All questionnaires for Southeast Netherlands were filled out by clinicians (10.3%). Overall, 67.9% of the respondents were paramedical staff and 30.8% physicians.

70.5% of all respondents agreed that a patient handover generally consists of the following components: oral communication between the physician in charge with the EMS personnel as well as with the physician who will accompany the IHT, moving the patient on the ambulance stretcher and disconnecting hospital and connecting EMS devices to the patient. The conversation about the patient should include information about the medical history of the patient, the current diagnosis and treatment and the destination of the transport. 25.6% of the respondents did not class some of the components as belonging to a patient handover. In addition, the following aspects were stated to belong to the handover procedure in the respondents’ opinion: up-to-date blood gas analysis (also after moving the patient on transport stretcher), informing relatives of the patient about risks of the IHT, calling the receiving hospital, inspection of all catheters and devices, acquisition of the medical report and checking the existence of a patient decree.

\(^{3}\) As different translations for the German paramedical professions exist, the German terms are given to prevent any translation errors.
The participants were asked to state the duration of patient handover intervals (average times for the last 12 months) for uncomplicated patients (not ventilated), ventilated patients and for critically ill patients, who are in need of additional devices such as ECMO.

In Figure 7, the percentages of the respondents’ answers are illustrated. Duration of patient handovers of uncomplicated patients is perceived as mostly taking less than 15 minutes (64.1% of normal handovers) or taking between 15-30 minutes (33.3%). Patient handovers for ventilated patients are mostly perceived as taking 15-30 minutes (43.6%), taking 30-60 minutes (26.9%) or less often taking < 15 minutes (23.1%). Answers for the duration of patient handovers of critically ill patients with more devices were given for all time frames ranging from < 15 minutes to > 2 hours. For all categories, no significant difference between answers of the different professions was found.

Further, the respondents were asked to indicate how often certain reasons have emerged in their experience of the last 12 months, which have caused a delay of patient handovers and therefore IHTs. Figure 8 shows the percentages of which issues are perceived to have happened occasionally, regularly or always.
The most common reason for delay is that the transport team has to wait until the medical record is completed by the physician in charge. 5.1% of the respondents stated that this has happened always, 38.5% filled in regularly and 34.6% occasionally. The second most common reason is waiting time for a CD with x-ray pictures, which was registered by 1.3% to have happened always, 26.9% to have happened regularly and 39.7% to have happened occasionally. The third most common reason is that patients are still being treated (1.3% for always, 3.8% for regularly, 29.5% for occasionally). Other reasons which are perceived by the respondents to take place on an occasional to regular basis are: an unsuitable ambulance is requested (a higher equipped ambulance and more highly educated transport team has to be alerted), IV or central venous catheter (CVC) access are missing (but the procedure has to be done before the transport), the patient is still being examined (x-ray, computer tomography (CT) or magnetic resonance imaging (MRI) is being performed) or the patient is still in surgery. The latter was stated as the least common reason for delay. Additional reasons stated were: physician in charge or nursing staff is missing for patient handover, luggage of patient is not packed in advance or transport documents (for billing) are not prepared.

Responses to the questionnaires confirmed the occurrence of problems or complications during patient handovers. The most common problems, which were stated to have always occurred in the last 12 moments during patient handovers, are: differences in structuring a patient handover by clinical and EMS staff missing knowledge of clinical staff about EMS equipment and compatibility of devices as well as competencies of EMS staff, missing knowledge of EMS
staff about clinical treatment procedures and equipment and missing personnel, which is necessary to start the patient handover. Between 1.3% and 5.1% of respondents stated that these issues have happened always (Figure 9).

Further, it is regularly perceived that information about the patient (such as patient history, diagnosis and treatment) is only provided to the physician who accompanies the IHT, but not to the EMS staff. In addition, respondents stated that they found handover procedures stressful and hectic, and also perceived different levels of education between clinicians and EMS staff as problems on a less regular but on occasional basis. Detailed percentages can be found in Figure 9. Additionally, one respondent stated that information provided to the receiving hospital is often lacking or incomplete.

**Figure 9 – Most common problems and complications during patient handovers (in % of all responses per issue)**
Discussion

Within the results section, detailed answers for all research questions are provided. This part elaborates on the most important findings concerning the total number of IHTs registered in the EUMIC database and responses to the questionnaire, reasons for transfer, the requested urgency of IHTs, reasons for delay of IHTs, problems arising during patient handovers, patient handover times, registered adverse events during IHTs, patient outcomes 24 hours after admission in the receiving hospital, the transfer relations between hospitals and total operation times.

