Emergency Care for Critically Ill Children in District General Hospitals

A study in district general hospitals in the Southwest part of the Netherlands

Spoedeisende zorg voor vitaal bedreigde kinderen in niet Academische ziekenhuizen

Een studie in niet Academische ziekenhuizen in Zuid West Nederland

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Voor Mirjam
Thies, Marlotte en ?

mijn ouders

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CHAPTER 1
General Introduction

1.1 Preface

Emergency care for critically ill children is an important aspect of day-to-day Paediatrics. The recognition of symptoms and signs, and adequate treatment by well-trained medical personnel is essential for children with life-threatening emergencies. Their lives and their future well-being depends on a well-designed and very consistent organisation of medical care of high quality. Children requiring emergencies have unique and special needs. This counts for out-of-hospital emergency medical services as well as within the diverse medical facilities itself. To design an adequate triage, referral and transport system for all vitally instable paediatric patients in the future, it is necessary to obtain an insight in the actual organization of the health care for such children, wherever they enter the health care system. By studying these aspects, a better understanding will emerge in the size of the patient group as well as possible regional guidelines, which can then be implemented by medical transport services and hospitals to ensure a high quality of care for this group of children. This information is also relevant and essential for policy makers in planning resources and facilities to ensure that children receive high quality emergency care by facilitating the presence of the correct material, medication and personnel in sufficient amounts. The information gathered, can and should also be used to calculate paediatric intensive care beds and facilities nationwide. It is important to state that policy makers, after detailed information from such studies are made public, should use this information to ascertain the presence of adequate transport facilities, staffed by highly trained medical personnel, as well as for the presence of adequate paediatric intensive care facilities including total number of beds, sufficient amounts of equipment including up to date material and medication. When all those resources are ensu-

red, medical personnel are responsible for 'doing the right thing' and 'doing the thing right', 'at the right place and time'.

The subject of this thesis covers determinants of the emergency care of critically ill children in the South West part of The Netherlands, encompassing 4 million inhabitants over an area of 8000 km^2. The first part of the general introduction gives a historic perspective of the development and evolution of the emergency care within Paediatrics, especially of the Paediatric Intensive Care Units (PICU's). An overview is given of the development of pre-hospital emergency care. Aspects of regionalisation of critical care as well as the development of quality of care measurements are highlighted. Finally, the development of the diverse severity of illness and outcome scores is reviewed.

Chapter two is a retrospective study of the characteristics of urgent transports of paediatric patients to the district general hospital of Delft, including those who needed 'adequate initial emergency care' ('golden hour'). The number of children out of the total population is calculated (per 100,000) for which the initial treatment during the first hour of admission at a district general hospital can be seen as a 'golden hour'. Also the number of children needing transport to a PICU, directly or via a district general hospital, from a defined area of the Netherlands is provided.

Chapter three is an evaluation of the presence of essential medical facilities and equipment, including medication for initial therapy of critically ill children in paediatric emergency settings in the district general hospitals of the Southwest region of the Netherlands. Are they prepared for this initial treatment and do they have the right equipment?

Chapter four is a prospective study of the organization of initial therapy within district general hospitals. In case of critically ill

children entering a district general hospital, who would act and where? The 'referral pattern' for both 'in-and outdoor' patients within these hospitals is presented.

Chapter five is a prospective study to determine the number and characteristics of children, suspected of a critical emergency, who were transported and presented, with or without announcement, from a defined area of the Netherlands to the district general hospital of Delft, during a one-year period. All characteristics such as age, sex and type of disease of this group are delineated. Characteristics like the total number of critically ill children out of the population, the way they come to the hospital but also the survival rate of this group is presented. The data are compared with the retrospective study presented in Chapter two.

Chapter six and seven encompasses a summary in English, Dutch and French with a discussion, conclusions and future perspectives, next to a list of abbreviations used in this thesis. Separately the curriculum vitae and a list of publications of the author are given.

1.2 Historic perspective

In Paediatrics, children either newborns or older, healthy or with different underlying diseases, may develop instability in vital signs in a relative short period of time. In the last three decades, paediatricians have developed many techniques and methods to treat such patients. Since the introduction in the mid 1980's of the sub specialisation of paediatric critical care by the American Board of Pediatrics, this subspecialisation has matured and developed greatly. The American Board and other paediatric societies worldwide developed, recommended and reviewed guidelines for the care and treatment of critically ill patients.[1-7] At the same time, the technological capacity to monitor and treat such paediatric

patients has advanced rapidly[6]. Along with these advances, there has been an evolution of Paediatric Intensive Care Units (PICU's) in tertiary care facilities, both in the US as well as in Europe. In the Netherlands this development took place in the period 1980 - 1995. Those PICU's are seen as the primary site for critically ill children to be transported to and in these PICU's the children are treated by specially trained paediatric intensivists and nurses. The majority of studies on critically ill children were performed in these kinds of centres, from which numerous data can be extracted such as incidence of certain diseases, age categories and classification of diseases. Many of those children however are primarily seen in district general hospitals. It is obvious that data on such children and information about their initial treatment in district general hospitals is essential for evaluating and assessing the need of regionalisation of care for this group of patients. After the consolidation of the development of PICU's in the diverse academic centres in The Netherlands during the '90-ties, a start in the improvement of initial care for the critically ill children entering district general hospitals was made. Like in The Netherlands, in the US a committee of the American Academy of Paediatrics was installed to provide guidelines for 'furnishing and equipping' paediatric emergency facilities in 'community hospitals'[2,4]. The aim was to create well-equipped emergency facilities for critically ill children, admitted either from outside but also for children, who were already hospitalised and suddenly needed emergency care.

Although the start of the development of emergency care within hospitals is relatively recent, the start of care 'outside' these facilities is of much earlier date. The transport of (war) victims in the old Greece can be seen as the start of the 'pre-hospital' emergency

care. In the Ilias of Homerus (ca. 800 before Christ) one reads that wounded warriors were taken by the arms by other warriors and brought to a chariot[8,9]. This chariot was driven to a field barrack behind the battle lines. The first organised form of transport of wounded persons took place during the Roman period. During the second Punic war (218 - 201 before Christ), wounded combatants were pulled back from the front lines by 'velites'; men 'only' equipped with bow and arrow. Unfortunately no comments were made on the different forms of treatments. The East Roman Emperor Mauritius introduced the possibility of 'treatment' of wounded soldiers. He designated the 'despotati', 8 of them per group of 300 warriors[9]. Those 'despotati' were 'too weak' for combat and had the task to pull the wounded back and treat them. They were only equipped with a bottle of water. When they succeeded in 'creating' an active warrior again, a reward followed. Armies took an important part in the development of emergency care of the critically ill. This can also be said of the introduction of the stretcher, as developed by the French surgeon Ravaton in 1768. The first 'ambulance' was introduced by the private physician of Napoleon named Larrey (1766 - 1842). He introduced the 'ambulance volante' who picked up the wounded soldiers, directly behind the lines and transported them to the first medical hospitals (lazarettes)[10]. In 1813 Percy, another French military physician set up the 'corps brancardiers'. These 'despotati' were not armed and were equipped with folded stretchers and rolls of bandages in their knapsack.

The first ambulance service was set up in New York in 1869[11]. In Europe the city of Vienna followed in 1878 and later on also cities in France and England[9]. In the Netherlands the first (bicycle) ambulance was introduced in 1909. This was initiated by the work of C.J. Mijnlieff, who worked in Amsterdam for the city

medical service. He wrote a thesis called 'First aid in case of accidents' in 1905 after working a short period of time in Vienna, as a volunteer with the 'Rettungsgesellschaft'[12]. After the Second World War, the organisation and quality of the ambulance transports in The Netherlands rose to an international standard. Legislation followed in 1971 by the 'Wet Ambulance vervoer', followed by the 'Eisen besluit' in 1976. In this 'Eisen besluit' all necessary equipment was enumerated, technical aspects of ambulances were written down and rules for its readiness were stipulated. Demands regarding the education of the ambulance personnel were legalised and agreements were made concerning its necessary funds. 'Central Posts' ('Centrale Post Ambulance vervoer-CPA') were introduced; a method to organise and integrate emergency care for a specific defined area. Ambulance transports were hereby categorised in 'A1' - 'A2' and 'B', depending on urgency. 'A1' was defined as urgent transport (direct danger of life) for which the ambulance has to be at the patient site within 15 minutes, using lights and sounds to get there. 'A2' was defined as transports of less urgency because there is no direct danger of life, while the urgency to get there still existed. 'B' urgency stands for ordered, low risk medical transports.

The pre-hospital emergency care was further improved during the period 1980 - 2000 by a systematic increase in knowledge, skills and training of paramedics and implementing criteria for carrying out this profession. A system of quality evaluation was set up and medical handling according to protocols was introduced. A part of this protocollation concerned the transport of children. In practice, paediatric transports are relatively infrequent for paramedics, resulting in 'scoop and run' behaviour[13]. Further definition of transport criteria and quality of personnel, even physician staffed instead of paramedic staffed, resulted in the creation of

mobile units[14,15]. Several studies supported this development by demonstrating a positive change in survival by this well trained form of care[16-19]. This can also be said for the inter hospital transfer of critically ill children from a district general hospital to a PICU. An improvement of the care was shown when specialists in this field performed the transport[5,20-24].

The introduction of critical care medicine within Paediatrics was accompanied by several epidemiological studies regarding this new form of care. For example it is of interest that the mean age of children needing intensive care admission is relatively low. Of all transported children to PICU's (under the age of 16 years, excluding neonates), the mean age lies under 3 years. Kissoon et al found that 85% of all transported paediatric patients in Canada were under the age of 6 years[25]. Other studies performed in different North American centres found similar percentages[26-28]. The mean length of stay in PICU's is very similar in studies from different countries. When vitally instable patients are admitted to PICU's in tertiary centres, Pollack et al found a mean length of stay of 3-5 days[29], while Butt et al found a length of stay of 3 days[30].

There is unfortunately however no consistency in diagnostic categories used in classification of vitally instable patients, in the different published studies[17,20,25,31]. Some use a classification of disease categories such as: Central Nervous System, Respiratory, Cardiac abnormalities and Major Trauma with a prevalence of respectively 18 - 50%, 20 - 50%, 5 - 25% and 1 - 5%[25-28]. Other studies prefer a '7 major organ system failure' classification, i.e. cardio-vascular, respiratory, neurological, gastro-intestinal, renal, metabolic and hematologic[17].

Primary cardiac problems comprised in contrast to studies in

adults, a relatively small number of the transported children, 5 - 25%. A possible explanation is that most children with cardiac, often congenital, abnormalities are diagnosed early in life and transported by neonatal teams to neonatal intensive care units (NICU's)[25]. In Canada, a study by Clyne et al showed that 20% of transported neonates has a cardiac disease as their primary problem[27].

Given the discussions regarding the diagnostic categories, it seems most practical to use the '7 major organ system failure' classification because it reflects the way patients are clinically evaluated during their stay in the intensive care.

Apart from age and disease categories, the ultimate prognosis of PICU admitted patients are very important in evaluating the care provided. For long-term outcome studies of children admitted to PICU's, it is essential to take pre-existing health status of children into account. A study by Butt et al in 1990 regarding long-term outcome after intensive care admission showed that 20% of children died while only 42% survived without sequelae and were likely to lead an independent existence[30]. Of those who survived with a major handicap (7%), interestingly almost all had had some form of disease or handicap before their PICU admission[30].

In conclusion, in the Netherlands, the final decades of the 20th century was the period in which the development of pre-hospital medical care was initiated and extended, especially after the Second World War. The development of specialised paediatric transports and Paediatric Intensive Care Units, mainly concentrated in Academic hospitals took place, like in most other European countries, in the 1980-ies. During this period epidemiological studies were performed in those centres to assess the characte-

ristics of critically ill children. Following this development, an improvement in the organisation of the critical care medicine outside the tertiary centres was considered as the next logic step to influence the outcome of each critical ill child, wherever he of she enters the medical system within a region. The first steps were made to come to an organised regional system of health care.

1.3 Regionalisation

As may be obvious, children with acute and severe diseases are often presented to all kinds of hospitals, more or less equipped to adequately provide care to these patients. The location where the child is presented, either academic or non-academic hospital, the availability of adequate medical supplies at site and the knowledge, skills and training of medical personnel at the initial care facility is crucial for the quality of care and the outcome of treatment[32-34]. Studies like the one of Pollack et al., showed a better survival chance when paediatric 'intensive care' is provided in tertiary hospitals than in non-tertiary care facilities[32].

In order to evaluate the care of critically ill paediatric patients in district general hospitals, it is necessary to define the term 'intensive care facilities'. Characteristics of (tertiary) paediatric intensive care units are a 24 hr/day in house availability of paediatric residents or paediatricians and nurses, skilled in paediatric intensive care[32]. Also a rapid availability of certified paediatricians in emergency care and important paediatric sub-specialists such as paediatric cardiologists or neurologists. In addition an intensive care facility dedicated and adapted to children has to be in place. Following this approach, an 'intensive care' is defined by the services received by the patient, as well as by the patient's physical location during his or her hospital stay. Such an 'intensive care unit' also includes any one of the following: hourly or alter-

nate hour vital signs measurements (pulse, blood pressure, respiratory rate); hourly or alternate hour measurement of neurological vital signs (pupil size and reaction, state of consciousness, movement, response to pain); use of continuous ECG monitor[32].

Thus, criteria are well established for characterizing a location as an intensive care unit, serving the children of a region. In most cases today, this is an academic medical centre facility.

In large countries such as the U.S. and Australia, tertiary care resources are often concentrated in centres at some distance from the homes of patients. Many children in such countries are admitted to all kinds of (local) hospitals often without the capabilities of paediatric intensive care facilities. In contrast, because of the size of the Netherlands and the availability of eight Academic Centres spread out over the country, each citizen and therefore any critically ill child can be in one of those centres within 30 - 45 minutes. Surprisingly, the percentage of critically ill children who do not primarily enter the medical system in The Netherlands through one of those eight academic centres has never been studied.

It is noteworthy that studies showed a difference in outcome in relation to the severity of illness between paediatric intensive care units in tertiary centres versus non-tertiary centres[1,32]. Unnecessary deaths have been associated with lack of regional organisation 35. This observation was and still is a driving force to improve organisational structures for paediatric healthcare, to specify criteria and standards for paediatric intensive care and thus for regionalisation of care-structure in general[1,32,36,37].

In the recent past, studies were initiated to evaluate characteristics of critical care associated with improved chances of survival[16,18,19,38]. For example factors such as inter-hospital and

intra-hospital transfer of patients were important[5,20-24,39,40]. In addition a strong relationship between outcome and severity of illness on admission as assessed by physiologic profiles was established[38,41]. The need for a formal, regional organisation of paediatric primary level of care was the main outcome to those studies[1,32]. Knowledge was obtained which was used to improve organizational structure for paediatric health care and to specify standards for paediatric intensive care[18,29,41,42].

Short communication lines, good cooperation, working with protocols and extensive collaboration with the central paediatric intensive care ward of the Academic Hospital is of great importance for successful treatment of these patients[43]. It has also, not unimportantly, been shown to reduce health costs[16,44]. Like a good co-operation with the regional PICU, the mutual co-operation of the different major district general hospitals in the same region is essential for optimal exchange of knowledge, patient data and initiatives of improving care for the region[1,31,36]. This will eventually result in improvement of care and outcome. For the future development of optimal intensive primary care in these non-Academic hospitals it is essential to initiate an investigation of their current quality of care. Points of interest are the material and human infrastructure of the care; the quality and appropriateness of the knowledge and the value of existing protocols in the different district general hospitals[45]. To improve this quality of care, it seems important to focus on the initial care for the patient during the first several hours in district general hospitals.

In some areas of the medical field including Paediatrics, regionalisation has already been implemented, for example for neonatal, perinatal, burn and trauma patients. Available studies strongly suggest improved outcomes of care with this kind of organised

regionalisation[1,46,47]. It also reduces the costs of care and can and will benefit research in the area of critical care to further optimise critical care.

In 1994, the American College of Critical Care Medicine and the Society of Critical Care Medicine have strongly endorsed the principle of regionalisation of paediatric intensive care[1,45].

In 1998 the committee on Hospital Care of the American Academy of Paediatrics followed by providing guidelines for 'equipping a paediatric unit in community hospitals', ranging from a list of basic facility needs to a 'minimal' list of essential medical equipment[4].

In line with their American colleagues, paediatric intensivists in the Netherlands stated in 1997 the necessity of centralizing paediatric intensive care[7]. At the same time, in some parts of the Netherlands initiatives were installed to improve regional health care. Among one of those initiatives was the development of specific guidelines, to be used in district general hospitals in the South-West part of the Netherlands. In this region, a group of paediatricians developed several guidelines in their effort to 'optimise and regionalise paediatric health care in general'. A committee, comparable to the Committee on Paediatric Emergency Medicine of the American Academy of Paediatrics, proposed lists of resources, necessary to assure optimal health care in the district general hospitals in the region[2].

In the US this process of regionalisation was already accelerated in the decade before this process even started in the Netherlands. One of the reasons was the distances between the different hospitals. During this process, different levels of care were introduced by the American College to obtain the most efficient regional use of resources. 'Level I' units represented delivery of care to the desperately ill patient with complicated needs

requiring the continuous availability of sophisticated equipment, specialized nurses and physicians, trained in the care of the critically ill. This level was further separated in 'level I C' units, representing a high level of clinical care and 'I A' units, which had an additional commitment to education and research in the field of critical care medicine and nursing[45]. 'Level II' units existed in hospitals that usually serve communities with limited resources, using protocols in cooperation with 'level I' units. The Task Force on guidelines of the Society of Critical Care Medicine stated that the state and federal governments should be 'encouraged to implement reimbursement schedules and methodologies' that would recognise the high cost of caring for the critically ill. They were also encouraged to support the 'rationalisation of critical care service and the development of referral and transfer agreements'[45]. In the Netherlands, initiatives from the national government concerning the organisation of Paediatric Intensive Care, including the transports of critically ill children started towards the end of the 1990's. This was initiated partially because of public pressure through the media and partially by pressure of the Dutch Society of Paediatricians. The intended effect of the pressure was recognition of the necessity of an adequate paediatric (non-neonatal) transport system by paediatric intensivists for all critically ill children in the Netherlands. Another intended effect was to obtain financial support for adequate supplies, including beds, equipment and personnel for all critically ill children who needed transport to PICU's within the diverse regions. Interestingly, the organisation and financial facilitation of care for neonatal paediatric patients including transport in the Netherlands, has already been implemented for many years by legislation. This well organised care for new-borns serves as the example for similar care for older children.

Several other aspects of regionalisation can be discussed. Generally spoken, national health care policies often favour centralisation, while at the local level, community and political pressure are most often opposed to these concepts due to problems with accessibility, image, prestige and fear of economic loss[1]. Centralisation has also administrative advantages such as more efficient utilization of personnel and equipment, more flexibility in staffing and bed utilization, reduction of administrative overhead[1]. Pearson et al. stated that with centralisation of care, there will be larger paediatric intensive care units and each of these units could run a specialist transport team to collect and transport very ill children from anywhere in the region[31].

A review of the literature shows the widespread need for such teams[20,22]. As Edge et al puts it: substantial reductions in morbidity and mortality can be achieved if very sick children are transported in helicopters or road ambulances by properly trained staff using adequate equipment[48]. In general, the availability of a paediatric-intensivists itself improves the outcome and efficiency of therapy of patients in paediatric ICU's[34]. Large paediatric ICU's can also provide this service very cost effectively as Shann stated in 1993[49].

In Europe this opinion is shared, partly based on results of European studies[14,15,50]. A centralisation of paediatric intensive care improves outcome. One aspect is the relatively infrequency in absolute number of critically ill patients in contrast to adult critical care. Two studies, one in Austria and one in Finland showed that of all urgent transports by physician staffed mobile units, 'only' 6.6% were paediatric transports[14,15].

It is of interest that in the U.S.A. by law, personnel from a transferring hospital must ensure that the skills and equipment available during transport will meet the anticipated needs of the patient[51] As mentioned before, possible negative aspects of regio-

nalisation, as seen by district general hospitals, are the potential loss of revenues for the referral institutions by sending the patients away. Also the fact that referring institutions may suffer public image problems causing low retention of personnel can be seen as a negative aspect[1]. The displacement of patients from their local support environment and the loss of skills and knowledge in local hospitals can also be seen as disadvantages[1]. Less flexibility when the system overloads, resulting in poor access to and/or inferior care is also an important factor. In the tertiary centres, a depersonalisation of care may take place (larger, busier, teaching institutions) besides the danger that, because of the growth of closed physician groups and rigid philosophies, the growth and progress in critical care medicine stagnates[1].

A period of transport is a period of potential instability[20,21]. Pearson et al. stated however, that if specialist paediatric emergency transport is available, the benefits of centralization far outweigh the adverse effects of having to take children to a regional (paediatric) intensive care unit[31]. On the other hand, the task force of the Society of Critical Care Medicine stated that 'if the diagnostic test or procedural intervention under consideration is unlikely to alter the management or outcome of that patient, the needs for transport must be questioned[5]. Studies provided criteria to reduce the risk for the patient during transport. This reduction was achieved through careful planning, selection of appropriate equipment and the use of qualified personnel[5,20-23]. During times when there is no specialized transport team available for interfacility transport, each facility level II unit has to develop contingency plans utilizing locally available resources to effect the transport[5]. By this construction the highest possible care for the critically ill child within the region is achieved. Such plans must be evaluated

and refined to assure a continuous quality learning process[5].

Above we have discussed several aspects of regionalisation of care for the critically ill paediatric patient. At the moment, a nation wide debate is ongoing in the Netherlands, regarding the development and implementation of an improved, adequate transport system of critically ill (non-neonatal) paediatric patients. It is essential for this category of children, that both the paediatricians in the different district general hospitals as well as those working in the Academic centres, develop well-defined criteria for optimal care and transfer protocols. They must be backed by national and regional governmental support.

The creation of well defined levels of care at the different facilities, together with the creation of good and practical criteria and commitments between local paediatricians and those working on the PICU ward in the Academic hospital, will certainly enhance the care for the critically ill patient in general. It can increase the knowledge and skills in district general hospitals and prevent the overloading in Academic centres, and ultimately lead to a better outcome for those patients needing critical care. Quality of care measurement may be a tool in assessing this goal and is certainly essential for improving and adapting an implemented health care system. Therefore, in the next paragraph, quality of care measurement will be further explored.

1.4 Quality of care measurement

In evaluating the quality of care given to patients needing intensive care treatment, it is important to develop criteria of good quality of care[52] In the recent past, the variations regarding treatment in the different institutions needed to be sorted out first, before a possible common approach to care could be proposed. Besides

primary goals such as patient care, protocols and outcome data also financial aspects were the driving forces for such investigations[53,54]. During the 1980's the general health care costs exceeded 10% of the Gross National Product (GNP) in the United States. A similar escalation in health care costs took place in Europe. A reform of the health care system reached the political centre stage, accompanied, as Iezzoni called it in 1993, by the twin mantras of 'cost containment' and 'access for all'[55]. Indeed, a lack of objective, evaluative data has been cited as a serious obstacle to health care reform[56].

Wyszewianski eloquently described the quality of care as 'Doing the right thing and doing the thing right'[57]. 'Doing the right thing' is marked by the intervention's efficacy and effectiveness, which are good parameters for the appropriateness of each intervention. Efficacy is the ideal treatment, which can be given to an individual under the best circumstances. Effectiveness refers to the benefit, derived from health service delivered under usual circumstances[52]. Unnecessary interventions without benefit for the patient or institute in which the patient is treated must be minimized and the extinction of such factors can also be seen as part of the quality of care.

'Doing the thing right' is even more important. It incorporates all aspects such as technical and management skills so that the treatment is acceptable by the patient. Technical backup next to good quality of medical handling are the major factors. However in the context of this thesis and the improvement of the quality of care in general, it seems important to add to 'doing the right thing and doing the thing right' the following: 'doing the thing at the right place at the right time'.

The concept of quality has a lot of facets. The focus on a specific aspect of quality seems often to be situational and depends on the

purpose of the assessment[58]. For example provider characteristics as the structure of care but also external influences like economical, ethical factors, patient characteristics and outcomes, physical or emotional are of importance in evaluating the quality of care. Another facet of quality of care is the development of guidelines for structuring the care provided. Hospital facilities and services; pre-hospital care and inter-hospital transport; research and training of personnel are all topics for creating guidelines. These guidelines are intended to assist hospitals in staffing and equipping the units properly and to ensure adequate patient care and professional credibility[2,4,59]. Those guidelines are not static, as future changes reflecting new knowledge and technologies should be anticipated[60]. Guidelines for structure in paediatric intensive care units have been published, like those of the American College of Critical Care Medicine[6,45,60]. Most investigations in this field were performed on intensive cares in Academic Hospitals around the world. Neonatal and or Paediatric facilities were compared with Intensive Care facilities for adults in different countries and on different continents[17,31,33,38,46,49,61-64]. Two major US, multi-centre studies of institutional performance regarding care of paediatric intensive care were published[32,38].

Scoring systems were used to sort patients into categories of efficient and inefficient PICU resource utilization[38]. Low risk mortality patients were identified both by an acute mortality risks of less than 1% throughout their ICU stay and the absence on every PICU day of any therapeutic modality requiring ICU admission. In this way, efficiency rating of each PICU was computed based on efficient and inefficient days of care. In Europe, similar outcome assessment studies were performed[17,33,62]. It is of interest that the majority of paediatric patients needing intensive care observation and therapy enter the medical circuit in district general hos-

pitals. Investigations regarding the use of guidelines of care, in district general hospitals were never performed. Guidelines for the structure and handling of patients with vital instability in these general hospitals, as far as they exist, are based upon the ones made for academic hospitals[6,65].

It is obvious that evaluating quality of care aspects in the first hospital those patients encounter, can be of great importance for the patient's outcome. Clearly, outcomes in general, are not exclusively the product of good quality of care by the provider. Some aspects of the health status of patients are explained by factors beyond the provider's control[66]. Therefore, it is prudent to state that differences in outcome between providers may be in part attributable to the structure and/or process of care[67,68]. Implementation of healthcare policies regarding intensive care, based on appropriate data could rapidly and reliably improve patient outcome. Identifying important aspects of current healthcare systems associated with improved chances of survival, and implementing these for larger populations could accomplish improvements in healthcare with the potential of saving numerous lives. In this thesis we aimed, to study the aspects of the quality of care in district general hospitals and by doing so provide information to create guidelines for structuring this care and optimising outcome for the South West part of the Netherlands.

Ideally, outcomes of monitoring are those who are detectable, preventable, are of high volume or high costs, are responsive to therapy, reflects the patients preference, have a bearing on the health status and are clearly attributable to the care delivered[52,66,67]. These characteristics should provide relevant clinical information and be accepted by physicians. Strategies to overcome this daun-

ting gap between methodological research, on the one hand, and implementation in medical practice on the other were developed[66,69]. The basis for the development of these strategies was the recognition of the fact that information, and especially information not tailored to the particular practice environment, did not, by itself change physician behaviour and thereby was not able to improve health care or health[66]. Greenfield et al mentioned that especially the moving of health status measurement from research spheres into daily practice environments would be the next phase in the field of health status assessments[66]. Aims in solving this problem were, in his view the following issues: 1) clarifying the true aim of health care; 2) standardizing measures of health across patients, providers and settings to evaluate benefit; 3) establishing cause and effect among structural input factors, care delivery processes and health outcomes valued by society and 4) determining if and when cost containment actions have adverse effects on health outcomes[66].

Performing an investigation on how paediatric emergencies are handled in district general hospitals could result in the implementation of a structure for handling paediatric patients with vital instability by the individual paediatrician in the region in a 'language, tailored to the particular practice environment'. Local working paediatricians should recognize the produced guidelines as very functional for their daily practice. The ultimate goal is that they will be 'do the right thing; do the thing right at the right place at the right time'.

To create quality of care measurements, one must use well-established tools. In the past, different tools like severity of illness and outcome scores were developed. In the next paragraph a survey of such scoring systems is presented.

1.5 Severity of illness and outcome scores

Health status instruments are useful in clinical settings to screen for functional problems, monitoring disease progression or therapeutic response, improve doctor-patient communications, assess quality of care or provide case mix adjustment for comparing other outcomes between patient groups. However, conceptual, practical and attitudinal barriers have prevented the wider use and implementation of such instruments[70]. One such instrument in a health care inquiry is the severity of illness. The severity of illness can be classified in different ways for example by using scores, assessing the current clinical situation[41,71-73]. For measuring outcomes however, prediction scores are needed. Prediction scores are developed following several common steps[52,74,75]. After selection of well-defined biological parameters for the study, a population is selected for evaluating a hypothesis[74-76]. Predictors to be used in the development of a model are identified and data are collected after which the model is validated[52]. Multiple logistic regressions are commonly used for model development[77]. Outcomes of health care are often multidimensional[52,67,69]. Which dimension should be evaluated depends generally on both the context and the purpose of the assessment. The context determines whose perspective should be evaluated[16]. Outcome measurement from the perspective of patients is seen as ideal[55,66,78]. In Paediatrics, out of the Physiologic Stability Index (PSI)[18,29,42], the Paediatric Risk of Mortality (PRISM) score was developed[41,79]. It consists of measured, physiologic parameters, which, with the performance of a logistic function, estimates the mortality risk or outcome. The number of physiologic variables has been reduced to 14, which made it easier to compute the score, and the PRISM reflects the severity of illness better than the PSI score. Each variable range is objectively weighted to reflect its contribution to mortality risk

on a logistic scale. The weight corresponding to the most abnormal recorded value from each of the 14 physiologic variables are summed to obtain the final PRISM score. The maximum number of PRISM points is 76, 38 from vital sign data and 38 from routine laboratory data. Variables not measured are assumed to be normal. Wide experience has proven PRISM to be valid for risk adjustment for large paediatric critical care populations. A new version of PRISM has been developed recently, PRISM III, which uses data collected in the first 12 to 24 hr to predict mortality[79]. Using the PRISM as a pre-transport indicator, Orr et al found in 1994 an underestimation of the severity of illness and thus an underestimation of the requirement of intensive care, by comparing the PRISM gathered after first contact by telephone and the PRISM made up by the paediatric transport team[80]. He stated that therefore the PRISM-score should not be used as a severity of illness measure or triage tool for paediatric interhospital transport[80]. For similar reasons, a comparison of severity of illness in the pre-transport setting can not be used to determine which patients will benefit from specialized paediatric transport, as proposed in 1989 by Kanter et al[24,80] and Amin et al in 1991[40]. Orr's results confirm the findings of Whitfield et al earlier, where he found an underestimation of the severity of illness with PRISM scores obtained during initial telephone call compared with PRISM scores generated by the transport team[80]. Kanter et al responded, with a study titled 'Paediatric mortality probability estimated from pre-ICU severity of illness', by saying that the limits of statistical predictions must also be recognized in the care of an individual[76]. Mortality rate predictions for a group of patients do not imply certainty of good or poor outcome for an individual patient. Knowing this, he stated that the ability to objectively estimate mortality probability from pre-ICU clinical observations

supports the use of the PRISM score as a description of pre-ICU illness severity in groups of patients[76].

Taken together we agree with the statement that PRISM scores, generated by the transport team from the PICU of the referring Academic Hospital, is a good indicator for the severity of pre-ICU illness in the group of paediatric patients with vital instable parameters.

There are however also some negative aspects of using the PRISM score. Shann et al mentioned several problems, using PRISM[82]. Because it is calculated from the most abnormal values of 14 variables over a 24 hr period, it is sometimes practically very difficult to collect information needed to calculate PRISM. In addition two methodological problems were mentioned[82]. First the fact that the score takes the worst value instead of predicting it. Secondly, the worst values in 24 hr scores would blur the possible quality difference between units, for example the least optimal unit's high mortality can be incorrectly attributed to it having sicker patients than the well functioning units. The PRISM score is therefore only valid in paediatric intensive care units to predict mortality rate in children who are being monitored and treated by well-trained paediatric intensivists[41]. In addition the PRISM score is not applicable in district general hospitals where general paediatricians are working. To overcome these problems, a new scoring system was developed, the Paediatric Index of Mortality (PIM)[82].

The PIM was developed as a simple model based on only 8 explanatory variables, collected at the time of admission to the intensive care. The first value of each variable measured within the period from the time of first contact to 1 hr after arrival is used. The variables are pupils responsiveness, base excess in arterial or capillary blood, PaO2, FIO2 measured at the same time of

PaO2 measurement, systolic blood pressure, existence of a specified diagnose, existence of mechanical ventilation at any time during first hour in ICU and if the admission is an elective one. The authors stated it to be accurate and to predict the risk of mortality in groups of children[82]. Ideally, a severity of illness measure for transport should not include laboratory values or any variables whose collection would result in a delay of the patients transfer[80].

In the past, various other patient classification systems were developed for the use in (mainly) adult populations. They served as guidelines for prognosis, cost analysis and staffing and inter-institutional comparison. One of the most commonly used is the Clinical Classification System/Score (CCS), a qualitative assessment of severity of illness[71,83]. The CCS is a bedside assessment of patient stability at the time of admission, using 4 classes. Class I represents the routine postoperative patients, not requiring intensive care; class II represents the physiologically stable patients requiring prophylactic overnight observation, class III represents the physiologically stable patients requiring intensive care nursing and monitoring and class IV represents the physiologically unstable patient requiring intensive care nursing and a physician care with the need for frequent reassessment and adjustment of therapy[71]. In 1993, a new scoring system called the 'clinical risk index for babies score' (CRIB) was introduced as a tool for assessing specific initial neonatal risk. It could also be used in comparing performance of neonatal intensive care units[73]. It was introduced as a robust index of initial neonatal risk that was more accurate than birth weight alone.

In summary in the last two decades, a number of classification systems were developed, serving as guides for prognosis, outcome, indication for intensive care admission, for paediatric and adults patients. The PIM score is generally considered as the best

and simplest score for the patient population seen by general paediatricians in daily clinical practice in the district general hospitals.

Many scoring systems were used to indicate the level of care needed for specific categories of patients. These scores are strongly linked with the severity of illness but also to the manpower requirement. The care provided in different facilities can for example be assessed using Therapeutic Intervention Scoring System (TISS) data[84]. These data can be linked to CCS data and can be helpful in assessing the amount of care received. Yeh et al demonstrated this association and considered this as a necessary step in the validation of the TISS in the paediatric population[71]. TISS is composed of 76 therapeutic interventions and monitoring modalities. Each TISS item has a score of 1 to 4 based on the invasiveness and complexity of the item. After the introduction in 1974 by Cullen et al, Keene et al[83,84] updated the TISS in 1983. After the introduction, TISS has also been incorporated as an integral part of the Acute, Physiology, Age and Chronic Health Eevaluation (APACHE) developed by Knaus et al[85]. This system is composed of an Acute Physiology Score (APS) and a chronic health evaluation (hence the acronym APACHE). This methodology, nowadays used in adult ICU's to predict hospital mortality risk for critically ill hospitalised adults, was revised in 1991 to the APACHE III score[72]. In 1994 Cowen and Kelley reviewed the development of this predictive scoring system[74]. In their opinion, APACHE III predicts hospital mortality accurately but has not been designed to look at other outcomes, such as functional status and 60-day mortality, which may prove to be more relevant for health care economics. Its advantage is that the APACHE III gives weighted variables but that it needs independent validation with a possible expectation bias introduced by daily update[74]. TISS scores are also useful as indices of quantity of care and resource use[16,86]. As

mentioned before the TISS is correlated with severity of illness and manpower requirement[42]. A comparison can be made from selected items in the TISS scoring system, that are representative of invasive monitoring, non invasive monitoring, standard care, or therapies unique to the intensive care setting[16]. The selected TISS items representing intensive care monitoring are arterial, central venous and urinary catheters, intra-cranial pressure monitors, strict input and output assessment, hourly vital signs, hourly neurological assessment, continuous ECG monitoring[31,84]. The selected items representative of intensive care therapies were e.g. mechanical ventilation, continuous infusion of vasoactive agents, I.V. nutrition (peripheral or central) and specific orders of replacement of blood losses[31]. The timing of measurement has to be standardized to reduce the bias or measurement error[67,87]. Special educated researchers have to control the data entry so that the entry errors are minimized and to ascertain systemic sampling. Thus, sharing the common opinion that the TISS score is a good score for the level of care given, there are practical difficulties in its use by general practitioners in district general hospitals. Therefore, the TISS score can only be used in district general hospitals to investigate the level of care, provided that a well-educated staff with an intensive care background has enough tools to perform these investigations.

Besides the structure and process of care, patient outcome is the third part of 'the Classic Triad' defining quality of care[58,69,88]. This increasing effort to measure outcome in the health system was called by Relman 'the third revolution in medical care'[89]. Development of a system for measurement of patient outcome was also necessary in comparing the quality of care of different institutions. In the past, outcome measurement comprises five

'D's': death, disease, disability, discomfort and dissatisfaction[69]. Modern systems focus more on the positive aspects of health; survival rates, status of physiologic, physical and emotional health and satisfaction[69]. To cover this outcome in paediatrics, the Paediatric Cerebral Performance Scale (PRPC) and the Paediatric Overall Performance Category Scale (POPC) were introduced[52,88]. These scales asses outcomes of Paediatric Intensive Care. Each scale has six points, each point represent greater functional impairment. The difference between the scores, the delta score, was defined as the change of function attributable to the index illness or injury and the care received for it. This way, pre-existing conditions before admission were incorporated. Outcome data have a number of applications[52]. First epidemiologically, in the sense that data can be obtained and compared from different institutions. Secondly to expand the experience base for individual practitioners[78], thirdly for the use to educate patients on natural course of disease and finally to relate their progress to other patients with similar characteristics[87]. Outcome data can also be used to evaluate the effectiveness of treatments or performances of systems[52,66,67,78], organizational administration[87], managed care negotiations and development of practical guidelines[65].

Measurement of the quality of care is time consuming and expensive[55]. On the other hand, when it is performed properly, it improves the health status of the individual, improves the quality of care and helps in organizing a good regional health structure.

1.6 Specific aims

This thesis was performed to obtain characteristics and determinants of the emergency care for critically ill children within 15 major district general hospitals in the Southwest part of the Netherlands, encompassing 4 million inhabitants.

• The objective of the first study was to assess the number and evaluate characteristics of critically ill children, transported from a defined area to the district general hospital of the city of Delft. This aim was carried out by means of a retrospective analysis of all ambulance transport charts and hospital data at admission, together with city council data from the study area (population 277,161 inhabitants; 1.8% of the Netherlands) during a one-year period. The study was performed in order to report the number of children per 100,000, admitted to the district general hospital and/or directly send to the PICU, who needed 'golden hour' intervention per year. This information is relevant for hospital facilities and policy makers in planning resources and facilities.

• The objective of the second study was to evaluate the presence of essential medical equipment and medication for initial therapy of critically ill children in paediatric emergency settings of district general hospitals in the Southwest part of the Netherlands. This aim was carried out by a prospective study of the inventory of all emergency rooms (ER) and emergency facilities on the paediatric department (PD) of the 15 major district general hospitals covering the Southwest part of the Netherlands.

• The objective of the third study was to study the organisation around the initial therapy of critically ill children in district general hospitals. The design was a prospective study of the 'routing' of critically ill children in district general hospitals. The aim was to determine, in case of a new patient, where the critically ill children would enter the hospital and which type of physician would act first. In case of deterioration of the clinical condition the same questions were raised: who would act and where. Finally the 'referral pattern' of those critically ill children was

assessed. Would they be transported towards the regional PICU or would they stay in the district general hospital and if so, where would they stay?

- The aim of the fourth study was to determine the number and characteristics of children, suspected of a critical emergency, who were transported and presented, with or without announcement, from a defined area of the Netherlands to one district general hospital. The design was, in contrast to the first study, a prospective analysis. During a one-year period all patient characteristics including transport and hospital data of all admitted children were assessed. How many were transported in their family's car, how many by ambulance. What were the characteristics of this group? Where do they enter the hospital and what happens there? How many of those admitted to the district general hospital were secondarily send to the PICU. The same study area was chosen as in study number one. Also this study was designed to obtain adequate characteristics to further plan intensive care need for children in the region and possibly by extrapolation for the whole country.

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CHAPTER 2

Urgent ambulance transport of (non-neonatal) paediatric patients to a district general hospital: how many are critically ill?

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Abstract

Objective: To study the number and characteristics of critically ill children transported from a defined area of The Netherlands to a district general hospital.

Design: Retrospective analysis of ambulance transport charts, hospital data at admission and city council data (population 277,161; 1.8% of The Netherlands).

Setting: City of Delft and surrounding villages (200 km², 0.5% of The Netherlands) during the year 1997.

Measurements: Of all pediatric ambulance transports and hospital data patient characteristics like age, sex, presenting problem were extracted. City councils provided demographic information.

Main results: From a total of 277,161 inhabitants, 57,851 had an age below 18 years (21%) and from this group, 511 were transported by ambulance (0.9%), 459 urgently, i.e. as having a 'life threatening illness' (0.8% of the pediatric population; 89.8% of all pediatric transports). Of all urgently transported children to the district general hospital of Delft (n=291), 70 (24%) needed crucial therapy ('golden hour') upon admission. The majority of all transports were teenagers with surgical trauma; a minority (3.7%) was directly transported to a pediatric intensive care facility.

Conclusions: From a defined area of The Netherlands, 0.9% of the children below 18 years were transported by ambulance to one of several general hospitals hospital. Calculated per 100,000 children below 18 years per year, including those transported directly to the PICU, 235 were critically ill and in such a condition that the first hour of their treatment could be considered as crucial for survival ('golden hour'), which is approximately 0.23% of the total population under 18 years.

Key words

Children, critically ill, transport, golden hour, general hospital

Introduction

Children at all ages and with different diseases may develop sudden instability in vital signs in a relative short period of time. Knowledge of pathophysiology of life threatening processes and technology to monitor and treat such patients have advanced rapidly and has led to the evolution of pediatric intensive care units (PICU's). These PICU's were initially set up in tertiary care facility centers. However, many critically ill patients are primarily seen in district general hospitals, which are wide spread in the Netherlands. There are 8 academic centers with PICU's and 104 district general hospitals in the Netherlands. Recently Shann questioned in a recent editorial in Intensive Care Medicine 'where do all children go?'[1]. In this study we aimed to obtain data regarding the transport by ambulance of critically ill children. A retrospective review of the charts of all pediatric patients, transported by ambulance to one district general hospital throughout a period of one year was performed to determine the following characteristics: age, sex, presenting problem/disease category, pediatric consultation and location from where transport initiated. The objective of this study was to obtain data, which can be of use in the evaluation and assessment of the organization of regional pediatric healthcare, including initial site of care and inter hospital transfer of critically ill children.

Materials and methods

The study was conducted over the year 1997 in the South West region of The Netherlands in the city of Delft and its surrounding villages. The region can be considered as average for the Netherlands (age, mean income, health statistics, education and unemployment level). Delft is located not far from Rotterdam, which has a PICU facility as part of the university hospital. Delft

has one hospital, which serves as a district general hospital in delivering specialist medical care including Pediatrics. It has 700 beds; 21 on the pediatric ward with extra 18 incubators and 10 cots on the neonatology ward. The hospital has no pediatric intensive care beds for which it relies on neighboring academic centers. Delft and its surroundings are served by two ambulance services, which are staffed with two paramedics per ambulance, generally one with experience or formal training and a medic-driver. All ambulance paramedics are BLS and ALS trained, with limitations, by protocol on ALS level like medication usage. The development of so-called 'ALS units' like in the U.S.A. did not take place, partly because of the fact that every patient can reach a hospital within 30-45 minutes in the Netherlands. From each ambulance transport, data on age, location, and response time are stored. One alarm telephone number is used for ambulance transport, which covers the area of the study. Each ambulance transport is coded as 'A1', when there seems to be urgency, which is decided by the general coordinator at the ambulance service center, to get within 15 minutes to the patient because of an apparent life threatening illness or situation. Emergency lights and acoustic signals are than used. It is the ambulance paramedic, who based on severity and distance to nearby hospital, decides to which hospital, either general or academic, and under which code the patient is transported. This code 'A1' is continued when the paramedics state a necessity to get into a hospital as soon as possible. All children in the region transported by ambulance and admitted to our hospital with an age between three months and 18 years, were included in this study. The hospital institutional review board has waved the necessity for informed consent. Transports of children with an age below three months were excluded to focus on non-neonatal transports. Neonatal transports

are well organized and are already subject of many studies while pediatric transports are not.

The A1 ambulance charts and admission data of these children were obtained and all available characteristics were analyzed in a standardized way and were used to select that group of children for which the first hour of their treatment could be considered a 'golden hour'. The term 'golden hour' which was used as an outcome measurement in this study was defined as the need of using medication and/or materials from a 'crash cart' for the initial treatment of the critically ill patient as judged by an experienced physician. In others words the child needed emergency care following ALS procedures upon arrival in the district general hospital. This is in contrast to others who include within the definition also the time interval between the incidents itself to the start of ALS procedures within the hospital. All data were assessed and coded twice by two independent investigators.

From the emergency room admission data, the disease category at presentation was extracted. There is however unfortunately no consistency in diagnostic categories used for the classification of vitally unstable patients in different published studies.[2,3]. We used the classification: respiratory (including asthma and pulmonary infection), circulatory (including sepsis and cardiac arrest), neurological (including convulsions), neuro trauma, surgical trauma, near drowning and intoxication. From each village and city in the region, demographics such as size (in km^2) and number of inhabitants and age distribution was collected.

Statistical analyses in the comparison of data of the transported children and those for which their initial treatment could be regarded as 'golden hour' were performed using chi-square tests. P-value levels of 0.05 were regarded as significant. By using the referral pattern of general practitioners in the region to our pedi-

atric outpatient department versus the other general hospitals in the region, we were able to calculate the population out of which we received our A1 transports. This population number, corrected for the referral to other surrounding hospitals, was used to finally obtain the proportion of children per 100,000, needing 'golden hour' therapy per year. The hospital of Delft can be considered as an average mid-size general hospital, with all different specialties available. It serves its city and surrounding villages for referrals from general practitioners.

Results

The study region of Delft and its surroundings (200 km^2; 0.5% of the country's area), has a population of 277,161 inhabitants (1.8% of the country's population) and should be considered as a densely urbanized part of The Netherlands. In the study period, from the population of 277,161 inhabitants, 57,851 (21%) had an age below 18 years (Table 1). The total number of ambulance transports was 7,836 (7,325 adults and 511 children; 7% pediatric). The percentage of transports for the whole population was 2.8% and for the pediatric population 0.9%. Of all transported adults 53.7 % were booked as 'A1', compared to 89.8% for children. Of all transports considered as urgent, 10.5% were pediatric. In the city of Delft, 180 children were transported as A1, which accounts for 1.0% of the pediatric population in that area (Table 2). A minority of the group was transported directly to a pediatric intensive care facility (3.7%). In 9% of all cases, the target destination was not reported on the transport form because no further transport was indicated after arrival at the scene. The problem was considered to be minor by the paramedics and they judged that patient did not need further medical treatment within a hospital. Of all children urgently transported to the general hos-

pital of Delft (164 out of the city and 127 out of the surrounding villages), 289 charts could be evaluated (99.3%).