Per year around 5000 IHTs are performed in EMR by various transport teams and different transport vehicles. The MICU in Limburg and Southeast Brabant usually performs around 120 patient transports per year, with a range of 94 to 154 patients per year [21]. As 151 cases of IHTs in the ICUZON are documented in the EUMIC database for 15 months, one can assume that there is little or no missing data of IHT MICU transports. Definite numbers on emergency IHTs carried out by standard ambulances are not available in the data, even though around 500 emergency IHTs are performed within the ICUZON region per year [21]. This data would be a relevant addition to the dataset. In the District of Aachen, 1203 IHTs with an accompanying physician were performed in 2015. Out of these, 1128 IHTs have been carried out by the IC ambulance of the District included in this study. Within 15 months, 1410 IHTs should have been registered. The registered 54 IHTs in the EUMIC database thus only represent ca. 3.8% of all IC ambulance IHTs in the District of Aachen for the timeframe of the study. In the District of Heinsberg, 551 IHTs with an accompanying physician were performed in 2015. Hence, for 15 months, around 689 IHTs should have been registered in the database. As a consequence, the 50 registered cases represent only ca. 7.3% of all IHTs which took place in the included time period. Overall, data on emergency transports with standard ambulances is missing from the ICUZON as well as from the District of Aachen. In addition, only a minor number of IHTs from the Districts of Heinsberg and Aachen are registered in the database. As a consequence, the IHTs included in this study only represent 4.1% of all IHTs usually performed in 15 months in the EMR. Reasons are unforeseen problems which caused a delay for data collection in all regions. Further, the cases registered in the EUMIC database do not include all IHTs that are performed in the regions as data is not always recorded by the transport teams due to different circumstances (Strauch, U. 2016, oral communication, 5th of July). It is thus questionable whether the cases entered into the EUMIC database are a representative sample of IHTs in the three regions.
The additional provided questionnaires were answered far less than anticipated, except for the District of Heinsberg, where 45 paramedical staff and 16 physicians filled in the questionnaires (in total 61 respondents). The EMS system in the District of Heinsberg had 193 employees in July 2016; therefore, the 45 respondents represent 23.3% of the EMS personnel. This number by far exceeds the number of respondents in the ICUZON and the District of Aachen. Both regions only handed in eight questionnaires. For the ICUZON, no EMS staff answered the questionnaire; for the District of Aachen, answers from physicians are missing.

Differences between Germany and the Netherlands or more in depth analyses between IHTs in the ICUZON and in the Districts of Heinsberg and Aachen were impossible to determine as most transports in the Netherlands were performed by a MICU while in the German parts, the IHTs were performed by IC ambulances or standard ambulances and an ITW was only used twice. Most IHTs were directed towards the two maximum care hospitals in the study region, namely MUMC+ in Maastricht and UKA in Aachen. A smaller number of IHTs was performed within each of the regions. In total, five cross-border IHTs were registered in the database, four IHTs from MUMC+ to different hospitals in Germany and one IHT from Eindhoven (NL) to Antwerpen (BE). A detailed analysis of collaboration relationships between hospitals in the EMR considering for example the different hospital departments goes beyond the scope of this study.

IHTs were performed to bring patients from lower equipped standard hospitals to tertiary or specialised hospitals, but also for follow-up treatment or to bring patients back into their home region. When stating the reasons for transfer in the EUMIC database, the predefined categories were not fully understood or filled in correctly by all respondents. Interventions such as operations and lung transplantation were mentioned as ‘other’ reasons for transfer, while these interventions would actually fall under the category ‘operation’. Moreover, Coro, which is another word for PTCA, was also stated as a reason for transfer in the category ‘other’.

In 51.8% of all IHTs, the requested urgency of transport was > 120 minutes. As around 60% of all IHTs were carried out by the MICU in Maastricht, this high number with a requested urgency > 120 minutes can be explained by the extensive preparation time that precedes a MICU transport. In the District of Heinsberg, emergency transports with standard ambulances from the regular EMS are also included in the data, therefore it is not surprising that all cases with a requested urgency < 30 minutes and between 30 and 120 minutes were accomplished in the requested time frame. The IC ambulance of the District of Aachen in comparison is located within the City of Aachen in the upper half of the long-stretched area that is the District of
Aachen. As a consequence, driving times < 30 minutes are sometimes impossible to accomplish.

Findings of the questionnaires showed that there are several reasons for a delay in patient handovers and therefore IHTs. The most common factors for delay were waiting times for medical records and CDs with x-ray pictures or because the patient was still being treated. Further, IV or CVC accesses were found to be missing occasionally. In addition, the request of an unsuitable ambulance was perceived as happened occasionally, which leads to waiting time for a better equipped and staffed unit to arrive. Almost all of the mentioned reasons for delay are necessary procedures to be done before an IHT can be performed. However, taking all necessary steps before the transport team arrives in the transferring hospital would improve the efficiency process of IHTs. Unnecessary waiting times for the transport teams could be reduced, leaving these units still available for other emergencies during this time.

Problems during patient handovers, which were stated to happen at least occasionally or regularly, are differences in structuring a patient handover, missing knowledge from both clinical staff and EMS about each other’s competencies, procedures and equipment, missing personnel as well as stress and a perceived hectic situation during the patient handover and relevant information about the patient are only given to the accompanying physician. An analysis with the goal of assessing how to best address these issues goes beyond the scope of this study, but it can be stated that communication, knowledge about EMS and clinical procedures as well as the structure of patient handovers need to be improved.