Of this transported group, 56% were boys and 44% were girls. When picked up from the streets, rather than from home, the percentage of boys increased to 59% (not significant). The majority of transported children were older than 10 years of age (Table 3). Near drowning patients could only be found in the age group of 1 to 4 years. Patients having an intoxication of any kind were found in the age group of 1 to 4 and in the group of older children, above the age of 10 years. With increasing age the percentage of children with a surgical trauma for which they were admitted urgently to a hospital increased while respiratory problems more frequently occurred in younger children; neuro trauma was seen throughout all age groups. Neurological problems (e.g. seizures) were the most frequent problem in the groups up till the age of 4. By studying emergency room admission files in Delft, we could determine if a child's first hour of treatment could be defined as a 'golden hour' (Table 4). During the initial phase of treatment, an experienced physician needed medication and/or material out of the 'crash cart' in 70 out of 289 admissions (24%). No statistical difference could be observed between the mean ages of children needing the 'golden hour' compared to all children transported. In contrast to the total group a statistically significant number of three year olds with neurological problems were seen in the golden hour group ($p<0.05$). A significant lower number of patients, transported with surgical trauma needed 'golden hour' treatment ($p<0.05$). Interestingly, only in 3% of all transports, the paramedics performing the transport consulted a pediatrician.

Discussion

In a defined urban area of the Netherlands, 0.8% of the young

population below 18 years was transported urgently by ambulance during a period of one year to a district general hospital. One quarter of them needed urgent and crucial (golden hour) therapy upon arrival at the hospital. Extrapolating our data, we found that 235 out of every 100,000 children under 18 years per year need an admission with an initial treatment that can be considered as 'golden hour'.

In clinical practice, children with acute diseases are presented to all kinds of hospitals. The medical facility to which the child is presented to is either academic or non-academic; the availability of adequate medical supplies, the knowledge, skills and training of medical personnel are crucial for quality of care and outcome of treatment[4-6]. In the past, studies often originated from intensive care units and they assessed characteristics, associated with improved chances of survival[7-10]. For example inter and intra hospital transfer of patients proved to be important[11-17]. Furthermore a strong relationship between treatment outcome and severity of illness at admission (as assessed by physiologic profiles) was described[18,19].These studies concluded that there is a need for a formal, regional organization of pediatric primary level of intensive care[4,20]. Such a regionalisation of care has also been shown to reduce health costs[7,21].

Our study is the first to report data on urgent transports and admission of critically ill children directly to a district general hospital in a representative area of the Netherlands. The importance of this study lies in the possibility to quantify pediatric care facilities necessary for the region. As a limitation of this study can be seen the use of data, created by different paramedics. Of all ambulance transports by the paramedics, 7% were pediatric. It is of interest that in studies of prehospital pediatric emergencies, performed in Austria and Finland by physician staffed mobile

units, similar percentages were found[22,23].

We showed that nearly 1% of all children living in the study area per year were urgently transported by ambulance with a life threatening appearance. Knowing that 21% of the total population is below the age of 18 years, it implies that there is a considerable number of children who will be transported for apparent critical illness towards a general hospital. However, only a quarter turns out to be truly seriously ill in the eyes of an experienced physician, defined as in need of intensive medical support ('golden hour') on admission. The observation that 89.8% of transports of children is urgent, compared to an adult A1 percentage of transports of 53.7%, can possibly be explained by psychological reasons. Although the paramedics are trained what to do including using protocols, the majority decide, when having a child in the ambulance, to use emergency lights and acoustic signals sooner than probably strictly necessary. This behavior can also be explained because of the relative inexperience ness of paramedics in recognition of disease, availability of medical command and familiarity with pediatric protocols in treating critically ill children. As described by Kumar et al[24], pediatric transports are relatively infrequent for paramedics, explaining their behavior as scoop and run. Evaluating urgent transports, one of the main observations is that the majority of pediatric transports are teenagers with a surgical trauma. Respiratory problems, as expected were mainly found in young children, the same accounts for the group of 'neurological problems', mostly febrile convulsion. Two cases of near drowning could be traced, all in the age group of 1 - 4 years. Intoxications of any kind were also found in the teenage group, where alcohol abuse and suicide attempts were observed.

As shown in Table 4, the percentage of children in the group with surgical trauma, which initial therapy can be seen as 'golden

hour' was the highest for the older children while, as shown in Table 3, this was only 14% (17/122) of transported children with surgical trauma in this group. The inverse effect can be seen when one assesses the group of 1-4 year-olds with neurological problems. The number of children in this group needing a golden hour therapy was significantly higher than the total number of transported children in this group.

The study was initiated to obtain an indication of the number of children per 100,000, needing a 'golden hour' on admission to a district general hospital during a one-year period. We found that, using a correction factor for referral percentages, per 100,000 children below 18 years, including those directly send to the PICU, 235 will need a 'golden hour' intervention per year (0.23%). This information is relevant for policy makers in planning resources and facilities in urban and rural settings, as well as for setting up interhospital transport.

In conclusion, a relative high number of 'vitally unstable' children as indicated by A1 ambulance transport status, were transported to a district general hospital during a one-year period, with a diversity of disease categories. Evaluation of these transports showed that only 24% of this urgently transported group needed a 'golden hour' after admission. This finding indicates that in general 0.2% of the total youth population per year will need treatment that is ALS based, upon arrival in a district general hospital. It is obvious that, in the light of the limitations of this study, after obtaining this 'golden hour' number in a retrospective analysis, a prospective study is needed to confirm these findings and to support the development of integrated hospital transfer system for critically ill children. Such a study is currently underway and should also be used to calculate pediatric intensive care beds and facilities nationwide.

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Table 1

Ambulance transport figures and characteristics of the region divided in those coming from the City of Delft or from the surrounding villages. Transports were considered as 'pediatric' when the age of the transported person was below 18 years. The total number of all urgent ('A1') pediatric transports in relation to the total pediatric population per year is given by the ratio 'pediatric A1/youth/yr'.

	City of Delft	*Surrounding villages*	*Total area*
Size (km^2)	26.3	174.2	200.52
Number of inhabitants	94,755	182,406	277,161
Number of inhabitants <18 yrs (youth)	17,471 (18.4%)	40,380 (22.1%)	57,851 (20.9%)
Total of all transports	3587	4249	7836
Total of all urgent transports (A1)	1922	2470	4392
Total of all pediatric transports	200	311	511
Total of all urgent pediatric transports (A1)	180	279	459
Ratio pediatric A1/youth/yr (%)	1.03	0.69	0.79

Table 2

Analysis of all ambulance transports and their destinations, regarding children up to 18 years during the year 1997.

	City of Delft	*Surrounding villages*	*Total area*
Total number of all pediatric emergency calls	220	343	563
Minor problem upon arrival not needing transport to a hospital	20 (9%)	32 (9.3%)	52 (9.2%)
Total of all transported children	200	311	511
Total of all 'A1' transported children	180	279	459
Admitted to hospital Delft	164 (91.1%)	127 (45.5%)	291 (63.4%)
Admitted directly to academic hospital	11 (6.1%)	6 (2.2%)	17 (3.7%)
Transported by ambulance directly to another, nearby general hospital	5 (2.8%)	146 (52.3%)	151 (32.9%)

Table 3

Characteristics of transported children, divided by age and disease categories, for the region during the year 1997 who were urgently ('A1') transported to Delft in number (and percentage).

Age group	*<1 yr*	*1-4 yr*	*5-10 yr*	*> 10 yr*	*total*
Total	8 (3)	64 (22)	45 (16)	172 (59)	289 (100)
Sex					
Girl	5 (63)	28 (44)	17 (38)	76 (44)	126 (44)
Boy	3 (37)	36 (56)	28 (62)	96 (56)	163 (56)
Disease categories by age group					
Respiratory	2 (25)	6 (9.4)	2 (4.4)	4 (2.4)	14 (4.8)
Circulatory	- (-)	2 (3.1)	2 (4.4)	9 (5.2)	13 (4.5)
Neurological	4 (50)	29 (45.3)	2 (4.4)	9 (5.2)	44 (15.2)
Neuro trauma	1 (12.5)	11 (17.2)	15 (33.3)	22 (12.8)	49 (17.0)
Surgical trauma	1 (12.5)	12 (18.8)	24 (53.3)	122 (70.9)	159 (55.0)
Near drowning	- (-)	2 (3.1)	- (-)	- (-)	2 (0.7)
Intoxication	- (-)	2 (3.1)	- (-)	6 (3.5)	8 (2.7)

Table 4

Characteristics of transported children (n=70, age between three months and 18 years) for which their initial treatment could be regarded as 'golden hour'; data are given in absolute numbers and percentages. Golden hour is defined as needing medical equipment and/or medication out of a 'crash cart' for initial therapy, as judged by an experienced physician, in others words following ALS procedures. Comparison is made with the same age groups and disease categories with and without golden hour (* p-value 0.05).

Age group	*<1 yr*	*1-4 yr*	*5-10 yr*	*> 10 yr*	*total*
Total	2 (3)	24 (34)	9 (13)	35 (50)	70 (100)
Sex					
Girl	1 (50)	12 (50)	5 (56)	15 (43)	33 (47)
Boy	1 (50)	12 (50)	4 (44)	20 (57)	37 (53)
Disease categories by age group					
Respiratory	1 (50)	2 (8.3)	2 (22.2)	- (-)	5 (7.1)
Circulatory	- (-)	1 (4.2)	1 (11.1)	4 (11.4)	6 (8.6)
Neurological	1 (50)	17 (70.8)*	2 (22.2)	4 (11.4)	24 (34.3)
Neuro trauma	- (-)	2 (8.3)	3 (33.3)	8 (22.9)	13 (18.6)
Surgical trauma	- (-)	- (-)	1 (11.1)*	17 (48.6)*	18 (25.7)
Near drowning	- (-)	2 (8.3)	- (-)	- (-)	2 (2.9)
Intoxication	- (-)	- (-)	- (-)	2 (5.7)	2 (2.9)

CHAPTER 3

Facilities and equipment in district general hospitals in the Netherlands: are we prepared for the critically ill paediatric patients?

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Abstract

Objective: To evaluate the presence of essential medical equipment and medication for initial therapy of critically ill children in paediatric emergency settings of district general hospitals.

Design: Prospective study of the inventory.

Setting: Fifteen major district general hospitals covering the South West part of The Netherlands.

Methods: Consensus regarding the optimal inventory equipment and medication was obtained from a questionnaire, filled in by 14 paediatric intensivists (expert opinion). They gave their opinion concerning a list of medication and materials, created and distributed by a regional paediatric committee in the early '90. Each item of this list was given a score; ranging from 1 as 'handy' to 5 as 'essential', hereby creating a tool for the assessment of the inventories. A team of investigators visited all hospitals twice to check the presence of all items of the list of materials and medication. First to examine the initial site of emergency care, designated by the local paediatrician as the localization to start treatment of a critically ill child coming from outside the hospital. For some this was the emergency facility on the Paediatric Department (PD), for others this was the Emergency room (ER). In a second visit all other remaining sites for emergency care for children in the hospitals were evaluated. A total score below 75% of the optimum, as obtained from the experts, was considered as not optimally equipped.

Main results: Equipment to meet 'respiratory problems' was considered by the experts as the most essential of the inventory with a score of 4.97. In the hospitals visited, both the ER and PD were optimally equipped regarding circulatory problems, ranging from 72 - 98% of the optimum. Five out of the total of 26 emergency sites scored below 75% (4 out of 11 PD, 1out of 15 ER) of the

total optimum inventory. The ER was in all aspects significantly better equipped than the PD. When the total group of hospitals were analysed and compared with each other, major differences and variations in the inventory for initial treatment of the seriously ill children were identified.
Conclusions: Emergency Rooms of district general hospitals throughout the South West part of The Netherlands are better equipped to meet the needs of critically ill paediatric patients coming from outside the hospital than the same facility in the Paediatric Departments. Only one ER out of the 15 hospitals scored below the 75% of the optimum. In some hospitals, the paediatricians involved in the treatment of children who become critically ill during their stay in the hospital (the 'indoor' patients), have less equipment and medication on the Paediatric Departments at their disposal than they have on their ER. Obviously, emergency care on the Paediatric wards should be equipped at the same level as in the ER because for both locations the 'golden hour' is critically important in final outcome.

Key words:
Children, Critically ill, Emergency room, General hospital, Paediatric department, Equipment

Introduction

Studies have affirmed that co-operation among district general hospitals in a region as well as with the tertiary, academic centre is essential for adequate patient care, optimal exchange of knowledge and initiatives of improving care for that region[1-3]. Out of this broad recognition of the need for improved care of critically ill children, recommendations and guidelines were developed[4-6]. In fact, in some areas of the medical field, regionalisation has already been implemented such as for neonatal, burn and trauma patients, resulting in strongly improved outcomes of care[2,7,8]. The Committee on Hospital Care of the American Academy of Pediatrics provided guidelines for equipping a paediatric unit in community hospitals, ranging from a list of basic facility needs to a 'minimal' list of essential medical equipment[9]. Many children who become acutely and/or critically ill are primarily admitted to a district general hospital[9]. Analysing data regarding the number of such children and gaining information about their type of illness and initial treatment in these hospitals is essential for the evaluation of care and assessment of the organization of paediatric health care of a region (van der Lely et al, manuscript submitted). In the Netherlands, such critically ill children, coming from outside the hospital will, in general, be presented to the Emergency Room (ER) of the district general hospital. However, depending on the time of day and/or local setting some of these 'outdoor' critically ill children will primarily be seen in the emergency room on the ward of the Paediatric Department (PD). Apart from patients becoming critically ill outside the hospital, sometimes patients on the PD need emergency care. In such cases the 'golden hour' of initial care is provided in the emergency facility on the ward. The availability of medical material and medication in the ER and in the PD of these district general hospitals will

provide an impression of the quality of care, which can be provided on site. The presence of adequate material and medications is a prerequisite for optimal care and reflects the quality of care for the initial 'golden hour' in the treatment of such children.

In the South West part of The Netherlands paediatricians together developed several guidelines in their effort to optimise and regionalize paediatric health care in general. A committee was installed, comparable to the Committee on Paediatric Emergency Medicine of the American Academy of Pediatrics, which produced lists of resources, necessary to assure good health care in the district general hospitals in the region[4]. The primary purpose of the Dutch regional committee was to compose a list of medical material and medication, necessary as inventory in a room where initial treatment of critically ill children would take place. The aim was to create well-equipped emergency facilities for critically ill children, coming either from outside or inside the hospital. The result of their work was a list of 29 'general' resources like a spinal needle; 25 items to meet 'circulatory' problems such as intraosseous infusion needles and 23 items to meet 'respiratory' problems such as different bag-valve devices and laryngoscope blades. The list of medication was categorized as medication for respiratory, circulatory, neurological support and medication to use for anaphylaxis, infection and intoxication. After approval, the list was distributed in the early '90-s amongst all paediatricians in the area, as part of an effort to implement a better local health care system for critically ill children. In a 'consensus report for regionalisation of services for critically ill or injured children', published recently, three components of such a regionalized integration of care of critically ill children were mentioned[6]. These three parts of regionalisation were defined as 'categorization', 'accreditation' and 'designation' of given care. We believe that

controlling the facilities on the presence of the items, mentioned in the different guidelines is an essential part of management of a regionalized system of care for the critically ill.

To assess the adequacy of the emergency facilities, we performed a study in all major district general hospitals in the South West part of The Netherlands to evaluate the medical equipment and medication in ER as well as on the different PD. The main purpose was to evaluate whether or not the emergency facilities were adequately prepared to provide optimal care in the 'golden hour' of treatment for the critically ill children. To our knowledge no such study has been performed previously.

Materals and methods

The study was conducted in the year 1999 in 15 major district general hospitals in the South West part of the Netherlands, encompassing 4 million inhabitants over an area of 8000 km^2 with one academic hospital (Figure 1). To study the presence of medical material and medication, we visited within one day all hospitals, using the list for medical equipment and medication that was created and distributed by the regional paediatric committee. The aim was to evaluate the various items in the room, designated by the local paediatrician as the localization to initiate the first phase of treatment of a critically ill child coming from outside the hospital. Three teams consisting of two researchers visited five hospitals each. The three teams were lead by an experienced physician/ research nurse, all trained in the same manner for scoring the different items. One day prior to evaluation, permission was asked from the local paediatricians for the site visit by telephone and through a letter, send by fax, explaining the procedure. All hospitals agreed and the results were analysed anonymously.

The initial site of emergency care not only depends on the

time of day, but also whether the physician has been phoned prior to arrival of a critically ill child. Some paediatricians primarily used the ER of their hospital for the initial treatment while others preferred a 'special room' in their PD for emergency care. On a second visit all the remaining sites for emergency care were visited using the same procedure. This made it possible to compare the inventory of the various emergency facilities for treating critically ill children. For the interpretation of the results, 14 paediatric intensivists working in all parts of the Netherlands in different hospitals and trained in different academic hospitals, were asked, by means of a questionnaire encompassing the list of items as provided by the local paediatric committee, to give their opinion about the necessity of the presence of various items in an emergency room. They were asked, per item, to indicate if the presence was 'handy' (score 1 point) ranging to 'essential' (score 5 points). The average scoring per item was used as 'expert opinion'. The content of the different facilities in the hospitals could thus be scored using the 'expert opinion' score per item as an optimum. All facilities with a total score below 75% of the optimum were considered as not optimally equipped. This arbitrary cut off was chosen to allow for variation per hospital. Ideally one would opt for higher percentages closer to the expert's optimum. In addition a comparison was made between the two facilities within the same hospital. Differences between the groups were analysed, using the Mann-Whitney test. The p-value was 0.05.

Results

Eleven out of the 14 paediatric intensivists who received the questionnaire responded and their scoring resulted in the 'expert opinion'. Given the expert opinion, the different item groups could be assessed in terms of importance. Even within the

groups, the importance of the presence of the different items could be further quantified. The higher the mean score (range 1 - 5), the more essential its presence was in the emergency facility. The different items were grouped as follows: total, general, respiratory, circulatory and medication. The items in the group 'respiratory resources' were considered as most essential (4.97), directly followed by 'medication' (4.73),' circulatory resources' (4.62), and 'general resources' (4.03) (Table 1). In the respiratory resources most items were considered essential while within the 'general resources' group, the presence for example of a weight scale for children was considered 'handy' rather than 'essential' (score 1.9). The experts considered most items in the 'circulatory group' as essential. Only the presence of central venous lines, winged needle infusion sets and needles to use for a 'Port a Cath' were considered of less importance. In the group of 'medication' there was little diversity, only medication to treat 'neurological' problems and 'intoxication' were considered as not truly essential. All local paediatricians in the fifteen hospitals, who were asked to participate, agreed to the visit. Assessing each hospital, the presence of the various items at the different emergency sites differed greatly (Table 2). Hospital number 4,6,8 and 13 only used their Emergency Room for treatment of critically ill children coming from outside the hospital. In these hospitals there was not such a facility on their paediatric ward. All ER's except one (hospital number 4) were, regarding the total score, sufficiently equipped (>75% of the experts opinion) in comparison to 7 out of the 11 PD. When breaking up the total score in the different groups a diverse picture emerged. Only ten facilities (9 ER and 1 PD) out of the total 26 had sufficient general resources at site. All facilities, except five (all PD) had a presence score of more than 75% of the optimum in the group of 'respiratory

resources'. The same was found for 'circulatory resources' except for two facilities with scores below 75% (also all PD). For the medication group, sufficient levels of the items were found in most cases except for three facilities (1 ER and 2 PD), with two scoring relatively low. In ten out of fifteen Emergency Rooms 100% of the essential medication was available in contrast to one out of the eleven Paediatric Departments. In the hospitals number 11 and 12 the Paediatric Department emergency facility scored for the total as well as for the different groups below 75% of the optimum. For the hospital number 9 and 14 the total score for the room on the ward was below 75% but this was due to low scoring in general resources and respiratory resources.
Comparing the scores within the hospitals, remarkable differences were found in percentages. Of the eleven hospitals with both ER and PD facilities for the treatment of critically ill children, only hospital number 3 had a higher presence of all items in the PD than in their ER. In the other ten hospitals the Emergency Room was better equipped for the care of critically ill children. Some hospitals, like number 11 and 12, scored rather low on the PD in all groups while they had an adequate score in their ER.
Comparing ER's with PD's within the different hospitals, a significant difference in the presence of the different item groups could be found at the expense of the PD (Figure 2). When the total group of hospitals were analysed and compared with each other, major differences were identified. As shown in Figure 2, the spread between ER's is relatively small, with all ER's within the 10th to 90th percentile. However, evaluating the PD's, several locations were equipped for the different groups of resources and medication outside the 10th to 90th percentile. The median of the level of presence of the items in the different groups was, both in the ER's as well as in the PD's, comparing to the experts opinion opti-

mum, the lowest in the group of 'general resources' (Figure 2). For the ER the median was 78.2%; for the PD the median was 63.2%.

Discussion

Emergency Rooms (ER) of the district general hospitals throughout the South West part of The Netherlands are far better equipped to meet the needs of critically ill paediatric patients than emergency facilities on the Paediatric Departments (PD). Five of the total of 26 emergency sites scored below 75% (4 PD, 1 ER) of the total optimum inventory, obtained by expert opinion. In some hospitals, the paediatricians involved in the treatment of children who become critically ill during their stay in the hospital (the 'indoor' patients), have less equipment and medication on the Paediatric Departments at their disposal than they have on their ER. In our opinion emergency care on the Paediatric wards should be equipped at the same level as in the ER because for both locations the 'golden hour' is critically important in the final outcome of these children.

In Pediatrics, children either newborns or older, healthy or with different underlying diseases, may develop instability in vital signs in a relative short period of time. In the last three decades, paediatricians have developed many techniques and methods to treat such patients. Since the introduction in the mid 1980's of the sub specialization of paediatric critical care by the American Board of Pediatrics, this sub specialization has matured and developed greatly. The American Board and other paediatric societies worldwide developed, recommended and reviewed guidelines for this process[2,4,5,9,10-12]. At the same time, the technological capacity to monitor and treat such paediatric patients has advanced rapidly[11]. Along with these advances, there has been an evolution

of paediatric intensive care units (PICU's) in tertiary care facilities. They are seen as the primary site for critically ill children to be transported to and in these PICU's the children should be treated by specially trained paediatric intensivists and nurses. Many of those children however are primarily seen in district general hospitals. Similarly to the Netherlands, in the US a committee, (of the American Academy of Pediatrics), provided guidelines for 'furnishing and equipping' paediatric emergency facilities in community hospitals[4,9]. The presence of appropriate material and medication at the location where the initial treatment in those general hospitals is started, along with adequately trained personnel are essential in providing the necessary care for this category of patients ('golden hour'). Such a list of material and medication, based on expert's opinion for its necessity, is a perfect tool to measure an inventory of paediatric emergency facilities, whether or not the children are coming from outside the hospital or from within.

In order to weight the list of necessary equipment we invited intensivists to provide us with their rating. The high number of paediatric intensivists that responded (79%) made it possible to use the item list in the evaluation of the inventories as an 'expert opinion'. The experts assessed the presence of material to meet respiratory and circulatory problems along with the appropriate medication, the most essential part of the inventory (Table 1). Interestingly, the district hospitals achieved the highest percentage score in these categories. This suggest that the general hospitals expect a maximal direct profit, in terms of morbidity and mortality, in an appropriate initial treatment of critically ill children with respiratory and/or circulatory problems. In our view however, the whole item list must be adequately present to create an optimum in inventory in places where critically ill children are

initially treated. For example medication to treat intoxicated children must also be available at site, independent of the frequency of occurrence. It is of interest that all hospitals in the Southwest part of the Netherlands, agreed to cooperate, indicating that a mutual desire exists in our region for the development of a better, possibly unified approach for the initial treatment of critically ill children.

When assessing the presence of the items within the different hospitals itself, major differences could be found. Regarding the total score, we found one ER, which was not sufficiently equipped. This hospital is clearly below average because it depends only on its ER for initial care and does not have such a facility on the ward. Interestingly, four paediatric departments had emergency facilities on their ward below the 75% norm for total score, with one facility even barely scoring 50%. Assessing the two locations within one hospital for emergency care, the ER is most often better equipped than the PD. The fact that ER's are better equipped, totally and in terms of 'general resources' could be the result of the influence of all kind of other medical specialists on the ER's, which is not true for PD's. Different training programs like the Advanced Trauma Life Support (ATLS) have their positive influence on personnel and indirectly on the inventory on the emergency sites where they are working in[13].

Other specialists than paediatricians for example often also use chest tubes and resuscitation boards, so the chance that they are part of an inventory is higher on an ER than on a PD. In general, on a PD only paediatricians decide whether items are present or not.

Four hospitals decided only to use their ER for primary treatment. In such cases we would expect an optimum inventory, however in only 2 of these 4 ER, all item groups were sufficiently

present with a high average score. In the remaining 11 hospitals, both the ER and PD are used for initial treatment for all children either from outside or inside the hospital. These findings are somewhat concerning, given the expert opinion and the list of items as agreed upon by the paediatricians working in the Southwest part of the Netherlands, it seems difficult to accept that facilities for emergency care are not all optimally equipped. Protocols and inventories should be followed especially when it concerns critically ill children.

Thus, comparing the differences in inventory between the Emergency Rooms and the Paediatric Departments, it is obvious that Emergency Rooms are better equipped for initial treatment of critically ill 'outdoor' children. Based on these findings, it seems that in some hospitals, it would even be better to treat 'indoor' critically ill children on the ER of the hospital. The results of this study suggest that an upgrading of several facilities is clearly needed. This study is only a one-moment assessment of the facilities but a regular evaluation is considered essential to be prepared for the critically ill children.

In addition to optimal equipment, it is obvious that other factors like the presence of experienced personnel to provide the care to those critically ill children are of major interest. Having a good and well-trained organization of care within and between the hospitals are also important factors for the quality of care. A study into such factors in the different district general hospitals in the Southwest part of the Netherlands is currently underway. Given the availability of good inventory lists for emergency care to children, each hospital should have a well-equipped facility.

Table 1

List of medical equipment and medication, tested for its presence in the different paediatric emergency settings in fifteen district general hospitals in the Southwest part of the Netherlands. The different items are grouped as resources regarding 'General-, Respiratory-, Circulatory-' and 'Medication'. Per group, the number of items are given and also the mean score per item, given by 14 paediatric intensivists (in order of importance). This score is used as 'expert opinion' (e.o.). The mean score, given by the experts, assesses the necessity, ranging from 1 = 'handy' to 5 = 'essential'.

GENERAL RESOURCES	**n= 29**	**mean score = 4.03**
RESPIRATORY RESOURCES	**n= 23**	**mean score = 4.97**
CIRCULATORY RESOURCES	**n= 25**	**mean score = 4.62**
MEDICATION	**n= 7**	**mean score = 4.73**
Respiratory		
Circulatory		
Neurological		
Intubation		
Anaphylaxis		
Infection		
Intoxication		

Continues next pages

GENERAL RESOURCES	MEAN SCORE (E.O.)
Pulse oximeter (adult/pediatric probes)	5.0
Oxygen delivery device with flow meter	5.0
Syringe pump (3x)	5.0
Suction pot (coupled on suction unit)	5.0
Protocolls/medicationlist	4.9
Non-invasive blood pressure monitoring	4.9
Heat lamp	4.9
Pressured suction unit (venturi)	4.9
Crash cart	4.8
Pressured air	4.8
Defibrillator with pediatric paddles	4.8
Telephone list medical personnel	4.7
Pupil reflex lamp	4.6
Clock	4.3
Cardiopulmonary monitor with pediatric capability	4.2
Resuscitation board	4.2
Bed side blood glucose gauge	4.1
Oxygen cylinder 2 liter (minimal 75 bar)	3.8
Wall chart	3.7
Spotlight	3.6
Spinal needles	3.5
Reflex hammer	3.3
Lumbar punction pressure gauge	3.1
Ear thermometer	3.0
Otoscope	3.0
Oxygen cylinder 10 liter (minimal 50 bar)	2.8
Ophthalmoscope	2.8
Esophagus thermometer	2.3
Weight scale	1.9
Total	116.9

RESPIRATORY RESOURCES	MEAN SCORE (E.O.)
Bag-valve-mask device: pediatric (450 ml) with oxygen reservoir	5.0
Bag-valve-mask device: adult (1000 ml) with oxygen reservoir	5.0
Bag-valve masks (infant, child and adult size)	5.0
Oral airways sizes 0 – 4	5.0
Laryngoscope handle large (with refill batteries en refill lamps)	5.0
Laryngoscope blades Straight/ Miller 0 en 1	5.0
Laryngoscope blades Curved/ McIntosh 1,2,3,4	5.0
Tracheal tube without cuff, size: 3,5	5.0
Tracheal tube without cuff, size: 4,0	5.0
Tracheal tube without cuff, size: 4,5	5.0
Tracheal tube without cuff, size: 5,0	5.0
Suction devices-catheters (Ch 6, 8, 10, 12 en 14)	5.0
Magill forceps pediatric	4.9
Magill forceps adult	4.9
Endotracheal intubation stylet (small)	4.9
Chest wall drains Ch 10, 12, 14, 16 en 20	4.9
Yankauer suction tube (mini)	4.7
Laryngoscope handle small (with refill batteries en refill lamps)	4.6
Tracheal tube without cuff, size: 3,0	4.6
Tracheal tubes with cuff: (at least 1, size > 7,0)	4.3
Tracheal tube without cuff, size: 2,5	4.2
Emergency crico thyrotomy device 3,5 en 6,0	4.1
Silicone spray / spray set	3.2
Total	114.3

CIRCULATORY RESOURCES	MEAN SCORE (E.O.)
Blood pressure cuff infant	5.0
Blood pressure cuff child	5.0
Intra venous canulas	5.0
Intra osseous infusion needle set (12 GA)	5.0
Intra osseous infusion needle set (15 GA)	5.0
I.V. fluids; crystalloid (e.g. NaCl 0,9 %)	5.0
Sterile syringe 1, 2, 5, 10 and 50 ml	5.0
Needles 19 x 1,5, 21 x 1,5, 23 x 1	5.0
Non sterile pair of scissors	5.0
Sterile surgical gloves size: 6.5, 7.0, 7.5, 8.0	5.0
Non-sterile surgical gloves size: small, medium and large	5.0
ECG electrodes, ECG cable	5.0
Disinfectants (e.g. chloorhexidine 0,5 % in alcohol)	5.0
Kocher stylet	4.9
I.V. administration sets	4.8
Rapid infusion bags (2x)	4.8
Vacutainers	4.8
Wound dressings	
(gauze swabs (5x5, 10x10), transparent dressings)	4.6
Sterile instruments (pincets, scissors)	4.6
Arm boards (2x)	4.5
I.V. fluids; colloid (e.g. Gelofuscine; HESS)	4.3
Sterile linen (e.g. coats, cloth)	4.2
Central venous Access devises	3.6
Port-à-cath needles	2.7
Butterflies	2.6
Total	115.4

MEDICATION		MEAN SCORE (E.O.)
Circulatory		5.0
Intubation		5.0
Anaphylaxis		5.0
Respiratory		4.9
Infection		4.8
Neurological		4.3
Intoxication		4.1
	Total	33.1

Addendum. MEDICATION GROUPS

Respiratory

- Adrenaline/Epinephrine
- Ipratropium
- Corticosteroids (Prednisolon/ Hydrocortison/ Dexamethason)
- Xylomethazoline
- Theophylline
- Salbutamol

Circulatory

- Adrenaline/Epinephrine
- Alprostadil (Prostin)
- Atropine (methyl atropine)
- deg. Calcium chloride
- Dopamine
- Dobutamine
- Furosemide
- Lidocaïne
- Sodium bicarbonate

Neurological

- Diazepam (Rectiole, I.V.)
- Difantoïne
- Mannitol 20%
- Naloxone
- Neostygmine/ mestinon
- Tiopentothal
- Phenobarbital
- Clonazepam
- Midazolam

Intubation

- Etomidate
- Thiopentothal
- Midazolam
- Vecuronium / rocuronium / atracurium
- Succinylcholine
- Fentanyl
- Ketamine

Anafylaxis

- Clemastine
- Corticosteroids

Infection

- Divers antibiotics

Intoxication

- Biperidene
- Flumazenil
- Naloxon
- Charcoal

Table 2

Analysis of the presence of all items per group in the Emergency rooms (ER) and Paediatric departments (PD) in the 15 district general hospitals in South West part of The Netherlands. The total number of points given by the intensivists was used as 'expert opinion' (see Table 1). These points were obtained by summing the score for the different items per group ranging from 1 - 5. This level was also used as a 100% level. The group of 'general resources' e.g. consisted of 29 items, having an expert opinion total score of 116.9 points.

Hospital number 4,6,8 and 13 only used their ER for treatment of critically ill children. All ER except one, were sufficiently equipped (>75% of the experts opinion) in comparison to seven out of the eleven PD. Only ten facilities (nine ER's and one PD) out of the total 26 had sufficient general resources at site. All facilities with an item level of presence below 75% of the optimum are collared.

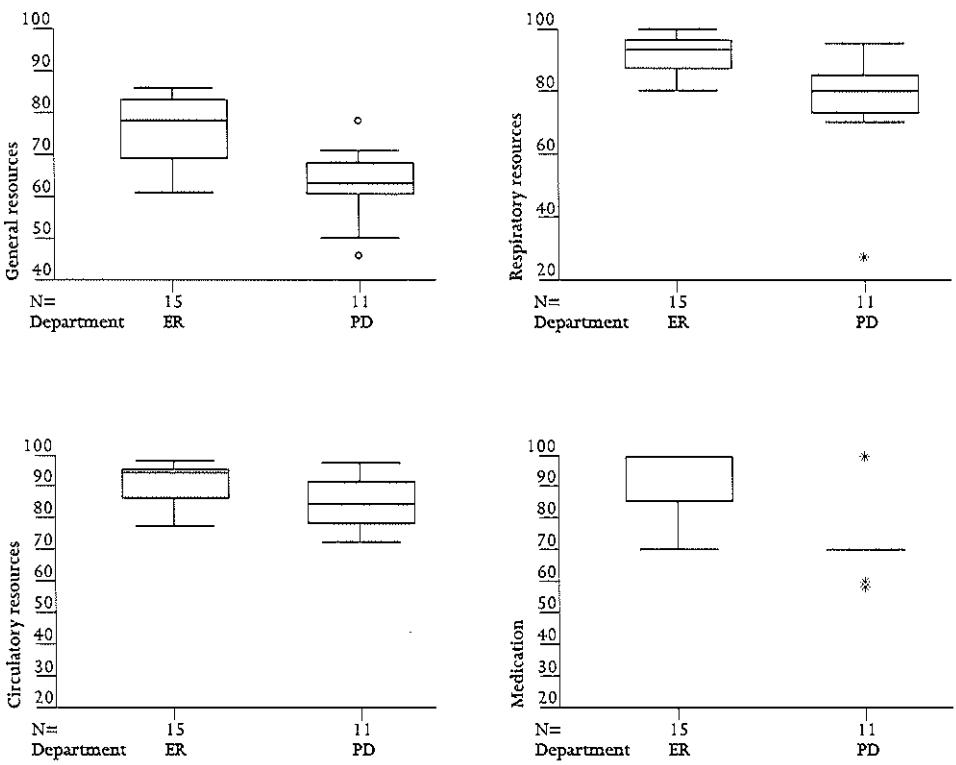
		Total (84)		Gen res (29)		Resp res (23)		Circ res (25)		Medication (7)	
		Pnt	%	Total pnt	%	Total pnt	%	Total pnt	%	Total pnt	%
Exp. opi:		**379.7**	**100.0**	**116.9**	**100.0**	**114.3**	**100.0**	**115.4**	**100.0**	**33.1**	**100.0**
Hospital:	**dept**										
1	ER	319.2	84.1	80.3	68.7	114.3	100.0	96.5	83.6	28.1	84.9
	PD	298.0	78.5	72.9	62.4	92.7	81.1	104.3	90.4	28.1	84.9
2	ER	306.9	80.8	80.0	68.4	99.7	87.2	99.1	85.9	28.1	84.9
	PD	299.1	78.8	74.5	63.7	106.4	93.1	90.1	78.1	28.1	84.9
3	ER	319.3	84.1	82.4	70.5	101.1	88.5	107.7	93.3	28.1	84.9
	PD	329.5	86.8	92.4	79.0	104.7	91.6	104.3	90.4	28.1	84.9
4	ER	284.0	74.8	71.6	61.3	90.0	79.5	99.1	85.9	23.3	70.5
	PD										
5	ER	314.6	82.9	74.0	63.3	99.8	87.3	107.7	93.3	33.1	100.0
	PD	290.3	76.5	82.7	70.7	82.5	72.2	97.0	84.1	28.1	84.9
6	ER	321.5	84.7	74.5	63.7	104.8	91.7	109.1	94.5	33.1	100.0
	PD										
7	ER	353.7	93.2	98.6	84.3	109.3	95.6	112.7	97.7	33.1	100.0
	PD	319.5	84.1	79.2	67.8	96.6	84.5	110.6	95.8	33.1	100.0
8	ER	320.6	84.4	99.4	85.0	99.6	87.1	88.5	76.7	33.1	100.0
	PD										
9	ER	347.1	91.4	95.5	81.7	109.4	95.7	109.1	94.5	33.1	100.0
	PD	259.1	68.2	58.7	50.2	80.1	70.1	92.2	79.9	28.1	84.9
10	ER	344.1	90.6	98.3	84.1	104.7	91.6	112.8	97.8	28.3	85.6
	PD	298.5	78.6	69.0	59.0	97.1	85.0	104.3	90.4	28.1	84.9
11	ER	319.2	84.1	96.1	82.2	95.1	83.2	94.9	82.2	33.1	100.0
	PD	264.7	69.7	79.1	67.7	83.2	72.8	83.2	72.1	19.2	58.0
12	ER	326.8	86.1	89.3	76.4	92.6	81.0	111.8	96.9	33.1	100.0
	PD	190.6	50.2	55.6	47.5	29.9	26.2	85.5	74.1	19.6	59.4
13	ER	357.0	94.0	100.5	85.9	114.3	100.0	109.1	94.5	33.1	100.0
	PD										
14	ER	338.3	89.1	91.4	78.2	107.0	93.6	106.8	92.6	33.1	100.0
	PD	274.5	72.3	73.9	63.2	82.8	72.4	89.7	77.7	28.1	84.9
15	ER	333.0	87.7	92.0	78.7	105.2	92.0	102.7	89.0	33.1	100.0
	PD	297.9	78.5	72.4	61.9	90.5	79.2	106.9	92.6	28.1	84.9

Figure 1

South West part of The Netherlands, encompassing 4 million inhabitants over an area of 8000 km² with one academic paediatric hospital.

Figure 2

Comparing the ER's and PD's of the hospitals with each other using the expert's opinion as an optimum identifies major differences. Data are given as median and 10th to 90th percentile. A difference in presence of all items in all groups could be found at the expense of the PD. There were significant differences between the ER and PD for the 'total groups', the general resource groups, the respiratory groups, the circulatory groups and the groups of medication (respectively 0.001, 0.004, 0.003, 0.038 and 0.003; asymp Sig; 2-tailed). The median of the level of presence of both facility types was, compared to the expert's opinion optimum, the lowest in the group of 'general resources'. For the ER the median of general resources, was 78.2%; for the PD 63.2%. For the total group these figures were respectively 84.7% and 78.5%. Some facilities were equipped even below the 10th percentile except for the 'circulatory resources' groups.



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CHAPTER 4

Critically ill paediatric patients in district general hospitals: who acts and where?

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Abstract

Objective: To study the organization around initial therapy of critically ill children in district general hospitals.

Design: Prospective study of the 'routing' of critically ill children in district general hospitals.

Setting: Fifteen major district general hospitals covering the South West part of The Netherlands.

Methods: By means of a questionnaire send to pediatricians in district general hospitals, consisting of the description of four patient cases with related questions. Three patients were sent to the hospital from outside and one child, who experienced convulsions, was already hospitalized. For the former three, representing an increasing level of expected severity of illness in the initial clinical condition, as given by patient cases of asthma, meningitis and near drowning, data were obtained concerning the site of initial therapy and the type of medical specialist who would provide initial care. Furthermore, information was gathered in case of deterioration of the clinical condition for all four cases: where were they being treated and by whom? Differences between disease categories were assessed. Also the 'routing' was studied of the different patients coming from outside the hospital ('external referral pattern') and the one who was already hospitalized on the pediatric ward ('internal referral pattern'); where they different? Finally, the referral pattern of intubated children was assessed, would they be transported towards the regional PICU or would they stay in the district hospital and if so, where would they stay?

Main results: In case of critically ill children entering a district general hospital during daytime having asthma, a suspicion of meningitis or near drowning, the Pediatric Department (PD) is in respectively 62%, 43% and 7% the primary site for initial contact.

For the Emergency Room (ER) these percentages were respectively 38%, 50% and 86%. In all hospitals a pediatrician would see a child with the suspicion of meningitis first (100%), in case of near drowning this occurred only in 57% of the hospitals. When respiratory insufficiency develops, anesthesiologists intubate all children, independently of the clinical disease causing the deterioration. Pediatricians indicated as possible locations for intubation the PD, ER as well as the Operation Theatre (OT) and the local Intensive Care ward (IC). Children who were already admitted on the PD because of convulsions and whose respiration becomes insufficient would be transferred in 36% of the hospitals to a specific location for intubation. This switch in location as a result of respiratory insufficiency was in the other 3 cases of a patient having asthma, meningitis and near drowning respectively 46, 29 and 0%.

The referral pattern for both the 'in- and outdoor ' patients was consistent in 50% of the hospitals, meaning that the initial site of the patient contact and the site of intubation in case of respiratory insufficiency was similar, regardless of the underlying disease. No specific difference in the 'routing pattern' between the groups of 'outdoor patients' and those already admitted could be found in the district hospitals. The route which critically ill children coming from outside, make, is very diverse, when the different hospitals are compared.

After intubation, in 86% of the hospitals the child would be transferred to the regional PICU. In the remaining 2 hospitals the child would be kept within the hospital itself.

Conclusions: The higher the expected level of severity of clinical condition is in critically ill children coming to the district general hospitals in the South West part of the Netherlands is, the lower the probability that the initial contact takes place on the Pediatric

Department. Similarly the pediatrician initially treats, on a severity scale, mild and moderately ill children, while other medical specialists primarily see severely critical ill children. The routing by pediatricians of the different critically ill children within these hospitals after initial contact contains an inconsistency in 50% of the cases, i.e.; the 'routing' from the initial site of patient contact towards the site of intubation was not similar for all cases. No specific difference in the 'routing' between the 'in- and outdoor patients' could be found in the district hospitals. The diversity of the different routes that the three 'outdoor' patients undergo within these hospitals is great. The vast majority of pediatricians would contact the regional PICU, in case of an intubated critically ill child, for further therapy in the tertiary center.

Key words
Children, Critically ill, General hospital, Medical Specialist

Introduction

Over. time, pediatricians have developed many techniques and methods to treat critically ill children. Since the introduction in the mid 1980's of this sub specialization of pediatric critical care by the American Board of Pediatrics, it has matured and developed greatly. The American Board and other pediatric societies worldwide developed, recommended and reviewed guidelines for the treatment of critically ill children[1-5]. At the same time, the technical capacity to monitor and treat such patients has also advanced rapidly. Along with these advances, there has been an evolution of pediatric intensive care units (PICU's) in tertiary care facilities. Pollack et al. showed a better survival chance when pediatric intensive care was provided in PICU's in tertiary hospitals than in non-tertiary care facilities[6]. In contrast to large countries such as the US and Australia, every citizen in the Netherlands can be in one of its eight tertiary centers within 45-60 minutes. However, many of those children are primarily seen in district general hospitals. In the Netherlands as in other countries, guidelines were provided for 'furnishing and equipping' pediatric emergency facilities in district general hospitals[7,8]. The presence of appropriate material and medication at the location where the initial treatment in those general hospitals is started, along with adequately trained personnel are regarded as essential in providing the necessary care for critically ill patients ('golden hour'). Wyszewianski (et al) once described this quality of care as 'Doing the right thing' and 'doing the thing right'[9]. Technical backup next to good quality of medical handling were major factors in 'doing the thing right'. To do 'the right thing', the presence of well-trained medical personnel is vitally essential. To support the medical personnel in district general hospitals in this aspect, guidelines were recommended by the different societies and associations worl-

dwide. The emphasis was put on adequate triage, referral and interfacility transport to pediatric critical care centers[4,7,10,11].

However a possible flaw in the organization of an optimal health care system for critically ill children is the fact that some general hospitals have no permanently designated pediatric beds for the critically ill and few, if any, staff dedicated exclusively to the management of such children. In these facilities, care for the critically ill is frequently provided by the general pediatricians or other health professionals with a wide range of pediatric training, skills, and experience. In the South West part of the Netherlands many of the district hospitals serve their communities, with a population base of around 250,000 inhabitants. To assess the internal referral network of district general hospitals as well as their external referral network, we performed a study in 15 district general hospitals in the South West region of The Netherlands to obtain data of the organization of initial health care regarding critically ill children, especially concerning the question 'who acts and where', using four patient cases. Our study is the first of its kind conducted in the Netherlands. Could a general referral pattern being found or are the patterns too diverse and could possible differences be explained by locally assigned conditions?

Giving an insight of the differences in organization might stimulate further development of regionalization and fine-tuning of critical care locally. Indirectly it can lead towards a better health care for those children needing critical care for the region as a whole, wherever they enter the health care system. Finally it may lead to adapted, appropriate regional guidelines, which can easily be implemented by hospitals to ensure a high quality emergency care for all critically ill children of the region.

Materials and methods

The study was conducted in 1999 in the 15 major district general hospitals of the South West part of the Netherlands, encompassing 4 million inhabitants over an area of 8000 km^2 with one academic hospital. In order to obtain data regarding the organization in these hospitals, a questionnaire was sent to the 15 different pediatric groups working in these hospitals. They were asked, by means of an accompanying letter, to cooperate by answering the questions and returning the questionnaire by mail. As agreed upon beforehand in the accompanying letter, all returned questionnaires would be analyzed anonymously. The content of the questionnaire consisted of the description of four imaginary patient cases, three coming from outside the hospital during a normal weekday and one who was already hospitalized. The three cases represented an increasing level in expected severity of illness in the initial clinical condition from mild, moderate towards severe, and were represented by cases of asthma, meningitis and near drowning. For the 'mild' case, a 2 year old, send by a general practitioner with a 'deterioration of asthma' was chosen. For the 'moderate case', a 4-year-old patient, send by a general practitioner was chosen with the suspicion of having meningitis, while a 2-year-old boy with a near drowning served as the 'severe' case. Paramedics announced the child's arrival during transport towards the hospital. The questions concerning a hospitalized child were related to the case of a 2-year-old boy, admitted on the Pediatric Ward the day before because of convulsions. Each case consisted of a short patient history, with related questions such as which medical specialist would see the patient first and also the location where the patient would initially be seen (Table 1 and 2). The same questions were asked in case of a deterioration of the clinical condition of the four patients. For the answer the questionnaire

offered 4 and 6 options respectively (see Table 2), regarding who would see the child and at which location. Differences between the hospitals regarding the type of specialist, disease category, location of initial and further patient contact and 'internal' and 'external referral' in case of a clinical deterioration, were assessed.