The patient handover time varied between 0:05 and 5:22 hours, even though it needs to be discussed whether five minutes can be a realistic value for a patient handover in the transferring hospital. The procedure usually includes a conversation with the physician in charge (about relevant medical information), moving the patient on the transport stretcher and connecting medical devices to the patient. These steps were confirmed by the questionnaire analysis. As in the database several patient handover times < 10 minutes were provided, it might be necessary to check the dispatch centre data, which is entered into the database. Surprisingly, the minimum time for a patient handover occurred with an IC ambulance (nine minutes) while the minimum time with a standard ambulance was 12 minutes. The significant difference in the patient handover time between the transport units will most likely originate from the far more critical condition of MICU patients, which makes patient handovers more complex.
Comparing the data about patient handover times of the EUMIC study with the findings of the questionnaires, it is striking that in the EUMIC data, the MICU has the lowest value of five minutes for a patient handover while the respondents of the questionnaire stated that handovers of critically ill patients mostly take 15-30 minutes, but can also take more than two hours. However, the questionnaire findings also revealed that handovers of critically ill patients with additional devices are perceived as sometimes taking less than 15 minutes. As the questionnaires’ answers are only perceived values and the EUMIC data about patient handover times differ significantly, more research is needed to explore the reasons for the differences as well as the reasons for delay in the individual cases.

The critical condition of most MICU patients might explain the high occurrence of adverse events in MICU transports. However, in order to be able to draw a link between the severity of a patient’s condition and the occurrence of adverse events, more registered cases and research are needed. During IHTs with standard ambulances and IC ambulances, less adverse events were indeed reported, but the difference was not significant. Fewer events occurred, even though these vehicles are less equipped or carry a less educated transport team than the MICU team with specialised IC personnel. Technical events and patient or team related events were registered at a ratio of 1 to 4, but all problems were solved either immediately or the patient status was stabilised by the end of the transport (after adjustments in medication, ventilation or resuscitation of the patient). Overall, no negative patient outcomes were reported at the end of the transport. Remarkable is the fact that in 2.8% of the 31 IHTs with adverse events, more than one adverse event emerged (with the highest number of four events during one transport). This explains why the number of adverse events in total exceeds the number of IHTs with adverse events. However, as the registration of adverse events takes place on a voluntary basis, there is a risk of missing data. In addition, as definitions of adverse events in the literature differ widely it cannot be clearly stated whether the findings of this research present a low or high number of adverse events.

Data on patient outcomes 24 hours after admission were missing in 39.2% and data from the District of Aachen was lacking completely. Therefore, numbers on survival or death do not give a representative overview about the performed IHTs. Further, numbers on the execution of the planned intervention in the receiving hospital were missing in around half of the cases (48.21%). It would be interesting to see whether data was not filled in, whether the intervention was not performed at all or whether it was performed at a later point in time. Without the data on whether a planned intervention has actually been undertaken, it is difficult to determine the
necessity of the transport retrospectively. If planned interventions are not conducted in a certain timeframe after the IHT, it might be argued that the IHT was not necessary. Financial considerations about the payment of care and IHTs might also influence decisions for or against an emergency or scheduled IHT. However, more data and research is necessary to discuss such a statement.

Gradual increases of IHTs over time could not be found within the EUMIC database as too little data was available. Within the District of Heinsberg no maximum care hospital is located; in the ICUZON and the City of Aachen (next to the District of Aachen) at least one maximum care hospital is located (see Figure 6). MUMC+ and UKA received the majority of patients from all IHTs; however, MUMC+ was also the hospital with the highest number of patient referrals to other hospitals. Three explanations for this can be mentioned; firstly, in the EUMIC database, far more IHTs of the ICUZON are registered leading also to a higher number of referrals by MUMC+; secondly, the UKA is not located within the study region, therefore, data about IHTs from the UKA might not be registered; and thirdly, IHTs from the UKA to other hospitals might take place without an accompanying physician and are therefore not included in the data collection of EUMIC. It might also indicate that Dutch maximum care hospitals re-transfer patients back to the original hospital for follow-up care or other specialised departments in a different manner than German hospitals do. However, this would need more research to confirm such a pattern. Cross-border IHTs only took place in five cases (each from MUMC+ to hospitals in Germany and in one case to Belgium). The MICU Maastricht covers a much wider geographical area with IHTs than the German transport units do, and also transfers patients within Belgium if necessary. Consequently, total operation times differed significantly between the different regions and the transport units. The mean of all IHTs of the MICU was 3:45 hours. The total operation time for IHTs with standard ambulances and IC ambulances were more similar with a mean of 1:57 hours for standard ambulances and a mean of 2:19 hours for IC ambulances. During the total operation time, the transport vehicle and team are not available for other transports or emergencies (in case of a standard ambulance). In the database, the dispatch centres have to fill in the time when the transport ended. This is not clearly defined, as the transport ending can be the time when the transport unit leaves the receiving hospital or when the unit arrives back at the ambulance station or after the team restored the operational readiness. Consequently, ‘end of transport’ might have been interpreted differently, which might have led to systematic differences in reported transport times between the different dispatch centres involved in the EUMIC study and to wrong interpretation results.
Limitations

The study has various limitations, which compromise the strength of the study. The amount of data registered in the database was considerably less than anticipated. In particular, IHTs from the German providers were not registered consistently. In the Netherlands, no emergency IHTs were included. Further, certain data within the registered cases was missing and could not be gathered additionally, even though the dispatch centres have been approached to provide missing data. As a consequence, relevant information might be missing and interpretations and conclusions might be biased. The results have a low statistical power and can only be seen as indication analysis; however, this limitation was unavoidable due to the data constraints.

The questionnaires were handed out in person or via email, which might have influenced the response rate of professionals. As the researcher is a German paramedic [Rettungsassistentin] herself and distributed questionnaires in her usual work place in the EMS of the District of Heinsberg, certain professionals might have been influenced in their decision to respond, which constitutes a certain researcher bias. Moreover, the researcher’s own experiences working in the German EMS can be named both as a limitation and a strength, as it facilitated a deeper understanding of the subject (including medical data provided through the database) but might have directed her research in an underlying way as German emergency IHTs are well-known.

The time period of the study is another limitation. In a longer study period, more data might have been available in the database and more questionnaires could have been distributed in person to obtain a higher response rate. Further, more professionals with different occupations could have been targeted to fill in the questionnaire, which would give a more representative view on the different transport units and differences between the German and Dutch system.
Conclusion

The IHTs registered in the EUMIC study only represent a small proportion of all IHTs which usually take place in the study region. The EUMIC coordinators should try to involve all regions in the EMR in the study as it is an excellent opportunity to gather a large amount of data for further research about IHTs, which is necessary to improve IHT processes and their quality. In order to receive a comprehensive overview of IHTs in the EMR, air-rescue IHTs should also be included.

When an IHT is entered into the EUMIC database, a great volume of different data is available such as the transferring and receiving hospital, adverse events during the transport, planned interventions and their execution in the receiving hospital as well as a considerable amount of medical data including patient outcome data 24 hours after admission in the receiving hospital. However, IHTs are not registered consistently in the study regions, except for the ICUZON and the MICU transports in this region. Therefore, EMSs should be approached again to ensure a structured data collection without missing cases. Clear instructions should be given on who is responsible for the data collection within a transport team as well as on how entering of the data should take place. It should be considered whether the data collection could be incorporated into the usual documentation process of the EMS staff to improve participation in the study.

Within the EUMIC database, a few minor adjustments could also improve the data collection. For each new IHT in the database, it is asked which intervention is planned in the receiving hospital. Therefore, transport team members cannot indicate if no intervention is planned. If an intervention is indeed planned but someone forgets to click on one of the given intervention options in part 1 of the database, it will not be asked in the follow-up (part 6) whether the intervention has actually been done. As a consequence, unnecessary data losses can occur. In addition, the categories for planned interventions given in part 1 should be better categorised or explained to prevent falsely stated interventions in the category ‘other’ when actually belonging to one of the given categories. Data on planned interventions can provide important information about the necessity of emergency transports.

Operation times provided by the dispatch centres should be documented more precisely as some data about the time a transport team spends in the transferring hospital for a patient handover seemed unrealistic. However, more research is needed to specify regular time intervals during IHTs in order to compare the EUMIC data.
Further research could entail a more detailed analysis of the various hospitals in the EMR including the specific reasons for IHTs per hospital and considering the level of medical care per hospital and the specialist departments provided. This way, the different collaboration relationships between hospitals in the EMR could be displayed.

Different reasons for the delay of patient handovers and IHTs were provided by the EUMIC data and the questionnaire answers. In order to improve the process of IHTs and reduce unnecessary waiting times for the transport teams, pre-transport checklists could be introduced in hospitals. A transport unit should only be requested if the patient is ready or will be ready in time for the transport and all necessary documents and procedures are prepared beforehand. Nonetheless, it needs to be ensured that this does not lead to any waiting time for emergency patients in need of immediate transport. The gathering of expert opinions might be helpful to determine more detailed solution processes in order to prevent IHTs getting delayed.

The questionnaire provided to professionals in the study region was useful for collecting additional information; however, adjustments should be made before another distribution to professionals in order to address the differences between professions and transport units, about which information is asked. Differences between EMS staff and clinicians could be studied in the future to facilitate the collaboration between the professions, which could lead to higher efficiency and quality of IHTs in the future.

Overall, the EUMIC study and its database are beneficial to gather significant data about IHTs, not only in the Dutch-German border region, but it could also be implemented in other EMS systems in different countries. However, there is a need to address inconsistent data collection by EMS personnel. It would be useful to perform this initial analysis of EUMIC data again when considerable more data is registered in the database as it provides a comprehensive overview about the data gathered.
References


18. EUMIC. Overview of overall cases per centre [Internet]. 2016 [cited 2016 May 12]. Available from: https://software.memic.unimaas.nl/eumic_website/