The cases of asthma, meningitis and near drowning were used to track down the 'routing' i.e. location of first contact until the location of intubation. Not only differences between the 15 hospitals could be obtained in this respect but also the 'internal' referral patterns could be assessed concerning the different diseases. Does it matter for the internal referral pattern if a patient with a meningitis or a patient with an exacerbation of asthma become respiratory insufficient? The same cases also served to give an insight in who would intubate at the different locations when a child becomes respiratory insufficient. Does this depend on the disease category? Does it depend whether or not a child is already hospitalized? The fourth patient, the child who was already hospitalized served in answering this question. Is there a difference in the 'internal' referral pattern between 'in- and outdoor' patients? Finally to track the 'routing' of a critically ill child after intubation an extra question concerning the patient with a near drowning was introduced: the location after intubation. Does a seriously ill child like the one with near-drowning stay in the local hospital after intubation and if so where, or is the child directly transported from the location of intubation towards the regional PICU?

Analysis of the answers of the questionnaire provides a general assessment of the infrastructure of care in the region. With all the guidelines, published in the past with the purpose to ensure a high quality emergency care for critically ill children, this study gives an insight in the practical aspects of initial health care in district general hospitals.

Results

All the pediatricians, except one group, who were asked to cooperate (n=15), returned the questionnaire within three weeks. All the questionnaires (n=14) were returned completely, except one. The pediatricians of hospital number 3 did answer all the questions, except the asthma patient questions (Table 3). Analyzing the questions 'who acts and where' regarding the different 'outdoor patients', showed major differences between the hospitals (Table 4 and 5). In the way the questions in case 1 were posed, a pediatrician primarily sees all 'outdoor asthma patients', while as can be seen in Table 4, this was left open in the case in patients with the suspicion of having meningitis. The result shows that also in meningitis cases the pediatrician is the first to see the child. However, a child suffering from near drowning is initially seen by anesthesiologists in 29% of the hospitals and by emergency physicians in 14% of the hospitals. When indicated, anesthesiologists intubate all children who need endo tracheal intubation.

The majority of the 'mild' patients represented by the asthma patient, is primarily seen in the Pediatric Department (PD, 62%), the remaining 38% go to the Emergency Room (ER) for initial treatment (Table 5). Nor the outdoor patient department (OPD), or the operation theatre (OT), or the local intensive care (IC), or the regional PICU, were indicated as primary emergency sites for asthma.

In patients with meningitis, the referral pattern is slightly different. Half of these patients would first be seen in the Emergency Room (ER, 50%) while 43% would be seen in the PD. It is interestingly to see that pediatricians in one hospital (number 11, see Table 3), have the policy to see children with the suspicion of meningitis first in their outdoor patient department (7%). The

OT, IC, nor the regional PICU would be used as initial emergency sites. Nearly all patients suffering from near-drowning, seen as a severe critical illness, would be seen in the ER (86%), only the pediatricians of two hospitals (respectively number 4 and 12, Table 3) would see them on their PD or on their Intensive Care for adults (IC). The OPD, OT, nor the regional PICU were indicated as primary emergency sites.

Assessing the 'routing' or 'internal referral pattern' of the 'mild' patients it is obvious that 4 out of the 5 hospitals (number 7,8,9,13 and 14) where asthma patients would initially be seen on the ER, a transfer to the PD follows in case of necessity for further monitoring and therapy (Table 3). This makes the total percentage of asthma patients admitted on the PD for further therapy and monitoring 92%. Only in hospital number 8, such a patient would stay on the ER, even when intubation is needed. In 50% of the hospitals where a child having asthma becomes respiratory insufficient, would be sent from the PD towards another location. Pediatricians in two hospitals where children initially were transferred from the ER towards the PD, even considered to move these children back to the ER (hospital 7 and 13). In four other hospitals (number 2,6,9 and 12), children were transferred towards the operation theatre (OT) for intubation. In conclusion, in 6 of the 13 hospitals, the location of intubation was different than the initial site of patient contact (46%).

Assessing the 'routing' for the patients considered having meningitis, results indicate that, comparable to those having asthma, in 4 hospitals pediatricians would decide to transfer such patients for further monitoring and therapy away from the initial site of patient contact, towards the PD (hospital number 8,9,11 and 14). The only difference with those children having asthma is that one of these four children did not originate from the ER but

from the outdoor patient department (hospital number 11). This makes the total percentage of meningitis patients admitted on the PD for monitoring and further therapy 71%. In case of respiratory insufficiency, pediatricians in four of the fourteen hospitals considered transfer away from the location of further monitoring and therapy when respiratory insufficiency was imminent (29%). The percentage of hospitals in which the site of intubation was different than the site of initial contact was also 29%.

Like in asthma patients, in case of the necessity for intubation, pediatricians in two hospitals where children were initially transferred from the ER towards the PD even considered to move those children back to the ER (hospital 9 and 14). However, in contrast to the asthma cases, the hospitals were different. The pediatricians of hospital number 14 would transfer the patient having meningitis back to the ER, in contrast to a patient having asthma, who would stay for intubation in this hospital on the PD. For these two types of patients, the location of intubation in hospital number 12 was also different. Here asthma patients are sent to the operation theatre for intubation, the ones having meningitis are intubated on the local intensive care, primarily in use for adult patients. Only in hospital number 2, the 'routing' is identical for both type of patients.

Assessing the 'routing' for the patients having near drowning, not one of the pediatricians considered transfer of such a patient when intubation was needed. All patients would stay in the initial site of patient contact (100%). In hospital number 4 this was the PD, in number 12 the local IC and in the remaining hospitals the initial site was the ER. It is of interest to see that children in hospital 2 suffering from asthma and meningitis would have been intubated on the OT and in case of near drowning on the ER.

Assessing the 'internal referral pattern' for the 'in- and out-

door' patients with a clinical deterioration, differences between the different hospitals can be found. In hospital number two, all 4 critically ill all children are kept on the initial emergency site (PD), when deterioration in their clinical condition happens. In general, children who were already admitted on the PD having convulsions, whose respiration became insufficient, would be transferred in five of the fourteen hospitals (36%). This switch in location, compared to the initial site of monitoring, was in case of a patient having asthma, meningitis and near drowning respectively 46, 29 and 0%. No specific difference in the 'routing pattern' between the groups of 'outdoor patients' and those already admitted could be found in the district hospitals. The diversity of the 'routing' of the different 'outdoor' patients' within these hospitals was very great.

Assessing all hospitals, in 7 out of the 14, the referral pattern for both the 'in- and outdoor' patients, independent of severity of disease, were consistent (50%). This means the steps from the initial site and the site of intubation was similar (hospital number 1,2,3,4,5,6,10). In the others there was at least one inconsistency in the policy of referral of the different children from and to the different sites. For example, the children who need an intubation in hospital number 12, were, when started on the PD, intubated either on the OT or on the IC. Whereas in hospital number 14, the patients who need intubation when started on the ER would go to either the PD or would stay on the ER.

Finally, assessing the 'routing' of a critically ill child after intubation the results show that all, except two (number 2 and 4) pediatricians involved in the intubation in the different hospitals would, transfer the intubated child towards the regional PICU. However, in hospital number 2, the child would go to the local IC, and in hospital number 4 the child would stay on its PD.

Discussion

Depending on the expected seriousness of the initial clinical presentation; the first contact with critically ill children in district general hospitals in the South West part of the Netherlands will, in case of 'mild' and 'moderate' illness such as asthma and meningitis respectively, be handled by pediatricians. In 'severe' cases such as near drowning, the pediatrician would share this task with other medical specialists. Interestingly anesthesiologists perform all endo tracheal intubations in pediatric patients. The location were an initial patient contact during daytime takes place is in 'mild' and 'moderate' cases the Pediatric Department, in 'severe' cases the Emergency Room. The referral pattern by pediatricians of the different critically ill children after initial contact within these hospitals contains an inconsistency in 50% of the cases, i.e. the 'routing' from the initial site of patient contact towards the site of intubation was not similar. No specific difference in the 'routing' between patients coming from outside the hospital versus those already admitted could be found in the district hospitals. The variation in the 'routing' of the different patients having asthma, meningitis or near drowning within these hospitals was great. A vast majority of pediatricians would contact the regional PICU, in case of an intubated critically ill child, for further therapy in the tertiary center.

All Pediatric practices in the region, except one, who were asked to cooperate, returned the questionnaire. The reason why a single group did not return the questionnaire was not indicated. All returned papers were filled in properly except in one case. These pediatricians probably overlooked one aspect of the questionnaire. The answer to the question 'who acts and where' within a district general hospital is very diverse. In general, children having asthma and meningitis are initially being seen by pediatri-

cians. For those suffering from near drowning this was only the case for approximately half of the pediatricians working in the South West region of the Netherlands. It suggests that pediatricians feel comfortable in the initial treatment of asthma and meningitis, but much less in near drowning. Pediatricians tend to rely more on anesthesiologists or emergency physicians in a case of near drowning. Of particular interest is that all pediatricians will ask anesthesiologists for the intubation, although some indicate that they will work together with anesthesiologists during intubation. In contrast to intubation of older children, pediatricians are well trained to intubate newborns in district general hospitals.

Recently published guidelines by the American Academy of Pediatrics regarding: 'Facilities and equipment for the care of pediatric patients in a community hospital' do not assign a type of medical specialist for the initial contact or care of critically ill children[8].

In practice and as showed by this study, critically ill children are initially seen both on the ER as well as in the PD. It is of interest that a recent study, showed a significantly better inventory of the equipment to treat critically ill children on the ER than on the PD of these hospitals (submitted).

When the respiration of a child in a district general hospital becomes insufficient, the child is intubated by one of the local anesthesiologists. Using the skills of an anesthesiologist in such cases is justifiable. However, the proportion of critically ill children, transported towards another location in case of the necessity of intubation, is relatively high. This study shows that pediatricians within the same hospital act differently when children have asthma, meningitis or convulsions and that they are transported to other locations for such a treatment (respectively in 46%, 29% and 36% of the cases). Only those suffering from

near drowning were considered to be that ill that a transfer was not attainable.

Such 'internal' transfers are quit common in community hospitals but not mentioned in published guidelines[7,8,12,13]. The differences in inventory between the diverse emergency sites must be a reason for those transfers. The importance of this aspect of the organization of health care must be emphasized in such guidelines. A primary site for emergency care that is well equipped is a prerequisite for optimal care in the first minutes and hours in the care of critically ill children. Regardless of the underlying disease the sequence of events should be more or less similar within one hospital.

A diversity of emergency sites (PD, ER, OT and local IC) was indicated as the place where intubation of respiratory insufficient critical ill children could take place. This diversity indicates that a unification in categorization and regionalisation of pediatric emergency facilities to form an 'emergency medical service' system within a region to optimize health care for those critically ill, is quit necessary. Local circumstances create local solutions for the best treatment of critically ill children. However, finding such diversity in the studied region does raise the question whether improving and unifying those 'local circumstances' can optimize the quality of care for such children. The finding that in only 50% of the district hospitals, the referral pattern of both the 'outdoor' as well as the 'indoor' patients was performed consistently, indicates the need for such an unified approach.

Finally, this study indicates that a vast majority of intubated children in the South West region of the Netherlands are sent to the regional PICU after the intubation (86%). However, different locations were indicated where the child would stay when intubated, waiting for the transport to the PICU. The differences in

local emergency settings and staff in the district general hospitals might explain the different answers but indicates again the necessity to come to the organization of a framework for a rational system that is flexible enough to accommodate local circumstances in the initial care for critically ill children.

In summary, the organization around critically ill children should be well designed and very consistent. All these children should preferably be seen in one well equipped emergency location and within one hospital the 'routing' of critically ill children should always be the same, especially when life threatening situations occur such as respiratory insufficiency needing intubation.

Table 1

Four patient cases and the related questions as used in the questionnaire sent to the local pediatricians, to assess practical aspects of health care for critically ill pediatric patients in the district general hospital of the region.

Case 1,2,3 were patients coming from outside the hospital. They represented an increasing level of expected severity of illness at initial clinical presentation, from mild (asthma), moderate (meningitis) towards severe (near drowning). Case 4, the child with convulsions, was already hospitalized. The type of questions and answering possibilities are explained in Table 2.

Case 1. A general practitioner (GP) calls you at daytime, asking for your opinion about a 2-year-old child with, in his opinion, a deterioration of 'his asthma'. He thinks the child needs oxygen and further medication and asks you where to send the boy.
Question: A.
After clinical evaluation, the clinical condition deteriorates.
Question: C
The clinical condition worsens and during physical examination a 'silent chest' is found. The respiration becomes insufficient and there is a need, in your opinion, for endotracheal intubation.
Question: E, F

Case 2. A general practitioner (GP) calls you at 02.00 p.m. on a normal working day while you just started to see your patients at the outpatient clinic. A 4-year-old child with its parents is 'on its way' to the hospital because of the suspicion of having meningitis. Because of the fact that they do 'live near the hospital', he decided 'not to wait for the ambulance services' but 'to send them straight away using the parent's car'. He asks where he has to send the child?

Question: A, B
Clinically the child has signs of meningitis and during physical examination, two petechiën are seen on one leg.
Question: C, D
After a while, the child looses its conscious, more petechiën are being seen and the child becomes respiratory insufficient. There is a need for endotracheal intubation.
Question: E, F

Case 3. A paramedic calls you during ambulance transport concerning a 2-year-old boy with a near drowning who is unconscious and who 'starts to become respiratory insufficient'. They are within minute's reach of the hospital. It is 11.00 a.m. on a routine working day.
Question: A, B.
There is a need for endo tracheal intubation.
Question: E, F, and G

Case 4. A nurse working on the pediatric ward calls you at 11.00 a.m. on a routine working day, concerning a 2 year old boy, hospitalized for observation the day before because of an atypical convulsion and fever. He just started to have convulsions again, already lasting more than 15 minutes, and these continued even after one dose of an anti convulsive drug. Monitoring showed transcutanously measured SaO2 of 90%.
Question: B
The clinical condition deteriorates.
Question: C
After a second appropriate dose of the drug, the convulsions cease but the transcutaneously measured SaO2 still stays 90%.
Question: D

The child clinical condition deteriorates and endotracheal intubation will be necessary because of respiratory failure.
Question: E, F

Table 2

Questions were separated in 4 levels: 'first contact', 'further monitoring', 'intubation' and 'post intubation'. The answering possibilities are listed by location (questions A,C,D,F,G) and the type of 'medical specialist' (question B,E).

Questions: **First contact**

A. Location initial patient contact.

B. First medical specialist to see the child

Further monitoring after deterioration of clinical condition.

C. Location of further monitoring

D. Location of further therapy

Endotracheal intubation

E. Medical specialist who will intubate

F. Location of intubation

Post intubation

G. Location of monitoring and therapy after the intubation

The answering possibilities used in the questionnaire in the four patient cases

Location:

PD. Pediatric department
ER. Emergency department
OPD. Pediatric outdoor patient department
OT. Operation theatre
IC. Local intensive ward (used for adults)
PICU. Pediatric IC Unit (in Academic Center)

Medical specialist:

P. Pediatrician
A. Anesthesiologist
E. Emergency care physician
O. 'other physician'

Table 3

List of answers as given by the pediatricians of 14 district general hospitals in the South West part of the Netherlands. First of all, the answers are shown concerning those children coming from outside the hospital ('outdoor patients') increasing in expected level of severity of the initial clinical presentation, from mild, moderate towards severe as represented by the case of asthma, meningitis and near drowning. Finally the answers concerning the child having convulsions ('indoor patient') are shown. The pediatricians of hospital number 3 did not answer all the questions. Only the answers concerning the asthma patient were not given.

Per hospital the answers to the questions per patient case is shown. The questions per patient case are referred to by A,B,C,D,E or F as explained in Table 1 and 2.

Changes in location in case of deterioration of the clinical condition are indicated as 'primary change' when the child is being transferred to another facility after initial contact. The term 'secondary change' is related to the transfer of a child towards the location where the endo tracheal intubation takes place

Patient:	Asthma				Meningitis						Near-drowning					Convulsion				
Question:	A	C	E	F	A	B	C	D	E	F	A	B	E	F	G	B	C	D	E	F
Hospital																				
1	PD	PD	A	PD	PD	P	PD	PD	A	PD	ER	E	A	ER	IC/PICU	P	PD	PD	A	PD
2	PD	PD	A	OT	PD	P	PD	PD	A	OT	ER	A/P	A	ER	IC	P	PD	PD	A	OT
3					ER	P	ER	ER	A	ER	ER	P	A	ER	PICU	P	PD	PD	A	PD
4	PD	PD	A	PD	PD	P	PD	PD	A	PD	PD	A/P	A	PD	PD	P	PD	PD	A	PD
5	PD	PD	A	PD	PD	P	PD	PD	A	PD	ER	P	A	ER	PICU	P	PD	PD	A	PD
6	PD	PD	A	OT	ER	P	ER	PD	A	ER	ER	P	A	ER	IC/PICU	P	PD	PD	A	OT
7	ER	PD	A	PD/ER	ER	P	ER	ER	A	ER	ER	A/P	A	ER	PICU	P	PD	PD	A	PD
8	ER	ER	A	ER	ER	P	PD	PD	A	PD	ER	P	A	ER	PD/PICU	P	PD	PD	A	PD
9	ER	PD	A	OT	ER	P	PD	ER	A/P	ER	ER	A/P	A/P	ER	ER/PICU	P	PD	PD	A	IC
10	PD	PD	A	PD	PD	P	PD	PD	A/P	PD	ER/IC	E	A/P	ER	PICU	P	PD	PD	A	PD
11	PD	PD	A	PD	OPD	P	PD	PD	A	PD	ER	P	A	ER	PICU	P	PD	PD	A	PD
12	PD	PD	A	OT	PD	P	PD	PD	A	IC	ER/IC	P	A	IC	PICU	P	PD	PD	A	IC
13	ER	PD	A	ER	ER	P	ER	ER	A	ER	ER	P	A	ER	ER/PICU	P	PD	PD	A	OT
14	ER	PD	A	PD	ER	P	PD	PD	A	ER	ER	P	A	ER	IC/PICU	P	PD	PD	A	PD

PD = Prim change

OT = Sec. Change

Table 4

Emergency site indicated by the pediatricians, as the location of choice for the treatment of children suffering from asthma, meningitis, near drowning and convulsions. The results are given in absolute numbers of hospitals as well as percentages in parenthesis. An indication for sites was asked at 'first contact', for 'further monitoring', in case of 'endo tracheal intubation' and for monitoring and treatment in the 'post intubation' phase. Possible answers were: PD=pediatric department, ER=emergency room, OPD=outdoor patient department, OT=operation theatre, IC=local intensive care ward, PICU=pediatric intensive care unit in the tertiary center.

Table 5

Type of medical specialist, related to the phase of therapy and clinical condition, given as possible answers in the questionnaire. The results are given in absolute numbers of hospitals as well as their corresponding percentages (P=pediatrician; A=anesthesiologist, E=emergency physician, O=other type of medical specialist). In the case of asthma, 13 pediatricians responded, in the other cases 14.

Table 4 Emergency site

	First contact				Further monitoring			Intubation				post-intub
	Asthma	Meningitis	Near-drowning	Convulsion	Asthma	Meningitis	Convulsion	Asthma	Meningitis	Near-drowning	Convulsion	Near-drowning
PD	8 (62%)	6 (43%)	1 (7%)	14 (100%)	12 (92%)	10 (71%)	14 (100%)	7 (54%)	6 (43%)	1 (7%)	9 (64%)	1 (7%)
ER	5 (38%)	7 (50%)	12 (86%)	0	1 (8%)	4 (29%)	0	2 (15%)	6 (43%)	12 (86%)	0	0
OPD	0	1 (7%)	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	4 (31%)	1 (7%)	0	3 (21%)	0
IC	0	0	1 (7%)	0	0	0	0	0	1 (7%)	1 (7%)	2 (14%)	1 (7%)
PICU	0	0	0	0	0	0	0	0	0	0	0	12 (86%)

Table 5 Medical specialist

	First contact				Intubation			
	Asthma	Meningitis	Near-drow	Convulsion	Asthma	Meningitis	Near-drow	Convulsion
Pediatrician	13(100%)	14(100%)	8(57%)	14(100%)	0	0	0	0
Anesthesiologist	0	0	4(29%)	0	13(100%)	14(100%)	14(100%)	14(100%)
Emergency physician	0	0	2(14%)	0	0	0	0	0
Other specialist	0	0	0	0	0	0	0	0

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CHAPTER 5

Admissions of critically ill (non-neonatal) children to a district general hospital: a prospective study of the number and patient characteristics

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Abstract

Objective: To assess the number and characteristics of critically ill children, presented with or without announcement, from a defined area of the Netherlands to a district general hospital.

Design: Prospective analysis of patient characteristics and hospital data of all critically ill children admitted to all emergency sites in one hospital and their follow up during the first 24 hours after admission.

Setting: The district general hospital of Delft (covering 200 km², 0.5 % of The Netherlands) in the Southwest region of the Netherlands during the year 2000.

Measurements: Of all children, characteristics like age, sex, race and position in the family was assessed. In addition, attention was given to the period before arrival in the hospital i.e. the location of origin of the critically ill child, the referral pattern and the duration of the period of recent illness. Information was obtained to assign a disease category as well as the type of transportation. Upon arrival specific admission characteristics were gathered like admission location and type of medical specialist or resident who would act first. Finally, 3 and 24 hours after admission, further information was obtained regarding the physical condition of the child, the disease category and the child's actual location. The national statistic office and all city councils provided demographic information.

Main results: Out of a population of 36,000 children below the age of 18 years per year, 70 were admitted because of a critical illness. The mean age of this group was 4.2 years, the youngest 4-month old, the oldest 16 years. The vast majority were of Caucasian origin (n=54, 77%) and 38 were boys (54%). Most frequently, the children were the second child in the family (47%) with a first-born frequency of 30%. Of the group of non-

Caucasian children, 50% of the parents could not speak the Dutch language properly. Most children were brought in from their homes (n=53, 76%). The majority of all children was transported by ambulance (n=44, 63%), the others by family cars (n=25, 36%, 1 % unknown). For the referral pattern, parents of 17 (24%) children decided to go to the hospital themselves, by family car, while the others were referred by paramedics (n=26, 37%), General Practitioners (GP, n=23, 33%) or other physicians (n=2, 3%) with 2 (3%) unknown. No statistical difference was found in time interval of onset of illness and initial contact in the hospital in relation to race, control of the Dutch language and position of the child in the family. At admission most children had neurological problems or suffered from trauma (both 31.4%). Circulatory problems were the main reason in 14 cases (20%), respiratory problems in 12 (17%). Most children were initially seen in the Emergency Room (ER) (n=56, 80%). A Senior House Officer was in 85% of the cases the first doctor to see the child. 'Paediatrics' was the first specialism in the initial contact in 84% (n=59) of the children, 'Surgery' in 10% (n=7) and 'Neurology' in 3% (n=2). After three hours, most patients were transported to the Paediatric Department (PD), only 5 out of the initial 56 were still on the ER. Twenty-four hours after admission, 5 (7.1%) were hospitalised in the regional Paediatric Intensive Care Unit (PICU), 31 (44.3%) were send home, 2 (2.8%) died within the district hospital (sepsis) and 32 (45.8%) were still hospitalised in the Paediatric Department.
Conclusions: From a defined area in the SW part of the Netherlands per year, 0.2% of the children below 18 years were admitted to a general hospital as critically ill. No statistical difference was found in time interval of onset of illness and initial contact in the hospital in relation to race, control of the Dutch

language and position of the child in the family. Based on this and an earlier study regarding the number of children directly transported to a PICU, we calculate that per year, directly or indirectly, 44 children out of every 100,000 children under 18 year's are so critically ill that they need to be admitted to a regional PICU. Of this group, 14 (32%) were initially admitted to the district general hospital, needed an urgent, secondary inter-hospital transport towards the PICU.

Key words
Children, critically ill, transport, general hospital.

Introduction

In rural, as well as in non-rural areas, many critically ill children are admitted to local hospitals, which provide different levels of care and, in the majority, lack paediatric intensive care facilities. In the last decade the health care system has been challenged more and more to identify the services and providers that offer the best value to those who are ill[1]. Paediatric societies, major health care insurance companies as well as different governmental organisations are in need of data to quantify the patient needs and especially the effects of the different medical interventions at the different locations. The ultimate goal of these efforts is a well-organised regional system to offer the best for those critically ill children, wherever they enter the medical system. However, the accuracy of currently available databases, which were not primarily designed to answer these questions, is frequently unreliable. Lack of objective, evaluative data has even been cited as a serious obstacle to health care reform, both in the US as well as in the Netherlands[2,3].