Appendices

1. EUMIC data registration

QUIT EMR Transport Team Registration

PART 1 General Demographics

1) Date: ___ ___ / ___ ___ / ___ ___
2) Time of alarm: ☐ 08.00-17.00 ☐ 17.00-23.00 ☐ 23.00-08.00
3) Transport Unit: ☐ ITW ☐ IC ambulance ☐ standard ambulance ☐ helicopter
4) Transport team (function)
   a. First team member: __________________________
   b. Second team member: __________________________
   c. Third team member: __________________________
5) Transport number: __ __ __ __ __
6) Responsible dispatch centre: __________________________
7) Transferring hospital: __________________________
8) Receiving hospital: __________________________
9) Year of birth: ___ ___ / ___ ___ / ___ ___
10) Length: ______ cm Body weight: ______ kg
11) Sex ☐ male ☐ female
12) Reason of transfer
   ☐ Follow up treatment
   ☐ No ICU/IMC beds available
   ☐ Return to patient’s region
   ☐ Treatment in expertise centre
     ☐ Cardiovascular surgery ☐ Cardiology ☐ General surgery ☐ ICU
     ☐ Neurosurgery ☐ Others: __________________________
     ☐ Others: __________________________
13) Requested urgency of transport
   ☐ 30 min ☐ 30-120 min ☐ >120 min
14) Major diagnosis (organ failure)
   ☐ CNS ☐ Lung ☐ Heart ☐ Intestinal ☐ Liver ☐ Kidney ☐ Bone Marrow
   ☐ Others: __________________________
15) Additional diagnosis
   ☐ Multitrauma ☐ Neurotrauma ☐ Sepsis ☐ Others: ________________
16) Intervention planned within 24 hours
   ☐ Assist device ☐ Operation ☐ PTCA ☐ TIPPS
   Others: __________________________
PART 2.1 Patient status at intake call

1) Neurological status
   □ altered □ awake □ comateus □ sedated
   pupil reaction: □ yes □ no   and   □ normal □ wide

2) Cardiac/hemodynamic status
   Rhythm: □ AF □ Pacemaker □ SR □ other: _____________________
   Frequency: ________/min
   Vasoactive medication: □ no □ 1 □ >1 vasoactive medication
   Blood pressure: _______/_______ mm Hg

3) Pulmonary status
   SPO2: _______ %   breathing frequency: ________/min
   Ventilation: □ not ventilated
   □ Noninvasive ventilation
   □ invasive ventilation

4) Nephrologic status:
   diuresis: □ unknown □ >0,5 □ <0,5 □ anuria □ CVVH

5) Laboratory findings (if available)
   ph: ______  PO2: ______  mmHg/kpa  PCO2: ______  mmHg/kpa
   Lactate: ______  mmol/l  Hb: ______  mmol/l / g/dl
   Thrombocytes: ________  K: _________  apt: _________
   INR: ___________  Total Bilirubin: _______________ mg/dl / micmol/l

6) Additional Medical devices
   □ ECMO □ IABP □ NO □ ECCO2 □ Others: _____________________

7) Situation stable within last 2 hours
   □ yes □ no

PART 2.2 Patient status at arrival transport team

1) Changes in patient status   yes / no
2) If yes, the parameter needs to be changed

PART 2.3 Patient status end of transport

1) Changes in patient status   yes / no
2) If yes, the parameter needs to be changed
PART 3 Transport team interventions

1) Interventions done yes / no
2) Situation stable during transport yes / no ➔ If yes, it needs to be explained
   a) Airway Intubation / alternative airway / others
   b) Breathing changes in ventilator settings:
       Peep / Tidal volume / inspiratory pressure / FiO2
   c) Circulation CPR / volume therapy / bleeding control / others
   d) Disability (medication)
      1. Changes in vasoactive medication
      2. IV bolus application
   e) Environmental Exposure
   f) Other IABP / ECMO / Other

PART 4 Transport related events

1) Adverse events yes / no
2) Technical errors:
   Ambulance / stretcher / ventilator / infusion pump / defibrillator / suction unit / monitoring / others
3) Patient / treatment / team related events:
   SPO2< 90% / Mean RR<60 or RR syst<80 / new tachycardia (>120/min) / new bradycardia (<40/min) / VF/VT / Asystolie/PEA / Unintended extubation / loss IV or arterial line / medication related complication / communication related complication / others

QUIT EMR Dispatch Center Registration

PART 5 Data dispatch center

1) Summary general demographics & personal details
   (transport number, transferring & receiving hospital, year of birth, sex, patient name and date of birth)
2) Operation times:
   Time of alarm
   Time of departure 1
   Time of arrival 1
   Time of departure 2
   Time of arrival 2
   Time of departure 3
   Time end of transport
QUIT EMR Receiving Hospital Registration

PART 6 Follow-up post transport

1) Patient alive? yes / no
2) Laboratory findings (within 60 minutes after admission (if available):
   pH / PaO2 / PaCO2 / Lactate
3) Not normal values (within 60 minutes after admission)
4) Interventions done (within 60 minutes after admission: CPR / Intubation
5) planned interventions (in Part 1)
   Intervention done yes / no + time of intervention done