The answer to the question how many critically ill children per year are urgently transported by ambulance, out of a defined area towards either a district general or to the regional Academic hospital was recently provided by a retrospective study (submitted). Out of a population of 58,000 children with an age below 18 years, we found that 17 (3.7%) were directly transported towards the regional Paediatric Intensive Care Unit (PICU) per year because of critical illness. Bases on the same data, the number of children per 100,000, transported by ambulance per year who were that ill that their initial treatment could be seen as 'golden hour' was calculated. Including those transported directly to the PICU, 235 were critically ill and in such a condition that the first hour of their treatment could be considered as crucial for survival

('golden hour'). This means that approximately 0.23% of the total population under 18 years per year are critically ill.

To obtain data regarding the effective preparedness, in terms of the inventory of diverse emergency sites within district general hospitals as well as the type of medical specialist who would 'acts first', other studies were recently performed in 15 community hospitals of the Southwest part of The Netherlands (submitted).

To confirm the findings of the retrospective analysis and to obtain further information concerning the total group of all critically ill children admitted to a district general hospital, a prospective study was initiated.

Where most of them presented by ambulance? By who were they send or did they come on their own initiative? Was there any delay in referral as a result of inadequate control of the Dutch language or because of the racial background or the position of the child in the family? When hospitalisation followed, where were the children after 24 hour? These data are important in the calculation of the number of Paediatric Intensive Care beds in the PICU units for the region as well as the Paediatric Emergency Transport Facilities, necessary to serve the regional community in given the best medical care for their most ill children. Such information is also relevant for policy makers in planning resources and facilities.

Materials and methods

The study was conducted throughout a one-year period, from December 1999 till December 2000. The study was conducted in the Reinier de Graaf Gasthuis in Delft, which serves as a district general hospital for the city of Delft and its surrounding villages. The region can be considered as average for the Netherlands (age, mean income, health statistics, education), has a population of

277,000 inhabitants on 200 km² (0.5% of the countries area). The hospital has 700 beds; 21 on the Paediatric ward with an extra 18 incubator and 10 cots on the neonatology ward. The number and characteristics of all critically ill children with an age of at least 2 weeks till 18 years, transported (by every means) and presented, with or without announcement, to a district general hospital were studied. Children with an age of less than two weeks were excluded to focus on the group of older critically ill children. Neonatal transports are well organised and evaluated in the Netherlands while Paediatric transport of older children is not. 'Critically ill' was defined as the need of using equipment and/or medication from a 'crash car' for the initial treatment of the patient as judged by an experienced physician, in other words following ALS procedures ('golden hour'). Of all critically ill children, transported by any means to the hospital, different characteristics were gathered like age, sex, race, and child number in the family and control of the Dutch language. Concerning the pre-hospital period, different characteristics were studied like referral pattern, duration of the recent illness and transport characteristics like the type of transport vehicle. The location where the children entered the hospital, Emergency Room (ER), Paediatric Department (PD) or other location, were studied as well as the type of doctor and medical specialist who 'would act first' during the initial treatment. At arrival and after 1 and 3 hours after admission, further information was gained like the physical condition and location of the child and the disease category. Finally, 24 hour after the admission, extra information was obtained concerning the child's physical condition and disease category and its location, was he or she hospitalised and if so, in the Paediatric Department or in the regional Academic Paediatric Intensive Care Unit (PICU). In order to increase the completeness of data collec-

tion one of the two supervising investigators checked all forms within 24 hours of admission. Unfortunately, there is no consistency in diagnostic categories used in the classification of vitally unstable patients in the different published studies[4,5]. We used the classification: respiratory (including asthma and pulmonary infection), circulatory (including sepsis and cardiac arrest), neurological (including convulsions) and trauma (including head and surgical trauma). By using the referral percentages of all general practitioners (GP) working in the region in and around Delft to the outpatient department of our district general hospital, we were able to calculate a population out of which we received our urgent transports. This figure was used, together with data of the retrospective study, to obtain the total number of critically ill children per 100,000 per year, needing hospitalisation on a PICU ward per year. Also the number of children needing secondary inter-hospital transport towards the PICU per 100,000 per year was assessed. The hospital institutional review board approved the study. Statistical analysis of the results was performed using chi-square tests.

Results

The study region of Delft and its surroundings has a population of around 277,000 inhabitants (1.8% of the country's population) and should be considered as a densely urbanised part of The Netherlands. In the study period, around 58,000 (21%) had an age below 18-years. Using the correction factor of the referral pattern in the region, we could define the size of the group of children out of which admissions to our hospital followed as 36,000. The total number of children, who were critically ill at admission to the hospital, was 70 (0.2%), 38 of them were boys (55%), 32 girls (45%). The mean age of the group was 4.2 years

with a median of 2.2 years. The youngest was 4 month-old, the oldest 16 years. The majority of children had a Caucasian background 54 (77%), the other racial backgrounds were very different with the second largest group being Turkish children, 4 (6%). Assessing the position of the child within the family, 21 (30%) were first-borns; 33 (47%) second born, while 6 (9%) were the third child in their families. The majority of parents of the critically ill children could speak the Dutch language well (n=62; 86%). On the other hand, of those of non-Caucasian origin, 50% could not speak the Dutch language properly. Most children were brought in from their homes (Figure 1). Others were picked up from the street or came from another location like a school with 2 children with an unknown origin. The majority (see Figure 1) was transported by ambulance; 44 (63%), the others by family car, 25 (36%) with 1 unknown. The General Practitioner (GP) of the family referred 23 of the 70 children, of whom 8 came by family car (35%) and 15 (65%) by ambulance (see Figure 1). Parents of 17 children (24%) decided to go to the hospital themselves, by family car, without referral by a physician. Paramedics of the ambulance referred twenty-six children (37%). Of 2 children, the person who referred the child was missing. Assessing the duration of the time interval from the start of the recent illness for which they seek help until arrival in the hospital, the results showed that for 46 children (66%), this time interval was less than one hour. Fourteen children (20%) had a time interval longer than one hour but shorter than one day; 9 (13%) longer than one day but shorter than 1 week and one child already suffered from the recent illness longer than 1 week. At admission 12 children (17.1%) had respiratory problems like pneumonia, 14 (20.0%) circulatory problems like hypotension, 22 (31.4%) neurological problems like convulsions and 22 chil-

dren suffered from a trauma (31.4%). These numbers did not change after three hours of admission.

Most children (n=56, 80%) arrived at the Emergency Room (ER), the others (n=14, 20%) were first seen on the Paediatric Department (PD) or Out Patient Department. A Senior House Officer (SHO) was in 85% (59) of the cases the first doctor to see the child. In 7% (5) this was a Consultant (C) and in 6% (4) both the C and SHO saw the child during the initial moment. For two children no data was available. Looking at the background of the initial doctors medical specialism, 'Paediatrics' was the first to look at the child in 84% of the cases (n=59), 'Surgery' in 10% (n=7), Neurology in 3% (n=2) and for two children this could not be traced.

After three hours of therapy only 5 of the initial 56 children brought to the ER were still there, the majority of children were transported and hospitalised in the Paediatric department.

Twenty-four hours after admission, 5 children (7.1%) were hospitalised in the regional Paediatric Intensive Care Unit (PICU), 31 children were sent home (44.3%), 32 were still hospitalised in the Paediatric Department (45.8%) and two (2.8%) died. These two children died in the first hours after hospitalisation due to sepsis, not reacting to adequate therapy. When still in the PD after one day, 12 children (17.1%) still needed respiratory support like oxygen, and 11 children (15.7%) needed circulatory support like medication or I.V. fluids.

Discussion

In a defined area in the SW part of the Netherlands, 0.2% of the children below 18 years were admitted to a general hospital as critically ill per year. No statistical difference was found in time interval of onset of illness and initial contact in the hospital in

relation to race, control of the Dutch language and position of the child in the family. Based on this and an earlier study we calculate that per year, directly or indirectly, 44 children out of every 100,000 children (0.044%) under 18 year's need an admission on a PICU, within the first 24 hours after entering the medical system in case of critical illness. Of this group, 14 who were initially seen in the district general hospital needed an urgent, secondary inter-hospital transport towards the PICU.

Emergency care for critically ill children has developed into an important field within Paediatrics. During the last three decades, this process was accelerated by the development of many techniques and methods to treat critically ill children, based on new technical findings and possibilities. In the US as well as in Europe the birth and evolution of Paediatric Intensive Care Units (PICU) took place within tertiary care facilities around 1980. However, in clinical practice, critically ill children are presented to all kinds of hospitals. The type of medical facility, the knowledge, skills and training of medical personnel are crucial for quality of care and outcome of treatment[6-8]. In the past, studies often originated from intensive care units and they assessed characteristics, associated with improved chances of survival like inter-hospital transfer of patients[5,9-13].

Our study is the first to report prospective data of admissions of critically ill children during a one year period to a district general hospital in a representative area of the Netherlands. Using the correction factor for referral percentages, we can calculate the number and characteristics of critically ill children per 100,000 youth per year.

We showed that 70 out of 36,000 children were admitted in a general hospital because of critical illness a year. In our retrospective study, in which we studied the urgent paediatric transports

by ambulance from a defined area to a district general hospital also 70 children needed crucial initial therapy ('golden hour') at admission. We expected a higher total number of critically ill children per year in the prospective study because all children were assessed who were brought to the hospital as critically ill, whether by ambulance or by family car.

Most children's background was Caucasian, which correlates with the population of the region. Of the admitted non-Caucasian children, 50% of their parents could not speak the Dutch language well. However, we could not find a statistical difference in the time interval of the start of the illness and the time of admission between Caucasian and non-Caucasian children. This suggests that influence of the local language is not a critical factor for parents in finding help for their critically ill child. The same counts for the child's racial origin as well as its position in the family and this time interval. There were more secondly born children admitted than children with other family positions. This has been reported in other studies, for example in Respiratory Syncytial Viral Infection admissions and could be explained by the infectious risk created by a first-born child in the house for the secondly born 14.

Most children were brought in from their homes (n=53, 76%, Figure 1), far more than those picked up from the streets (n=10, 14%). This can be explained by the relative low mean age (4.2 years) of the children. It is of interest to see that, when a General Practitioner (GP) referred a critically ill child, they 'only' decide to use an ambulance for transport in 35% of the cases. This observation can possibly be explained by psychological reasons such as 'scoop and run' behaviour of the GP and fits with daily practice of those working with critically ill children in general hospitals. Given the fact that in the Netherlands, an ambulance can reach

every location within 15 minutes, it is questionable if the percentage use of ambulances by GP should be so low. Only by using an ambulance for transport with trained staff, a safe and secure transport of all critically ill children can be achieved. At admission, a Senior House Officer (SHO) initially sees most children. The initial contact mostly takes place in the Emergency Rooms (80% of the cases). This correlates with data, gained in one of our retrospective studies, where we found that 86% of critically ill children was seen on the ER. A recent study regarding the organisation around initial therapy of critically ill children in district general hospitals showed that Paediatricians initially treats, on a severity scale, mild and moderately ill children while other medical specialists like anaesthesiologists treat severely critically ill children (submitted).

Evaluating the different disease categories at admission and after three and 24 hours, no major change in percentages of the different groups could be found, implicating the doctors were sure what kind of illness in these children they were treating. It is of interest to see that after 24 hours after initial contact for a critical illness, 44% of them were sent home. This can be explained by the large group of febrile convulsions referred as 'critically' ill next to the children with 'trauma' that after arrival needed therapy but no hospitalisation lasting longer than 24 hours. Two children died within an hour after admission because of a fulminate sepsis after maximum treatment and support. More of interest is the number of children that was send towards the Academic Paediatric intensive Care Unit (PICU) after first being stabilised, following APLS procedures after admission in the general hospital. This figure, 5 children out of the population of 36,000 represents the number of secondary inter-hospital transport towards the PICU per year. Studies in the past showed that a reduction in

morbidity can be obtained when specialised paediatric staff perform the transport[15,16]. Extrapolating this number implicates a need of 14 secondary inter-hospital transports per 100,000 children, in the area per year, with staffed specialised paediatric staff. This information is relevant for policy makers in planning resources. Incorporating this figure with the 30 critically ill children out of the same region per 100,000 children per year which were directly transported to the PICU, as found in the retrospective study, makes a total of 44 PICU admissions, direct or indirectly out of 100,000 children.

In conclusion, evaluating the group of children admitted to a district general hospital as critically ill, the number of these children was found as 180 - 200 per 100,000 or approximately 0.2% of the total population of children below 18 years. No statistical difference was found in time interval of onset of illness and initial contact in the hospital in relation to race, control of the Dutch language and position of the child in the family. Extrapolating our data and using data from our retrospective study, we found that per year approximately 44 children out of every 100,000 (0.044%) children less than 18 years needs an admission on a PICU. Applying this calculation to the whole population of the Southwest part of the Netherlands (4.4 million inhabitants), with approximately 924,000 children below 18 years, the yearly need for PICU admissions is 410. Data from our study correctly fits the yearly admissions to the PICU in Rotterdam, the only academic hospital in the region.

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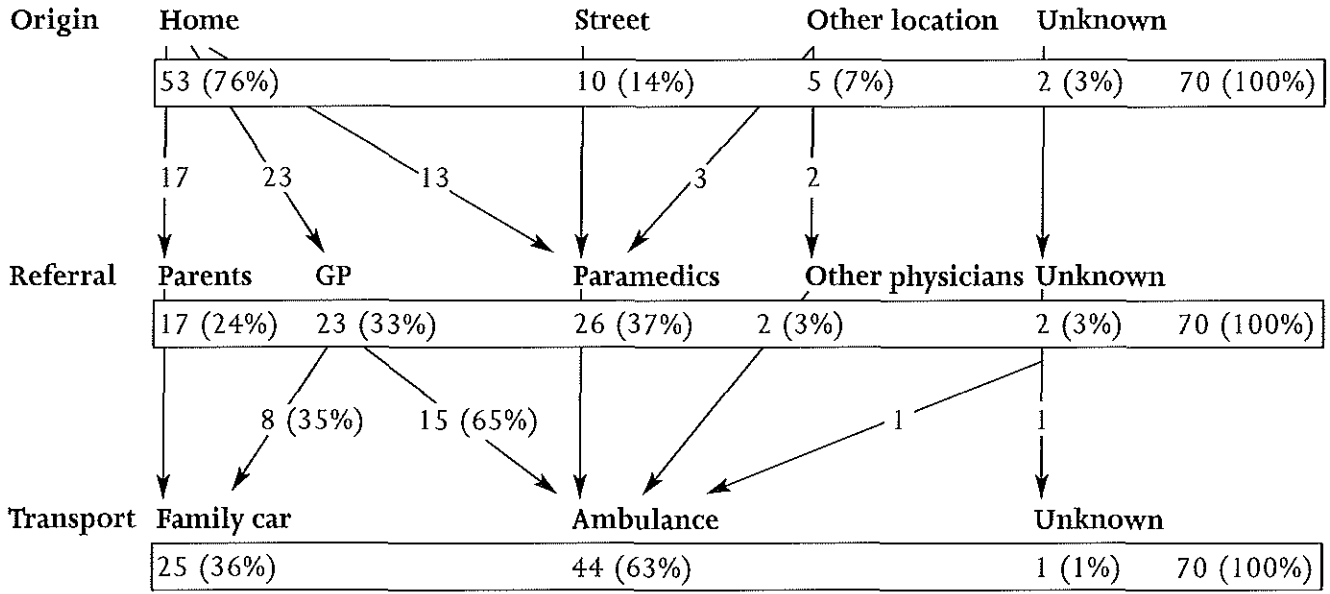
Figure 1

Characteristics of critically ill children, admitted to the district general hospital of Delft (covering 200 km², 0.5% of the Netherlands) in the Southwest region of the Netherlands during the year 2000. Out of a population of 36,000 children below the age of 18 years per year, 70 were admitted because of a critical illness. Most children were brought in from their homes (n=53,76%). The majority of all children was transported by ambulance (n=44, 63%), the others by family cars (n=25, 36%, 1% unknown). For the referral pattern, parents of 17 (24%) children decided to go to the hospital themselves, by family car, while the others were referred by paramedics (n=26, 37%), General Practitioners (GP, n=23, 33%) or other physicians (n=2, 3%) with 2 (3%) unknown. The General Practitioner (GP) as referral person, sent 8 of the children by family car (35%) and 15 (65%) by ambulance.


Origin
Home
Street
Other location
Unknown
53 (76%)
10 (14%)
5 (7%)
2 (3%)
70 (100%)
17
23
13
3
2
Referral
Parents
GP
Paramedics
Other physicians
Unknown
17 (24%)
23 (33%)
26 (37%)
2 (3%)
2 (3%)
70 (100%)
8 (35%)
15 (65%)
1
1
Transport
Family car
Ambulance
Unknown
25 (36%)
44 (63%)
1 (1%)
70 (100%)

CHAPTER 6

6.1 General Discussion

Emergency care for critically ill children has developed into an important field within Paediatrics. During the last three decades, this process was accelerated by the development of many techniques and methods to treat critically ill children, based on new technical findings and possibilities. Over the years this new subspeciality of Paediatric Emergency Care and Paediatric Intensive Care has fully ascertained its position within Paediatrics. Diverse Paediatric societies worldwide supported this development, out of which recommendations followed with regard to the training of medical personnel and equipment necessary to achieve a high standard of quality of care for the treatment of critically ill children. Guidelines for this process were further developed and reviewed. In time, a necessity to create special clinical units where these children could be treated optimally emerged. In the US as well as in Europe the birth and evolution of Paediatric Intensive Care Units (PICU'S) within tertiary care facilities took place around 1980. Those PICU's were seen as the primary site for critically ill children to be transported to and in those PICU's these children were treated by specially trained paediatric intensivists and nurses. Criteria for PICU locations were established such as the rapid availability of other certified paediatricians like paediatric cardiologists as well as the presence of appropriate material and medication. In the recent past, studies were initiated to evaluate characteristics of critical care associated with improved chances of survival. Studies affirmed improved outcomes when critically ill children were treated in a PICU, by paediatric intensivists. By creating specialised paediatric transport teams for the inter-hospital transport of such children towards a PICU, a further reduction in mortality was proven.

In clinical practice, children with acute diseases are presented to all kinds of different hospitals. The facility to which the child is transported, the availability of adequate medical supplies, the knowledge, skills and training of the medical personnel are crucial for quality of care and outcome of treatment. Because of this wide range of important prerequisites, diverse committees of Paediatric societies worldwide provided guidelines for equipping paediatric emergency facilities in community hospitals for the initial treatment of critically ill children. Statements followed, indicating the necessity of regionalisation of the care including centralising of the paediatric intensive care. Studies in outcome affirmed the need for a formal, regional organisation of paediatric primary level of intensive care as well as a need of a distinction in level of care per facility. This process of regionalisation of care accelerated in the US decades before this even started in the Netherlands. One of the major reasons was the distance between the different hospitals in the US. Clear engagements had to be made on levels of care and responsibilities, induced because of the legal climate as well as financial resources. During this process, different levels of care were introduced to obtain the most efficient regional use of resources. Finally, the different facilities were certified for their different level of care.

As mentioned before, in the Netherlands this process of regionalisation for the care of critically ill children has not yet been well established compared to the US. No formalised differentiation in levels of care of different paediatric facilities exists. The same can be said of the transport system of such critically ill children towards one of the eight PICU's in the Netherlands; a formalised nation wide system does not exist. This is in contrast to some other areas of the medical field in the Netherlands like Neonatology and Trauma, for which a nation wide system of high

quality transport does exist. These transports are already well established, acknowledged and financially supported by the national government. Parallel to this lack of an adequate transport system, in comparison with the organisation of the neonatal intensive care, no acknowledgement and special financial support exist of the actual need for PICU beds, nation-wide. Initiatives from the national government to come to a better organisation of Paediatric intensive care as a whole started only recently. Public pressure through the media and pressure of the Dutch Society of Paediatricians were important factors for this action.

To facilitate an acknowledgement by the government of a nation wide transport system for critically ill children towards one of the eight PICU's, it is necessary to have data concerning all characteristics of the group of critically ill children entering the medical system on a yearly basis. Data like the total number of children, the location where they enter the medical system and who does take care of them during the initial moment must be at hand. This information, provided by paediatricians is essential for policy makers in calculating the amount of paediatric intensive care beds and facilities as well as transport needs. Independent of the political backup by means of financial facilitation of resources, other data should also be at hand. To come to a high quality regional organisation of paediatric critical care, information of the actual situation is primarily needed. Paediatricians working in the field should obtain and gather this information. An evaluation of the presence of essential medical equipment and medication for initial therapy in regional paediatric emergency settings is one of them. All aspects of the actual organisation at the diverse paediatric emergency sites in the region are another factor. The question: who acts and where and with what equipment, has to

be answered.

In summary, during the last decades an exceptional improvement in the quality of care for critically ill children took place by means of new technical possibilities next to introduction of PICU's in tertiary centres. In several countries, a formalised system of different levels of care by different emergency facilities within a region did improve the quality of care. This process of 'regionalisation of care' was backed by policy makers and financially supported. The capacity of PICU's and transport facilities was adapted to the needs. In the Netherlands this process is only just starting. This thesis provides a number of relevant findings for daily practice, which can help to accelerate this process. The findings presented in this thesis should help policy makers in their decision-making and support paediatricians to come to engagements within a region with the only purpose to improve the quality of care of critically ill children, wherever they enter the medical system.

Future perspectives

Focussing on the Southwest region of the Netherlands, it can be stated that this is an ideal region to become the first in our country with a formalised engagement in levels of care by the different major district general hospitals and preferably in good agreement with their PICU facility. First because of the clear progress in recent years in the cooperation between the different groups of paediatricians working in the different general hospitals in the region. Secondly because of the clear role of the only paediatric academic hospital of the region, which supports the development of an advanced system of regionalisation of care. Features of this system are the mutual engagements by the different groups of Paediatricians, representing sub specialities within Paediatrics, to

work together, and hereby serving each other communities with their specific knowledge. Each group with a specific field of interest is working closely together with colleagues within the academic hospital on levels of patient care, education and research.

In this breeding ground, the field of paediatric oncology has been the first in the region, which created an advanced form of 'regionalisation' of care.

By obtaining data and characteristics concerning the critically ill children of the region, a boost in the development of regionalised care for this group must be forth coming. This must be achieved in the coming years in the Southwest part of the Netherlands. Groups of well-trained paediatricians must be adequately able to initially treat these children. Paediatric intensivists should do transport towards the regional PICU. The regional PICU in turn must have enough beds, personnel and equipment for the further treatment of all transported children. Engagements have to be made and put in place on the different levels of care, which can be given by the different district hospitals. Detailed assignments have to be made concerning the transport of critically ill children between the different levels and emergency sites and the PICU. The task for policy makers in the coming years will be the creation of the legal basis and financial support for this process. When this regionalisation of paediatric critical care medicine is implemented and supported, it will serve as an example for other regions of the country. The birth of a nation wide system is the logical next step. Finally when implemented, the engagements and guidelines have to be inspected every couple of years. The levels of care of the different emergency sites must than be revised and optimised by controlling the presence of the equipment, the right personnel and the organisation in which they work.

6.2 Summary

In this thesis we tried to find answers to a number of clinically relevant questions concerning the care of critically ill children within district general hospitals. By obtaining data and characteristics of this group of patients, the organisation and level of care within 15 district general hospitals in the Southwest part of the Netherlands was assessed. Similarly, the process of regionalisation of this specific aspect of paediatric care was further delineated. The findings will, most likely, help policy makers in their decisions concerning the development of the necessary paediatric transports in the region, as well as sufficient number of PICU beds, personnel and resources. The ultimate goal is that, when implemented, a high quality level of care for all children entering the medical system at any emergency site in the region is assured.

In **Chapter One** a historic perspective is presented of the introduction and evolution of paediatric critical care medicine. Aspects of regionalisation are discussed and the development of quality of care management is highlighted. A survey of severity of illness and outcome scores in Paediatrics is presented after which the specific aims of this study are stated.

In **Chapter two**, data and characteristics of critically ill children, transported from a defined area to a district general hospital are assessed, by means of a retrospective analysis. Of the paediatric population, total 57,851 below the age of 18 years, 0.9% was transported to the hospital per year; 89.1% of them as urgent. Characteristics of the transported group of children, like age, sex and presenting problem were extracted. The majority of all transports were teenagers with surgical trauma, a minority (3.7%) was directly sent to a paediatric intensive care facility. In 10% of all

paediatric emergency calls, transport to a hospital was judged as 'not necessary' at arrival on the scene. Of all urgently transported children, 24% needed crucial therapy ('golden hour') at admission to the district general hospital. The number of children per 100,000, who needed such a 'golden hour' intervention per year, was found as 235, which is approximately 0.23% of the total population less than 18 years.

In **Chapter three**, the results of evaluations of essential medical equipment and medication of Emergency Rooms (ER) and Paediatric Departments (PD) of 15 district general hospitals are presented. The objective of this prospective study was an evaluation of all Paediatric emergency settings within the different locations. A consensus of the optimal inventory was obtained from a questionnaire, answered by 14 Paediatric intensivists and used as 'expert opinion'. They gave their opinion concerning a list of medication and materials, created and distributed by a regional paediatric committee in the early '90. Each item of the list was given a score, ranging from 1 as 'handy' as 5 as 'essential', hereby creating a tool for the assessment of the inventories. Differences between the diverse hospitals as well as differences between emergency sites within one hospital were found and described. Equipment to meet 'respiratory problems' was considered by the experts as the most essential of the inventory. In the hospitals visited, both the ER and the PD were optimally equipped regarding circulatory problems. Five out of the total of 26 emergency sites in the 15 district general hospitals scored below 75% of the optimum inventory (4 out of 11 PD, 1 out of 15 ER) as created by the 'experts'. The ER was in all aspects significantly better equipped than the PD. When the total group of hospitals were analysed and compared with each other, major differences and variations in the

inventory for initial treatment of the seriously ill children were identified.

In **Chapter four** the organisation around the initial therapy of critically ill children in district general hospitals was studied prospectively. The aim was to determine, in case of a new patient, where the critically ill child would enter the hospital and which type of physician would act first. Popularly spoken: who acts and where? Four types of patients were presented and their 'routing' within the hospitals were assessed. Three patients, a 'mild' case (2-year old, deterioration of asthma), 'moderate' case (4-year old, meningitis) and 'severe' case (2-year old, near drowning), were admitted from outside the hospital and one was already hospitalised (2-year old, convulsions).

It seemed that the higher the expected level of severity of clinical condition is in critically ill children coming to the district general hospitals, the lower the probability that the initial contact takes place on the Paediatric Department (PD). Similarly the Paediatrician initially treats, on a severity scale, mild and moderate ill children, while other medical specialists primarily see severely critically ill children.

Finally the 'referral pattern' was studied; would they be transported towards the regional academic PICU or would they stay within the general hospital, when a clinical deterioration took place?

First, the routing by paediatricians of the different critically ill children within these hospitals after initial contact contains an inconsistency in 50% of the cases, i.e.; the 'routing' from the initial site of patient contact towards the site of intubation was not similar for all cases. No specific difference in 'routing' between the 'in- and outdoor patients' could be found in the district hos-

pitals. The diversity of the different routes that the three 'outdoor' patients undergo within these hospitals is great. The vast majority of paediatricians would contact the regional Paediatric Intensive Care Unit (PICU), in case of an intubated critically ill child, for further therapy in the tertiary centre.

In **Chapter five** the number and characteristics of critically ill children, presented with or without announcement, from a defined area of the Netherlands to a district general hospital are presented by means of a prospective analysis. At all emergency sites, data were collected during the initial evaluation and 3 and 24 hour after presentation. Characteristics like age, sex, race, position in the family and control of the Dutch language were assessed. In addition, the period before arrival in the hospital were studied like the location of origin of the critically ill child, the referral pattern and the duration of the period of recent illness. Finally, after 3 and 24 hours of admission, further information was gained such as the physical condition of the child, the disease category and the child's location.

Out of a population of 36,000 youth per year, 70 were admitted because of a critical illness. The mean age of this group was 4.2 years, 77% had a Caucasian background and 55% were boys. Most children were brought in from their homes (76%). General practitioners referred 23 (33%) critically ill children. Parents of 17 (24%) children decided to go to the hospital themselves, by family car. Paramedics referred 29 (41%) children. Most children (80%) were initially seen on the Emergency Room (ER). A Senior House Officer (SHO) was in 85% of the cases the first doctor to see the child. Twenty-four hours after admission, 5 (7%) were hospitalised in the regional Paediatric Intensive Care Unit (PICU), 33 (44%) were send home, 2 (3%) were deceased and 32 (46%)

were still hospitalised on the Paediatric Department.

In conclusion, from a defined area in the SW part of the Netherlands, per year 0.2% of the children below 18 years were admitted to a general hospital as critically ill. No statistical difference was found in time interval of onset of illness and initial contact in the hospital in relation to race, control of the Dutch language and position of the child in the family. Extrapolating our data and using data from our retrospective study, as described in Chapter 2, we found that per year, 44 children out of every 100,000 children under 18 years need an admission on a PICU. Of this group, 14 (32%) were initially admitted to the district general hospital, needing an urgent, secondary inter-hospital transport towards the PICU.

Chapter six encompasses a general discussion and future perspectives together with the summary.

Chapter seven contains a list of abbreviations used in this thesis. Separately the curriculum vitae and list of publications of the author of the thesis are presented.

6.3 Discussion générale

Les soins intensifs pour les enfants sont devenus une partie importante dans la pédiatrie. Durant les trois dernières décennies ce changement a été accéléré par le développement des techniques et méthodes nouvelles pour traiter les enfants présentant un état de santé critique.

Au fil des années la sub-spécialité des soins intensifs pédiatriques et soins d'urgence pédiatrique a tout à fait assuré sa position dans la pédiatrie. Les sociétés de pédiatrie nationales, partout dans le monde, ont soutenu ce développement avec des recommanda-

tions concernant la formation du personnel médical et l'équipement nécessaire pour atteindre un haut niveau de soins des enfants dans un état critique. Des standards pour accompagner ce processus ont été développés et ont été revus. Au fil du temps on a éprouvé de plus en plus le besoin de créer des unités spécialisées pour le traitement des enfants très malades. La réalisation des unités pour les soins intensifs (Paediatric Intensive Care - PICU) a démarré aux Etats-Unis et en Europe en 1980. Les PICU's ont été vues comme l'endroit préféré pour placer les enfants dans un état critique et dans les PICU's les enfants ont été traités par des 'intensivists' et des infirmières spécialement formées. Des standards pour les PICU's ont été établis tels que la disponibilité d'autres pédiatres spécialisés comme le pédiatre-cardiologue ainsi que la présence d'un certain équipement et la disponibilité de certains médicaments. Dans le passé récent des études ont été réalisées pour évaluer si les soins intensifs ont amélioré les chances de survie. Les études ont démontré que les résultats sont meilleurs si les enfants ont été traités dans la PICU et par des 'pédiatres-intensivists'. On a également démontré que la mortalité diminue encore plus quand des équipes pédiatriques spécialisées s'occupent du transport entre les hôpitaux. Dans la pratique de la médecine de première ligne, les enfants atteints de maladies aigües sont présentés dans les différents genres d'hôpitaux selon la géografie. L'endroit ou l'enfant est transporté, avec son infrastructure médicale disponible, la connaissance, le savoir faire et la formation du personnel médical pourraient être déterminants pour le résultat du traitement. A cause de la variété des facteurs importants, de commissions des sociétés de pédiatrie nationales ont fourni partout dans le monde des standards pour l'équipement des salles de soins d'urgence pour le traitement initial des enfants présentés dans les hôpitaux généraux. Des propositions ont suivi concer-

nant la nécessité de régionalisation des structures de santé publique y compris les soins intensifs pédiatriques. Les études ont confirmé le besoin d'officialiser la régionalisation des soins intensifs pédiatriques par la distinction des différents niveaux de soins. Le processus de régionalisation a démarré aux Etats-Unis des décades avant même le début aux Pays-Bas. Provoqué surtout par la distance entre les différents hôpitaux, le processus de régionalisation a démarré aux Etats-Unis des décades avant un début de régionalisation aux Pays-Bas. Aux Etats-Unis des engagements clairs devaient être pris à cause du système légal et de la façon de financement. Pour ces raisons, des niveaux de soins ont été introduits pour l'utilisation optimale des ressources régionales et les différentes facilités ont été accréditées officiellement pour le niveau de soin. Comme déjà mentionné, aux Pays-Bas le processus de régionalisation n'a pas encore été établi. En contraste avec d'autres domaines comparables comme la néonatologie et la traumatologie dans les soins intensifs pédiatriques (non néonatologiques) une officialisation n'a pas été réalisée ni concernant les niveaux de soins, ni concernant le support financiel spécifique pour les lits PICU, ni concernant le transport des enfants vers les huit PICU des Pays-Bas. Des initiatives du gouvernement national pour mieux organiser le soins intensifs pédiatriques dans le pays ont démarré récemment. Des pressions exercées par les média et par l'association des pédiatres des Pays-Bas ont été importantes pour l'aboutissement de la législation. Pour faciliter la reconnaissance d'un système de transport national des enfants dans un état critique vers une des huit PICU, il est essentiel de disposer des caractéristiques du groupe d'enfants dans un état critique pendant toute une année et au niveau régional.

Dans l'étude on retrouve le nombre d'enfants, le lieu d'entrée dans le système de santé publique et la caracteristique de la mala-

die de l'enfant. Une information de valeur pour le calcul du nombre de lits PICU et les besoins en matière de transport spécialisé.

Auprès des experts on a obtenu un 'score de nécessité' de quel équipement et de quels médicaments dans la salle d'urgence, et avec le score on a testé l'équipement et les médicaments disponibles. Savoir quel personnel médical présent à l'entrée était également essentiel pour pouvoir apporter avec une réponse à la question: 'Qui agit comment, avec quel équipement et avec quelle disponibilité de quels médicaments'?

Les données rassemblées dans cette thèse aideront les pédiatres régionaux à prendre des décisions nécessaires et pourraient aussi les aider à atteindre, à n'importe quel endroit du système médical, le mème standard élevé de qualité des soins pour les enfants dans un état critique.

Perspectives du Futur

Grâce à l'étude et la collaboration engagée des différents groupes de pédiatres des hôpitaux régionaux on espère officialiser la collaboration par la création des niveaux de soins en accord avec la PICU régionale qui est integrée dans le seul hôpital universitaire de la région.

Cela dans le cadre d'une régionalisation plus générale avec engagement mutuel des différents groupes de pédiatres selon intérêt et connaissance spécifique et en collaboration étroite avec les collègues de l'hôpital universitaire. Une collaboration qui pourra se diversifier dans les domaines des soins, des études et de la recherche. Dans cette ambiance une collaboration régionale a déjà été crée dans le domaine de l'oncologie. Avec les renseigments de notre étude concernant les enfants dans un état critique un stimulant très fort existe pour la régionalisation des soins de ces enfants. Les groupes de pédiatres régionaux devront être suffi-

samment formés pour le traitement initial de ces enfants et les 'pédiatres-intensivists' de la région devront s'occuper du transport de l'enfant vers la PICU qui ne pourra pas manquer de lits, de personnel et de l'équipement pour le traitement.

Des accords détaillés concernant les différents niveaux des hôpitaux concernés et le transport entre les différents sites devront être élaborés par les managers de santé régionale. Cet modèle de régionalisation pourrait servir d'exemple dans le pays et un système national pourrait en être une conséquence logique.

Il va sans dire que dans cet système national reposant sur un financement solide, existerait un contrôle systématique de l'organisation de tous les centres, du personnel et de l'équipement.

6.4 Résumé

Dans cette thèse, nous essayons de trouver des réponses à un certain nombre de questions concernant les soins aux enfants gravement malades dans des hôpitaux généraux régionaux. En obtenant des données et des caractéristiques du groupe de patients, l'organisation et le niveau des soins dans 15 hôpitaux généraux régionaux situés dans le sud-ouest des Pays-Bas ont été évalués. En même temps, le processus de régionalisation de cet aspect spécifique de soin pédiatrique a été approfondi. Les résultats vont, très vraisemblablement, aider les responsables dans leurs décisions concernant le développement des transports pédiatriques nécessaires dans la région, ainsi que du nombre suffisant de lits, de personnel et de ressources dans un Centre de Soin Intensif Pédiatrique CSIP. L'objectif suprême étant que, une fois implanté, un haut niveau de qualité des soins pour tous les enfants entrant le système médical soit assuré dans chaque centre d'urgence.

Dans **le premier chapitre**, une perspective historique est présen-

tée avec une introduction et une évolution de la médecine pédiatrique des soins intensifs. Les aspects de la régionalisation sont abordés et le développement de la qualité de la gestion des soins est mis en valeur. Une enquête sur la gravité des maladies et les résultats est présentée, puis les objectifs spécifiques de cette étude sont formulés.

Dans **le deuxième chapitre**, les données et caractéristiques des enfants gravement malades, transportés d'un endroit donné vers un hôpital général régional sont établies, par le biais d'une analyse rétrospective. De toute la population pédiatrique, soit 57.851 enfants âgés de moins de 18 ans, moyenne annuelle, 0,9% furent transportés dans un hôpital; dont 89,1% en urgence. Les caractéristiques de ces enfants transportés en urgence, tels que l'âge, le sexe et les premiers symptômes, furent archivées. La majorité des transports concernait les adolescents atteint de lésion chirurgicale, une minorité (3,7%) fut directement envoyée dans un centre pédiatrique de soins intensifs. Pour 10% de toutes les interventions pédiatriques d'urgence, le transport à l'hôpital fut jugé 'non nécessaire' dès l'arrivée sur le lieu de l'accident. Parmi tous les enfants transportés en urgence, 24% nécessitaient une thérapie décisive 'golden hour' dès l'admission à l'hôpital général régional. Le nombre moyen annuel d'enfants qui nécessitaient cette intervention de 'golden hour' était de 235 pour 100.000, soit approximativement 0,23% de la population totale des enfants de moins de 18 ans.

Le troisième chapitre présente les résultats des évaluations des principaux équipements médicaux et médicaments des Salles d'Urgence (SU) et Départements Pédiatriques (DP) de 15 hôpitaux généraux régionaux. L'objectif de cette étude rétrospective

était d'évaluer tous les appareils et instruments Pédiatriques d'urgence dans les différents sites. Un consensus de l'inventaire optimal fut atteint grâce à un questionnaire rempli par 14 Pédiatres travaillant en centre d'urgence et utilisé comme 'opinion d'expert'. Ils donnent leur opinion par une liste de matériaux et médicaments, créée et distribuée par un comité régional pédiatrique au début des années 90. Chaque élément de la liste a un score, de 1 'pratique' à 5 'essentiel', ceci créant un outil pour la détermination des inventaires. Les différences entre les divers hôpitaux ainsi qu'entre les sites d'urgences dans un hôpital furent analysées et rapportées. Les équipements pour assister les problèmes respiratoires sont considérés par les experts comme le plus important de tout l'inventaire. Dans les hôpitaux visités, à la fois les Salles d'Urgence SU et Départements Pédiatriques DP étaient équipés de façon optimale pour les problèmes respiratoires. Cinq parmi les 26 centres d'urgence dans les 15 hôpitaux généraux régionaux totalisent moins de 75% par rapport à l'inventaire optimal (4 parmi 11 DP, 1 parmi 15 SU) d'après l'information des 'experts'. Les SU étaient sous tous les aspects beaucoup mieux équipées que les DP. Quand la totalité des hôpitaux furent analysés et comparés entre eux, d'importantes différences et variations furent identifiées pour le traitement initial des enfants gravement malades.

Dans le **quatrième chapitre**, l'organisation autour de la thérapie initiale des enfants gravement malades dans les hôpitaux généraux régionaux fut étudiée. Le but étant de déterminer, dans le cas d'un nouveau patient dans quel service de l'hôpitalles enfants trés gravement malades pourraient être admis et quel type de médecin devrait intervenir en premier. En résumé: qui agit et où? Les patients ont été répertoriés en quatre types et leur 'acheminement' parmi les hôpitaux fut déterminé. Trois patients, un cas

'léger' (âgé de 2 ans, détérioration d'asthme), un cas 'moyen' (4 ans, méningite) et un cas 'grave' (2 ans, noyade) furent admis a l'hôpital et un patient était déjà hospitalisé (2 ans, convulsions). Il paraissait que plus le niveau attendu de gravité de l´état clinique était grave pour les enfants gravement malades arrivant dans les hôpitaux généraux régionaux, plus la probabilité était faible que le contact initial se fasse dans le Département Pédiatrique PD. De même, le Pédiatre traite initialement, sur une échelle de gravité, les cas légers et modérés, alors que les autres spécialistes médicaux voient d'abord les enfants très gravement malades.

Enfin, le 'model référé' fut étudié; Devraient-ils être transportés vers l'hôpital universitaire régional CSIP ou devraient-ils rester a l'hôpital général, en cas de détérioration de l'état clinique?

Premièrement, l'acheminement par les pédiatres pour les différents enfants gravement malades contient des inconséquences dans 50% des cas; C'est à dire que l'acheminement du site initial vers le site d'intubation n'était pas le même pour tous les cas. Il n'y avait pas de différence spécifique d'acheminement entre les patients 'entrant et sortant' dans les hôpitaux régionaux. La diversité des différentes routes que les trois patients 'sortant' ont suivies entre ces hôpitaux est grande. La grande majorité de pédiatres contacteraient le Centre de Soin Intensif Pédiatrique CSIP dans le cas d'un enfant gravement malade intubé, pour de plus amples thérapies dans le centre tertiaire.

Dans **le cinquième chapitre** le nombre et les caractéristiques des enfants gravement malades, présentés avec ou sans notification, d'un endroit défini aux Pays-Bas vers un hôpital général régional, sont présentés par une méthode d'analyse prospective. Dans tous les sites d'urgence, les données furent recueillies pendant l'évaluation initiale et 3 et 24 heures après la présentation. Les caracté-

ristiques telles que l'âge, le sexe, la race, la position dans la famille et le maniement de la langue néerlandaise furent notées. En plus, la période avant l'arrivée à l'hôpital fut étudiée, comme l'endroit d'origine de l'enfant gravement malade, le model référé et la durée de la période de la maladie. Finalement, après 3 et 24 heures d'admission, de plus amples informations furent notées comme la condition physique de l'enfant, le type de la maladie et l'emplacement de l'enfant.

D'une population de 36.000 jeunes annuellement, 70 furent admis à cause d'une maladie critique. La moyenne d'âge de ce groupe était de 4,2 ans, 77% avaient un profil caucasien et 55% étaient masculins. La plupart des enfants furent emmenés depuis leurs lieux d'habitation (76%). Des médecins généralistes ont envoyé 23 (33%) enfants gravement malades. Les parents de 17 (24%) enfants décidèrent eux-mêmes d'aller à l'hôpital, par leurs propres moyens. Les paramédicaux ont envoyé 29 (41%) des enfants. La plupart des enfants (80%) furent initialement consultés dans la Salle d'Urgence ER. Un cadre dirigeant était dans 85% des cas le premier docteur à voir l'enfant. Vingt-quatre heures après l'admission, 5 (7%) furent hospitalisés dans un Centre régional de Soin Intensif Pédiatrique CSIP, 33 (44%) renvoyés à la maison, 2 (3%) décédés et 32 (46%) hospitalisés dans le Département Pédiatrique DP.

En conclusion, dans la région du sud-ouest des Pays-Bas, 0.2% des enfants par an, âgés de moins de 18 ans furent admis dans un hôpital général comme gravement malades. Dans le lap de temps entre le déclenchement de la maladie et le contact initial avec l'hôpital, aucune différence statistique n'a été trouvée en ce qui concerne la race, le maniement de la langue néerlandaise et la position de l'enfant dans la famille. En extrapolant nos données et en utilisant les données de l'étude rétrospective, comme décrit

dans le chapitre 2, nous concluons que, annuellement, 44 enfants sur100.000 enfants de moins de 18 ans, nécessitent une admission dans un CSIP. De ce groupe, 14 (32%) furent initialement admis a l'hôpital général régional, nécessitant un second transport d'urgence inter-hôpital vers le CSIP.

Le sixième chapitre contient une discussion générale, les perspectives futures et le résumé.

Le septième chapitre contient une liste des abréviations utilisées dans cette thèse. Le curriculum vitae et la liste des publications de l'auteur de la thèse sont présentés séparément.

6.5 Algemene Discussie

Spoed Eisende Hulp voor ernstig zieke kinderen heeft zich ontwikkeld tot een belangrijk onderdeel van de kindergeneeskunde. In de afgelopen dertig jaar heeft met name de snelle ontwikkeling van nieuwe technieken naast de komst van nieuwe behandelmethoden bijgedragen aan deze snelle ontwikkeling. Het hierdoor ontstane nieuwe subspecialisme pediatrische spoedeisende hulp en pediatrische intensive care heeft zich in deze periode een stevige positie verworven binnen het vakgebied van de kindergeneeskunde. Verschillende pediatrische verenigingen in diverse landen hebben deze ontwikkeling onderkend en ondersteund. De ontwikkeling van voorschriften betreffende de training van medisch personeel en de noodzakelijke aanwezigheid van de diverse materialen en medicamenten vloeide hieruit voort. Deze voorschriften bleken noodzakelijk om tot een hoog kwalitatief zorgniveau voor de groep ernstig zieke kinderen te komen.

Deze ontwikkeling vond als eerste plaats in academische centra in de Verenigde Staten alwaar de 'Pediatrische Intensive Care

Units' (PICU's) ontstonden. Deze werden gezien als de beste plek voor de behandeling en verzorging van deze groep kinderen door de aanwezigheid van speciaal hiervoor getrainde kinderartsen en kinderverpleegkundigen. Criteria voor een PICU werden vastgesteld. Enkele hiervan zijn de snelle aanwezigheid van andere pediatrische subspecialisten zoals een kindercardioloog en de aanwezigheid van de juiste materialen en medicijnen. In het recente verleden werden studies verricht om die karakteristieken te kunnen ontdekken in de zorg van vitaal bedreigde kinderen die staan voor een hogere overlevingskans. Deze studies bevestigden een hogere kans op overleven indien vitaal bedreigde kinderen werden opgenomen op een PICU en werden behandeld door pediatrisch intensivisten. Door het instellen van speciale pediatrische transportteams voor interhospitaal transport van vitaal bedreigde kinderen naar een PICU werd een verdere reductie in de mortaliteit bewerkstelligd. In de klinische praktijk blijkt echter dat kinderen met bedreigde vitale functies in diverse ziekenhuizen gepresenteerd worden. De locatie waarheen het ernstig zieke kind getransporteerd wordt, de aanwezigheid van adequate medische voorzieningen aldaar, de kennis, handigheid, vaardigheid en training van het medisch personeel op de plek van initiële opvang zijn cruciale factoren die de kwaliteit van zorg bepalen naast de uiteindelijke uitkomst van de behandeling. Naar aanleiding van het feit dat er diverse factoren zijn, die uiteindelijk de uitkomst bepalen, hebben meerdere commissies van de diverse pediatrische verenigingen richtlijnen opgesteld om te komen tot een optimale inrichting van pediatrische spoedeisende hulp faciliteiten. Daarnaast werden richtlijnen opgesteld en indicatiegebieden geponeerd ter bevordering c.q. centralisatie van de pediatrische intensive care.