5) Clinical status of the patient 24 hours after admission in the receiving hospital
   a) Neurological status
      altered / awake / comatose / sedated
      pupil reaction: yes/no and normal / wide
   b) Cardiac/hemodynamic status
      Rhythm: AF / Pacemaker / SR / other
      Frequency
      Vasoactive medication:
      no / 1 iv vasoactive medication / >1 vasoactive medication
      Blood pressure
   c) Pulmonary status
      SPO2: ______ %  breathing frequency: ___________ /min
      Ventilation: □ not ventilated
                     □ Noninvasive ventilation
                     □ invasive ventilation
   d) Nephrologic status:
      diuresis: □ unknown □ >0,5 □ <0,5 □ anuria □ CVVH

6) Laboratory findings (24 hours after admission +/- 2 hours)
   ph: ______ PO2: ______ mmHg/kpa  PCO2: ______ mmHg/kpa
   Lactate: ______ mmol/l  Hb: ______ mmol/l / g/dl
   Thrombocytes: ___________ K: ___________ apt: ___________
   INR: ___________ Total Bilirubin: ___________ mg/dl / micmol/l

7) Additional medical devices
   □ ECMO V-A (Veno-Arterial)
   □ ECMO V-A +IABP
   □ ECMO V-V (Veno-Venous)
   □ IABP
   □ NO (Nitric Oxide)
   □ ECCO2
   □ Others, namely
2. Cover letter for additional questionnaire

English version

Dear MICU team members.

While working as a Rettungsassistentin in Germany and studying healthcare management at Maastricht University, I am currently writing my master thesis within the euregional EUMIC study. As you might know, EUMIC analyses several aspects of inter-hospital transfers of critically ill patients. Data is gathered about transport vehicles, operation times, changes in patient status, intervention of transport teams, adverse events and the mortality rate 24 hours after transport.

In my master thesis I especially look at operation times, the process of patient handovers and problems, which can arise when handing over a patient to the transport team and therefore can cause unnecessary delay in the transfer to the receiving hospital.

I would like to include your experiences into my analysis in order to answer the research questions as thoroughly as possible.

The following questionnaire is anonymous and does not allow drawing any conclusion on individuals. The results will most likely be published in a professional medical journal. By filling out the questionnaire you agree with using the questionnaire results for research in the EUMIC project.

If you have any questions or remarks, do not hesitate to contact me:
Anja.sommer@student.maastrichtuniversity.nl
Mobile phone: +49 1575 3266014

Thank you very much for your participation!
Anja Sommer
Liebe Rettungsdienstler, liebe (Not-)Ärzte,


In meiner Masterarbeit befasse ich mich vor allem mit den Einsatzzeiten bei Verlegungen, dem Prozess der Übergabe an sich, sowie mit Problemen, die bei Patientenübergaben auftreten können und die Abfahrt zum Zielkrankenhaus verzögern.

Mit Hilfe eurer Antworten will ich eure Erfahrungen mit in die Analyse einbringen um die Fragestellungen möglichst umfassend beantworten zu können.

Der Fragebogen ist anonym und lässt keine Rückschlüsse auf einzelne Personen zu. Die Ergebnisse werden voraussichtlich nach Abschluss der Masterarbeit in einem medizinischen Fachjournal veröffentlicht. Mit dem Ausfüllen des Fragebogens erklärt ihr euch mit der Verwendung der Daten aus dem Fragebogen zu Forschungszwecken im Rahmen des EUMIC-Projektes einverstanden.

Bei Fragen oder Anmerkungen stehe ich gerne zur Verfügung:
Anja.sommer@student.maastrichtuniversity.nl
Mobil: +49 1575 3266014

Vielen Dank für eure Mitarbeit!
Anja Sommer
Bitte ankreuzen

1) In welcher Region arbeiten Sie?

☐ Limburg
☐ Heinsberg
☐ Städteregion Aachen
☐ Andere, nämlich:

2) Welche Tätigkeit üben Sie aus? (Mehrfachnennung möglich)

- Rettungsdienst
  ☐ Rettungssanitäter
  ☐ Rettungsassistent
  ☐ Notfallsanitäter
  ☐ Notarzt

- Klinikpersonal
  ☐ Pflegepersonal
  Facharzt
  ☐ Anästhesie
  ☐ Innere
  ☐ Chirurgie
  ☐ Anderes, nämlich:

3) An wie vielen Patientenübergaben – Klinikpersonal an Rettungsdienst – im Rahmen von Verlegungen waren Sie in den letzten 12 Monaten ungefähr beteiligt?

☐ < 5  ☐ 5-10  ☐ 10-25  ☐ 25-50  ☐ >50

4) Wie viele Patientenverlegungen mit Begleitarzt (Arzt aus der Klinik oder Notarzt) haben Sie in den letzten 12 Monaten durchgeführt?

☐ < 5  ☐ 5-10  ☐ 10-25  ☐ 25-50  ☐ >50
Bitte beantworten Sie alle folgenden Fragen bezogen auf Ihre Einsätze in den letzten 12 Monaten.