Het proces van regionalisatie van de zorg deed zijn intrede en

ontwikkelde zich in de Verenigde Staten, een tiental jaren voordat dit in Nederland gebeurde. Eén van de redenen waarom dit proces in de Verenigde Staten begon heeft te maken met de grote afstanden tussen de verschillende ziekenhuizen in dat land. Er moesten duidelijke afspraken worden gemaakt over de verschillende niveaus van zorg die op verschillende locaties geboden kon worden. Bij dit proces moet het rechtssysteem en de invloed van financiers van de zorg niet vergeten worden. Gedurende dit proces werden verschillende zorgniveaus afgebakend om te komen tot de meest efficiënte regionalisatie van de zorg, hierbij gebruik makende van aanwezige materialen in de verschillende regio's. Verschillende ziekenhuizen werden tevens 'gecertificeerd' voor de diverse zorgniveaus. Evaluatie studies, verricht na implementatie van dit zorgsysteem, toonden een verbeterde uitkomst voor de totale groep van vitaal bedreigde kinderen.

Op dit moment is in Nederland een systeem zoals dat in de Verenigde Staten bestaat nog niet geïmplementeerd. Echter regionalisatie in de zorg voor de groep van vitaal bedreigde kinderen is in volle gang. Van een geformaliseerde differentiatie in zorgniveaus tussen de verschillende ziekenhuizen en afdelingen is op dit moment nog geen sprake. Voor het transportsysteem om vitaal bedreigde kinderen naar één van de acht academische pediatrische intensive care units te brengen geldt hetzelfde. Er bestaat geen landelijk transport systeem, noch dat hier financiering voor is. Dit in tegenstelling tot enkele andere velden van de geneeskunde in Nederland zoals de neonatologie en de traumatologie waarvoor dit wel geldt en reeds geïmplementeerd is. Voor deze vakgebieden bestaat een landelijk werkend systeem van hoog gekwalificeerd transport. Dit systeem is ontwikkeld en geïmplementeerd door de nationale overheid en wordt tevens financieel ondersteund. Om een transport systeem voor vitaal bedreigde

kinderen op te zetten, te implementeren en ervoor te zorgen dat dit financieel ondersteund wordt, is het ten eerste van belang om data te verzamelen over de aantallen en de karakteristieken van deze groep, onafhankelijk van de plek waar deze kinderen het medisch systeem binnentreden. Kort gezegd, data moeten eerst voorhanden zijn voor er besluitvorming kan plaatsvinden. Deze gegevens, die door kinderartsen geleverd moeten worden, zijn van belang voor de berekening van het aantal pediatrische intensive care bedden evenals de verder hieraan gekoppelde faciliteiten zoals een transportsysteem, materialen en verpleegkundige zorg. Om tot enige verbetering te komen moet eerst de huidige situatie in kaart gebracht worden. Kinderartsen in alle centra moeten hiertoe samenwerken om tot objectieve en betrouwbare informatie te komen waar beleidsmakers iets mee kunnen. Een van de praktische punten is inventarisatie van de aanwezigheid van materiaal en medicatie voor de eerste opvang van deze groep kinderen in de verschillende regionale ziekenhuizen. Ook andere aspecten van de initiële zorg in deze klinieken zoals de organisatie, wie behandelt, waar, wanneer en hoe, moeten nader bekeken worden.

Samenvattend kan gesteld worden dat er in de laatste dertig jaar een buitengewone verbetering in de kwaliteit van zorg voor de groep van vitaal bedreigde kinderen is bewerkstelligd, geïnitieerd door nieuwe technische mogelijkheden en de introductie van pediatrische intensive care units in tertiaire centra. In verschillende landen bestaat inmiddels een geformaliseerd systeem van differentiatie in niveaus van zorg in de verschillende klinieken binnen een regio, hetgeen de kwaliteit van zorg in het geheel heeft verbeterd. Dit proces van regionalisatie van zorg wordt ondersteund door beleidsmakers, ook op financieel gebied. De capaciteit van de pediatrische intensive care units en ook de trans-

portfaciliteiten werden aangepast aan de behoeften.

In Nederland kan gesteld worden dit proces pas slechts een aanvang heeft genomen.
De uitkomsten van de studies waaruit dit proefschrift bestaat, leveren verschillende bevindingen op die gebruikt kunnen worden om dit proces ter verbetering van de regionalisatie van de zorg te versnellen. Deze uitkomsten kunnen beleidsmakers en kinderartsen helpen in het besluitvormingsproces om te komen tot afspraken betreffende de zorg in de regio Zuid west Nederland.

Initiatieven van de nationale overheid met hetzelfde doel zijn pas recent gestart. Aandacht in de media voor dit onderwerp en druk van de Nederlandse Vereniging voor Kindergeneeskunde waren belangrijke factoren bij de initiatie hiervan. Gelet op de regio Zuidwest Nederland kan gesteld worden dat dit een ideale regio is om binnen ons land als eerste geformaliseerde afspraken te maken en te implementeren, omtrent de niveaus van zorg in de verschillende regionale ziekenhuizen voor deze groep kinderen. Goede afspraken met de PICU-faciliteit te Rotterdam behoren hierbij. Dat dit de eerste regio kan worden waar goede afspraken worden gemaakt mag verwacht worden gezien het feit dat er al in verleden reeds goede afspraken zijn gemaakt door de verschillende kinderartsen, ter verbetering van de zorg voor kinderen met andere ziektebeelden. Tevens kan gesteld worden dat de rol van de enige pediatrische intensive care unit in het enige academische ziekenhuis in de regio een duidelijke is, namelijk stimulering en ondersteuning van de ontwikkeling van een systeem van regionalisatie van zorg.

De samenwerking tussen de groepen kinderartsen in de verschillende ziekenhuizen in de regio heeft met name in het laatste jaar een versnelling doorgemaakt. Er wordt reeds gesproken over

een systeem waarin men van elkaar kennis gebruik kan maken. Dit door patiënten vanuit eigen gebied voor specifieke kennis dan wel behandeling naar een kinderarts te verwijzen in een ander regionaal ziekenhuis met ervaring binnen dit veld. Als vervolgens kinderartsen met hetzelfde aandachtsgebied binnen de diverse regionale klinieken zouden gaan samenwerken, tezamen met subspecialisten binnen het academisch ziekenhuis, zou er sprake zijn van een verdere optimalisering van de zorg.

In de praktijk zijn kinderartsen met het aandachtsgebied oncologie binnen de regio Zuid West Nederland zeer ver gevorderd in deze optimalisatie van zorg door middel van regionalisatie. Dit succes is een stimulans voor andere kinderartsen die werkzaam zijn in hun specifieke aandachtsgebied van de kindergeneeskunde.

Toekomstperspectief

Het aanleveren van gegevens en karakteristieken van de groep van ernstig zieke kinderen binnen de regio is een stimulans om te komen tot een regionalisatie van de zorg voor deze groep kinderen. Deze verbetering in de organisatie middels implementatie van onderlinge samenwerkingsafspraken komt alle ernstig zieke kinderen in de regio ten goede. Deze verbetering van de zorg in de regio Zuidwest Nederland moet bereikt worden in de komende jaren. Algemene kinderartsen binnen de verschillende klinieken moeten in staat zijn, in ieder geval getraind zijn, om de initiële opvang van vitaal bedreigde kinderen goed te doen. Pediatrisch intensivisten moeten vervolgens, indien er een indicatie bestaat, het transport faciliteren en begeleiden, van het kind naar de regionale pediatrische intensive care unit. De PICU moet daarvoor genoeg bedden, personeel en materiaal ter beschikking hebben om de vervolgbehandeling van alle getransporteerde kinderen mogelijk te maken. Afspraken moeten gemaakt worden,

geïmplementeerd worden en men moet zich eraan houden als het gaat tot welk niveau welk kind in welk ziekenhuis kan blijven voor behandeling. Heldere afspraken over het transport van ernstig zieke kinderen moeten gemaakt worden, zowel binnen de verschillende ziekenhuizen als tussen de verschillende ziekenhuizen en de PICU. Het is de taak van de beleidsmakers de komende jaren om deze ontwikkeling een legale basis te geven en financieel te ondersteunen. Wanneer de regionalisatie van zorg in de regio Zuid West Nederland geïmplementeerd is en ondersteund wordt kan dit als voorbeeld dienen voor andere regio's binnen ons land. Het opzetten van een nationaal systeem is dan de volgende logische stap.

Tenslotte kan gesteld worden dat de geïmplementeerde afspraken regelmatig moeten worden gereviseerd en eventueel worden bijgesteld. Dit geldt bijvoorbeeld voor de 'zorgniveaus' van de ziekenhuizen, waarbij visitaties om te kijken naar aanwezigheid van materialen, het juiste personeel en de organisatie, moeten plaats vinden. Tevens geldt dit voor de onderlinge afspraken, wie doet wat, waar, wanneer en hoe.

6.6 Samenvatting

In dit proefschrift wordt getracht antwoord te geven op enkele klinisch relevante vragen rond de zorg van vitaal bedreigde kinderen in niet academische ziekenhuizen. Hiervoor werden binnen 15 ziekenhuizen in de regio Zuid West Nederland data en kenmerken van deze groep patiënten en van de organisatie van de zorg rond deze kinderen verzameld. Tegelijkertijd werden aspecten van het proces van regionalisatie van de zorg voor deze specifieke groep patiënten binnen de regio onderzocht. De bevindingen kunnen gebruikt worden door beleidsmakers in de door hen te nemen beslissingen rond de ontwikkeling van het zo

noodzakelijke hoog kwalitatief interhospitaal transport systeem voor ernstig zieke kinderen. Tevens kunnen ze gebruikt worden voor het bepalen van het aantal noodzakelijke kinder intensive care bedden en het hierbij horende personeel en benodigde materiaal. Het ultieme doel is de uiteindelijke realisatie van een kwalitatief hoogwaardig systeem van zorg voor alle kritisch zieke kinderen in de regio, onafhankelijk waar ze het medisch systeem binnen komen.

In **Hoofdstuk Een** wordt een historisch perspectief geschetst van de introductie en evolutie van de pediatrische spoedeisende hulp. Naast aspecten die de regionalisatie betreffen wordt de ontwikkeling van kwalititeits parameters van geboden zorg besproken. Tevens wordt een overzicht gegeven van de in het verleden gebruikte ziekte-scorings-systemen en uitkomst scoresystemen. Tot slot worden in dit hoofdstuk de specifieke doelen van het onderzoek weergegeven.

Hoofdstuk twee betreft een retrospectief onderzoek naar de aantallen en karakteristieken van alle, per ambulance vervoerde kinderen binnen de regio Delft e.o. (200 km², 0,5% van Nederland). Van alle 57.851 kinderen onder 18 jaar in het gebied bleek 0,9% per jaar met de ambulance vervoerd te zijn. 89,1% hiervan werd vervoerd als 'urgent'. Kenmerken van deze groep zoals leeftijd, geslacht en gepresenteerd ziektebeeld werden onderzocht. De meerderheid van de transporten betrof het vervoer van tieners met een chirurgisch trauma. Een minderheid (3,7%) werd direct naar een academisch ziekenhuis vervoerd i.v.m. de klinische conditie van die kinderen en de hierdoor te verwachte opname op de aldaar aanwezige Pediatrische Intensive Care Unit (PICU). Bij 10% van alle pediatrische '112' meldingen bleek na aankomst van de ambulance bij het

kind en na onderzoek van het kind door de ambulanciers, verder vervoer naar een ziekenhuis niet noodzakelijk.
Van de groep van 'urgent' vervoerde kinderen (code 'A1') bleek bij 24% na aankomst in het ziekenhuis hoogwaardige urgente medische zorg essentieel in het eerste uur van opvang ('golden hour'). Bij extrapolatie van gevonden waarden naar een populatie van 100.000 kinderen onder de 18 jaar, kan gesteld worden dat er per jaar 235 kinderen zijn, degenen meegerekend die direct naar een PICU zijn vervoerd, waarvoor een 'golden hour' interventie noodzakelijk is. Dit komt neer op 0,23% van de totale populatie onder de 18 jaar.

In **Hoofdstuk drie** worden de gegevens gepresenteerd van de studie naar de aanwezigheid van materialen en medicamenten die voor de opvang van vitaal bedreigde kinderen essentieel zijn. Deze evaluatie van de inventaris van plaatsen waar ernstig zieke kinderen initieel worden gezien, vond plaats in 15 regionale ziekenhuizen in de regio Zuid West Nederland. Deze inventarisatie vond zowel op de diverse 'Eerste hulp' afdelingen als op de kinderafdeling van de 15 ziekenhuizen plaats. Het doel van deze prospectieve studie was naast primair een objectieve evaluatie te verrichten, een vergelijk te maken binnen en tussen ziekenhuisorganisaties. De 'optimale inventaris' werd samengesteld door de mening te vragen van 14, in verschillende delen van het land en in verschillende ziekenhuizen werkzame kinder-intensivisten. Hun gezamenlijke mening werd gebruikt als 'opinie van de expert'. Het ging om het door hun aangegeven belang van de aanwezigheid van de verschillende items die vermeld stonden op een inventarislijst, destijds gemaakt in de regio in het begin van de jaren 1990 door een regionale commissie bestaande uit kinderartsen 'met als doel een uniforme, optimale inventarisatie te

bewerkstelligen'. Door aan elk item een waarde te geven, uiteenlopend van een 1 voor 'handig' tot een 5 voor 'essentieel', kon een lijst worden samengesteld waaraan de diverse inventarissen konden worden gespiegeld.

Verschillen tussen en binnen ziekenhuizen werden gevonden en beschreven. De aanwezigheid van materiaal voor de behandeling van respiratoire problemen werd door experts gezien als het meest essentieel. In de ziekenhuizen bleek echter het materiaal voor de behandeling van circulatoire problemen het meest aanwezig, zowel op de eerste hulp afdeling als ook op de kinderafdeling. Bij 5 van de in totaal 26 onderzochte plaatsen (4 van de 11 kinderafdelingen en 1 van de 15 eerste hulp afdelingen) waar vitaal bedreigde kinderen initieel worden gezien, bleek de aanwezigheid van de spullen onder de 75 procent van het optimale niveau te liggen. De eerste hulp afdelingen waren overigens op alle gebieden significant beter voorzien van materialen en medicatie dan de kinderafdelingen.

In **Hoofdstuk vier** wordt de organisatie rond de opvang van ernstig zieke kinderen in 15 regionale ziekenhuizen in de regio Zuid West Nederland middels een prospectief onderzoek nader bekeken. Aan de hand van een vragenlijst met 4 patiënten casussen werd onderzocht, in het geval van een ernstig ziek kind, waar en hoe de eerste opvang plaats zou vinden en welke dokter, van welk specialisme, deze opvang zou verrichten. Kort gezegd: wie handelt en waar? Bovendien werd de 'route' van de kinderen binnen de ziekenhuizen geïnventariseerd indien er sprake zou zijn van een klinische verslechtering. Waar zouden ze heen gaan voor verdere observatie en behandeling en in geval van noodzaak van endo tracheale intubatie, wie verricht deze handeling en op welke plek. Van de vier patiënten werden er drie patiënten opgenomen

'van buiten' en de vierde was reeds opgenomen op de kinderafdeling, de dag ervoor. De gepresenteerde klinische conditie van de 3 varieerden van 'mild' (een 2 jarig kind met astma), 'matig ernstig' (een vier jarige met meningitis) tot 'ernstig' (een 'bijna' verdrinking van een 2 jarige. Degene die reeds was opgenomen betrof een peuter, opgenomen i.v.m. 'convulsies'. Wat blijkt is dat wanneer de verwachte klinische conditie slechter is, de kans dat het initiële patiënten contact op de kinderafdeling plaats vindt afneemt. De kans dat een kinderarts initieel start met de behandeling van een ziek kind neemt af met een toename van de ernst van het verwachte ziektebeeld. Vervolgens werd de route van het ernstig zieke kind, na de eerste opvang binnen de kliniek, onderzocht; zouden ze vervoerd worden naar de regionale Kinder Intensive Care of zouden ze binnen het regionale ziekenhuis blijven en zo ja waar? Er bleek een inconsistentie te bestaan in de route die de diverse kritisch zieke kinderen doorlopen binnen de verschillende ziekenhuizen; de route van de plek van initieel onderzoek naar de plek van mogelijke endo tracheale intubatie bleek voor de diverse kinderen in 50% van de gevallen niet uniform. De meerderheid van de kinderen zou echter bij klinische verslechtering door de kinderartsen aangeboden worden voor opname in de regionale kinder intensive care van het academisch ziekenhuis.

Hoofdstuk vijf bevat een prospectieve analyse, gedurende de periode van een jaar, van het aantal vitaal bedreigde kinderen en hun kenmerken, aangeboden voor opname in de regionale kliniek 'Reinier de Graaf Gasthuis' te Delft. Hiervoor werden binnen dit ziekenhuis op alle locaties waar deze patiënten werden aangeboden, gegevens verzameld bij opname. Tevens werden gegevens verzameld van de periode voordat het kind in het ziekenhuis was.

Hierbij werd gekeken naar de duur van de ziekteperiode, de transportduur en wijze van transport naast gegevens zoals de klinische conditie en de locatie van verblijf gedurende de eerste dag van opname. Van de groep van 36.000 kinderen onder de 18 jaar uit het verwijzend gebied werden 70 kinderen als vitaal bedreigd opgenomen. De gemiddelde leeftijd was 4,2 jaar, de meerderheid waren jongens (55%) en de meerderheid was van Kaukasische origine (77%). De meeste kinderen kwamen van huis (76%). Huisartsen verwezen 33% van de groep, in 24% van de gevallen bleken de ouders zonder tussenkomst van een arts de kinderen, met eigen vervoer naar het ziekenhuis te hebben gebracht. Tachtig procent van de kinderen werd gezien op de Eerste hulp afdeling, de meesten initieel door een arts assistent (85%). Na een dag waren 5 kinderen (7%) naar de regionale Kinder Intensive Care door verwezen, waren 33 kinderen (44%) weer huiswaarts gezonden, bleken 2 kinderen overleden te zijn (3%) en waren 32 kinderen (46%) nog opgenomen binnen het regionale ziekenhuis. Samenvattend kan worden gesteld dat per jaar 0,2% van alle kinderen met een leeftijd onder de 18 jaar, aangeboden waren aan een regionaal ziekenhuis. Bij deze kinderen bleek het tijdsinterval van het moment van ziek worden tot het zich melden in het ziekenhuis onafhankelijk van de raciale origine en de beheersing van de Nederlands taal van de ouders. Extrapolatie van de gevonden getallen en de gegevens uit Hoofdstuk 2 gebruikend, kan gesteld worden dat 44 op 100.000 kinderen onder de 18 jaar, per jaar aangeboden worden voor opname op een Kinder Intensive Care. Van deze groep waren 14 (32%) kinderen eerst opgenomen in een regionaal ziekenhuis, hetgeen het aantal hoog kwalitatieve inter hospitaal transporten weergeeft.

In **Hoofdstuk zes** is de algemene discussie, het toekomst perspectief en de samenvatting terug te vinden. Dit zowel in het Engels, Nederlands als Frans.

Hoofdstuk zeven bestaat uit een lijst met gebruikte afkortingen, het dankwoord, het curriculum vitae van de auteur en diens publicatielijst.

CHAPTER 7

7.1 List of abbreviations:

A	Anaesthesiologist
A1 / 2	Ambulance service urgency code
ALS	Advanced life support
APACHE	Acute, physiology, age and chronic health evaluation
APS	Acute physiology score
ATLS	Advanced Trauma life support
B	Ambulance service urgency code
BLS	Basic life support
CCS	Clinical classification system/score
CPA	Centrale Post Ambulance vervoer
CRIB	Clinical risk index for babies score
CSIP	Centre de Soin Intensif Pédiatrique
DP	Départements Pédiatriques
E	Emergency physician
ECG	Electro cardio gram
ER	Emergency room
GP	General practitioner
IC(U)	Intensive care (unit)
NICU	Neonatal intensive care unit

O	Other type of medical specialist
OPD	Outdoor patient department
OT	Operation theatre
P	Paediatrician
PD	Paediatric department
PICU	Paediatric intensive care unit
PIM	Paediatric index of mortality
PRISM	Paediatric risk of mortality
PRPC	Paediatric cerebral performance scale
PSI	Physiologic stability index
POPC	Paediatric overall performance scale
SU	Salles d'Urgence
SW	South west
TISS	Therapeutic intervention scoring system

7.2 Dankwoord

Mijn dank gaat uit naar een ieder die heeft bijgedragen tot het verwezenlijken van dit proefschrift. Op het gevaar af iemand te vergeten wil ik toch een aantal mensen noemen.

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bezocht om data te verzamelen.

De kinderartsen, kinderverpleegkundigen en het personeel van de diverse spoedeisende hulp afdelingen van de regionale ziekenhuizen in Zuid West Nederland wil ik bedanken voor hun bereidwilligheid mee te werken aan het onderzoek en de praktische hulp die ik van hen heb gekregen in het verwerven van de gegevens voor de studies.

De heren Bliemert en Heurman van de ambulancedienst te Delft en Den Haag dank ik voor hun steun bij het beschikbaar stellen van de transportgegevens.

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Tot slot bedank ik Mirjam. Ik draag dit boek aan haar en aan onze kinderen op.

7.3 Curriculum vitae

De auteur van dit proefschrift werd op 13 augustus 1963 geboren te Vlaardingen. In 1981 behaalde hij het VWO-diploma aan de Christelijke Scholengemeenschap Westland Zuid te Vlaardingen. In dat najaar begon hij met een studie geneeskunde aan de Erasmus Universiteit te Rotterdam, alwaar op 16 december 1988 het artsexamen werd afgelegd.

In 1989 en 1990 was hij achtereenvolgens AGNIO algemene chirurgie in het Academisch Ziekenhuis Rotterdam Dijkzigt Ziekenhuis (hoofd Prof. dr. J. Jeekel) en AGNIO kindergeneeskunde in het Academisch Medisch Centrum Emma kinderziekenhuis te Amsterdam (hoofd Prof. dr. C.J. de Groot).

Op 1 februari 1991 begon hij zijn niet-academische opleiding kindergeneeskunde in het Academisch Ziekenhuis Maastricht (opleider Prof.dr. R.H. Kuijten). Vanaf 1 januari 1993 werd de opleiding voortgezet in het Academisch Medisch Centrum Emma kinderziekenhuis (opleider Prof.dr. C.J. de Groot).

Op 1 november 1995 werd hij ingeschreven in het specialistenregister als kinderarts. In hetzelfde jaar, op 1 januari, was hij de opleiding tot kinderarts-intensivist gestart op de afdeling Intensive Care Kinderen van het Academisch Medisch Centrum Emma kinderziekenhuis (hoofd Drs. R.P.G.M. Bijlmer). Na 2 jaar werd deze opleiding afgerond en werd hij geregistreerd als subspecialist.

Vanaf 1 januari 1997 is hij werkzaam als kinderarts in het Reinier de Graaf Gasthuis te Delft.

Tot zijn aandachtsgebieden behoren de zorg voor kinderen die vitaal bedreigd zijn, kinderen met diabetes mellitus en de kindergastro-enterologie.

Tevens is hij intensief betrokken bij de locale en regionale

scholing ter verbetering van acute opvang van ernstig zieke kinderen.

Hij is getrouwd met Mirjam Engel en heeft 2 kinderen, Thies (1996) en Marlotte (1999).

7.4 List of publications

National

With peer-review

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4. Verhallen JTCM, Lely van der N, Kant SG
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   Ned. Tijdschrift voor Kindergen. 2000 (68), No3 p115-7.

Without peer-review

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2. Lely van der N, Gerver WJM
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3. Van Hoek-Ottenkamp WG, Lely van der N
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