5) Wie lange dauerten die Patientenübergaben (kompletter Übernahmeprozess) in der Regel …
   - … bei komplikationsarmen Patienten (nicht beatmet)?
     - ☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 Stunden  ☐ > 2 Stunden
   - … bei beatmeten Patienten?
     - ☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 Stunden  ☐ > 2 Stunden
   - … bei kritisch erkrankten Patienten, die erweiterte Geräte wie z.B. ECMO benötigen?
     - ☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 Stunden  ☐ > 2 Stunden

6) Bitte geben Sie an, wie häufig ein Transportteam aus folgenden Gründen warten musste, bevor Übergabe und Verlegung stattfinden konnten?

<table>
<thead>
<tr>
<th>Grund</th>
<th>Nie</th>
<th>Selten</th>
<th>Gelegentlich</th>
<th>Oft</th>
<th>Immer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient noch im OP</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Patient wird noch behandelt</td>
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<td></td>
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<tr>
<td>Patient noch in einer Untersuchung</td>
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<td></td>
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<tr>
<td>(Röntgen / CT / MRT / etc.)</td>
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<tr>
<td>Es muss noch auf Ergebnisse gewartet werden:</td>
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<tr>
<td>- Arztbrief</td>
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<tr>
<td>- CD mit Röntgen-Bildern</td>
<td></td>
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<tr>
<td>IV Zugang / ZVK o.ä. müssen noch gelegt werden</td>
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<tr>
<td>Ungeeignetes Rettungsmittel ist alarmiert worden</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>➔ anderes Rettungsmittel muss nachalarmiert werden</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Anderes, nämlich:</td>
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</tr>
</tbody>
</table>
7) Aus welchen Komponenten besteht Ihrer Meinung nach eine Patientenübernahme an den Rettungsdienst? (Mehrfachnennung möglich)

☐ Mündliche Übergabe des behandelten Arztes
  ☐ an das Rettungsdienst-Personal
  ☐ an den Transportbegleitenden Arzt
- Die Übergabe beinhaltet Informationen zu:
  ☐ Anamnese
  ☐ Diagnose
  ☐ Behandlung
  ☐ Ziel des Transportes
☐ Umlagerung des Patienten auf die Rettungsdienst-Trage
☐ Ab- und Anschließen von Geräten
☐ Anderes, nämlich:
  ______________________________________________________
8) Bitte geben Sie an, welche Probleme oder Komplikationen bei Patientenübergaben (kompletter Übernahmeprozess) an den Rettungsdienst aufgetreten sind und wie häufig dies geschah.

<table>
<thead>
<tr>
<th>Komplexität und Prozess</th>
<th>Nie</th>
<th>Selten</th>
<th>Gelegentlich</th>
<th>Oft</th>
<th>Immer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient war/wurde instabil</td>
<td>➔ akute Notfallsituation</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Kommunikationsprobleme</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Unterschiedliches Niveau Klinik-Arzt – RD Personal</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Unterschiedliche Struktur der Übergabe (z.B. ABCDE)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Übergabe erfolgt nur an den Begleitarzt, nicht an das restliche RD-Personal</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Fehlendes Equipment des Rettungsdienstes</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Fehlendes Personal</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Stress / Hektik während der Übergabe</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Umlagerungsbedingte Zwischenfälle (IV Zugang, Thoraxdrainage o.ä. muss neu gelegt oder nachbehandelt werden)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Fehlende Kenntnis des Rettungsdienstpersonals über Behandlung und Geräte der Klinik</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Fehlende Kenntnis des Klinik-Personals über Abläufe im Rettungsdienst</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Kompetenzen des Rettungsdienstpersonals</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Geräte des Rettungsdienstes / Kompatibilität</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Anderes, nämlich:</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
9) Durch welchen Patientenstatus gestalteten sich Verlegungen besonders problematisch?

☐ Patient kam direkt aus dem OP
☐ Patient war beatmet
☐ Mehrere Perfusoren
  ☐ Katecholaminpflichtig
  ☐ Analgosediert
☐ ECMO o.ä.
☐ Patient war instabil
☐ Patient war infektiös
☐ Anderes, nämlich:

Dutch version

Enquete patiëntentransport / IC-transport – EUMIC studie (Juni 2016)

A.u.b. het juiste veld aankruisen

1) In welke regio werkt u?

☐ Limburg
☐ Heinsberg
☐ Städteregion Aachen
☐ anders, namelijk:

2) Welke functie heeft u? (meerdere opties mogelijk)

- Reddingsdienstpersoneel
  ☐ Ambulanceverpleegkundige

- Ziekenhuispersoneel
  ☐ verpleegkundig personeel
  ☐ arts
    ☐ intensivist
    ☐ anesthesist
    ☐ perfusionist
    ☐ interne geneeskunde
    ☐ chirurg
    ☐ anders, namelijk:
3) Bij hoeveel patiënten overdrachten – ziekenhuis personeel aan ambulancedienst – in het kader van patiënten transport bent u in de afgelopen 12 maanden ongeveer betrokken geweest?

☐ < 5  ☐ 5-10  ☐ 10-25  ☐ 25-50  ☐ >50

4) Hoeveel patiënten transporten heeft u in de afgelopen 12 maanden met de MICU uitgevoerd?

☐ < 5  ☐ 5-10  ☐ 10-25  ☐ 25-50  ☐ >50

➔ De volgende vragen dient u te beantwoorden op basis van uw ervaringen in de afgelopen 12 maanden

5) Hoe lang duurde een patiënten overdracht/overname normaal gesproken

- … bij patiënten zonder complicaties (zonder beademing)?

☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 uur  ☐ > 2 uur

- … bij patiënten waar beademingen nodig is?

☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 uur  ☐ > 2 uur

- … bij patiënten in kritieke toestand, die speciale apparatuur nodig hebben zoals een ECMO?

☐ < 15 Min  ☐ 15-30 Min  ☐ 30-60 Min  ☐ 1-2 uur  ☐ > 2 uur
6) Hoe vaak is het voorgekomen dat een transportteam omwille een van de volgende redenen moest wachten voor de overdracht en het transport van een patiënt kon plaatsvinden?

<table>
<thead>
<tr>
<th>Reden</th>
<th>Nooit</th>
<th>Zelden</th>
<th>Af en toe</th>
<th>Vaak</th>
<th>Altijd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patiënt nog in operatiekamer</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Patiënt wordt nog behandeld</td>
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<td></td>
</tr>
<tr>
<td>Patiënt wordt nog onderzocht (Röntgen / CT / MRI / etc.)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Er moet nog op resultaten gewacht worden</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>▪ Arts brief</td>
<td></td>
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<tr>
<td>▪ CD met Röntgen beelden</td>
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<tr>
<td>Infuus / CVL o.i.d.moet nog aangelegd worden</td>
<td></td>
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<tr>
<td>Ongeschikt voertuig is gealarmeerd</td>
<td></td>
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<tr>
<td>→ een MICU moest later alsnog gealarmeerd worden</td>
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<tr>
<td>Anders, namelijk:</td>
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</tr>
</tbody>
</table>

7) Uit welke onderdelen bestaat naar uw mening een patiënten overdracht aan een ambulancedienst? (Meerdere opties mogelijk)

☐ Mondelinge overdracht door de behandелend arts
☒ Aan het ambulancedepersoneel
☐ Aan de MICU arts
- De overdracht betreft informatie over:
  ▪ Anamnese
  ▪ Diagnose
  ▪ Behandeling
  ▪ Doel van het transport
  ▪ Verleggen van de patiënt op de brancard
  ▪ Af- en aankoppelen van apparaten
  ▪ Anders, namelijk:

47
8) Geeft u a.u.b. aan welke problemen of complicaties bij patiënten overdrachten aan de ambulancedienst zijn opgetreden en hoe vaak deze zijn voorgekomen.

<table>
<thead>
<tr>
<th>Patiënt was instabiel</th>
<th>Nooit</th>
<th>Zelden</th>
<th>Af en toe</th>
<th>Vaak</th>
<th>Altijd</th>
</tr>
</thead>
<tbody>
<tr>
<td>acute interventie nodig</td>
<td></td>
<td></td>
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</tbody>
</table>

**Communicatieproblemen:**

- Niveauverschil tussen de behandelend arts en het ambulancepersoneel
- Structuurverschil bij de overdracht (bijvoorbeeld ABCDE)
- Overdracht wordt enkel met de begeleidend arts (MICU-arts) besproken, niet met het ambulancepersoneel
- Ambulancedienst beschikt niet over de benodigde apparatuur
- Personeel ontbreekt
- Stres/hectiek tijdens de overdracht
- Incident tijdens overtillen van de patiënt (Infuus, Thoraxdrainage o.i.d. moet opnieuw worden aangelegd of behandeling is nodig)
- Ambulancedienstpersoneel beschikt niet over voldoende kennis over de behandeling en apparatuur in het ziekenhuis
- Ziekenhuispersoneel beschikt niet voldoende kennis over de werkstructuur van de ambulancedienst
  - Competentie van het ambulancepersoneel
  - Apparatuur van de ambulancedienst/compatibiliteit

**Anders, namelijk:**
9) In welke situatie deden zich de meeste problemen voor tijdens de transporten?

- Patiënt die direct uit de operatiekamer kwam
- Patiënt werd beademd
- Meerdere perfusoren
  - Inotropie behoefig
  - Analgosedatie
- ECMO
- Patiënt was instabiel
- Patiënt is infectieus
- Anders, namelijk:

______________________________________________________________________________
4. Map of distant locations of receiving hospitals
### 5. Overview of transferring and receiving hospitals in EUMIC study

<table>
<thead>
<tr>
<th>Region</th>
<th>Total number of IHT as transferring hospital</th>
<th>Total number of IHT as receiving hospital</th>
<th>Percentage per hospital</th>
<th>Percentage per region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Netherlands (outside of research area)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ICUZON (Limburg + Southeast Brabant)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Germany (outside of research area)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>District of Heinsberg</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>City of Aachen</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>District of Aachen</td>
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</tbody>
</table>

**Note:** The above table and diagram illustrate the distribution of interhospital transfers (IHT) in the EUMIC study. Each hospital is represented by a specific code, and the arrows indicate the direction of transfers. The numbers in the table indicate the total number of transfers from and to each hospital, with the percentage of these transfers compared to the total number of IHT within each region and hospital.