

PROVISION OF PAEDIATRIC CARE IN RURAL TANZANIA: A CONTINUOUS CHALLENGE

An Analysis of Previously Published Work

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DEDICATION

To all children in this world that they may experience love and joy throughout their lives

To my own children

Sören, Ricarda, Laura, Maurits

To my caring parents

Ruth and Günther Krüger

And to my beloved wife

Thea

ABSTRACT

Health services for children in developing countries like Tanzania are in a critical state. Quality and quantity of preventive and curative services at all levels of the health system are neither sufficient nor always of high standard.

The objective was to analyse the state of the quality of paediatric care at a rural first-level hospital in Tanzania, thereby contributing to a solid scientific knowledge base for recommendations for change and improvement locally, in the country and potentially beyond its health system.

Seven studies were conducted at the facilities of Haydom Lutheran Hospital in northern Tanzania. Throughout 1996-2002 and 2006-2007, baseline demographic and quantitative data on the state of child health and of difficulties in the diagnostic and therapeutic approach in paediatric care were collected retrospectively first, using the reproductive-and-child-health clinic records, ward and laboratory records and annual reports. Then a program to improve obstetric and neonatal care within the hospital was analysed, using a before-and-after design. The final study on a telemedicine network examined its utilisation and impact on paediatric services in 40 institutions by analysing the log files. The “Continuum of Care” model was applied as the framework against which the research findings were evaluated.

In this rural setting, the majority of deliveries took place at home without skilled birth attendants. Therefore, many sick neonates and children had to be brought to health centres to receive care. But this group did not benefit from the provision of emergency transport when urgent treatment was required. The constraints in diagnostic facilities (here cranial ultrasound and laboratory work-up for anaemia and infections), impeded proper patient management. Treatment options for meningitis were limited due to the bacterial resistance pattern. The occurrence of congenital syphilis, a preventable disease, pointed to failures of the public health system. The study on obstetric and neonatal care in the hospital revealed that considerable improvement could be achieved, but this needed to be followed and supervised for prolonged periods. The telemedicine approach was feasible in terms of supporting paediatric care in this resource-constrained setting.

The research findings reflected the actual capacity of the Tanzanian health services while demonstrating considerable opportunities for improvement. The “Continuum of Care” model proved as a valuable framework for analysis of the complex health system with its inherent breaks and fragmentations, and has the potential to serve as a generic guideline for system changes. Deficiencies of the model became obvious in the area of diagnostic approaches and broader treatment options.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
HIV	Human Immunodeficiency Virus
HLH	Haydom Lutheran Hospital
IMCI	Integrated Management of Childhood Illness
IMR	Infant Mortality Rate
LBW	Low Birth Weight
NMR	Neonatal Mortality Rate
RCH	Reproductive and Child Health
U5MR	Under-Five Mortality Rate
VHF	Very High Frequency (Radio)
WHO	World Health Organization

LIST OF PAPERS

Paper I

C. Krüger, O.E. Olsen, E. Mighay, M. Ali (2011) Where do women give birth in rural Tanzania? *Rural and Remote Health* 11: 1791 (10 pages)

Paper II

C. Krüger, O.H. Evjen Olsen (2003) Inequities among the very poor: effect of young age on care-seeking. *Lancet* 361: 1744-1745

Paper III

C. Krüger, N. Naman (2010) Cranial ultrasound in neonates and infants in rural Africa. *South African Journal of Child Health* 4: 83-87

Paper IV

C. Krüger (2010) When ethnology informs clinical medicine: non-Bantu peoples without apparent sickle cell disease in the Mbulu area in Northern Tanzania. *Rural and Remote Health* 10: 1620 (3 pages)

Paper V

C. Krüger, I. Malleyeck (2010) Congenital syphilis: still a serious, under-diagnosed threat for children in resource-poor countries. *World Journal of Pediatrics* 6: 125-131

Paper VI

H. Vaagland, B. Blomberg, **C. Krüger**, N. Naman, R. Jureen, N. Langeland (2004) Nosocomial outbreak of neonatal *Salmonella enterica* serotype Enteritidis meningitis in a rural hospital in northern Tanzania. *BMC Infectious Diseases* 4: 35 (5 pages)

Paper VII

C. Krüger, M. Niemi, H. Espeland, N. Naman, I. Malleyeck (2012) The effects of standardised protocols of obstetric and neonatal care on perinatal and early neonatal mortality at a rural hospital in Tanzania. *International Health* 4: 55-62 (+ 2 webappendices)

Paper VIII

C. Krüger, M. Niemi (2012) A telemedicine network to support paediatric care in small hospitals in rural Tanzania. *Journal of Telemedicine and Telecare* 18: 59-62

I. INTRODUCTION

I.1. The State of Child Health in Developing Countries and in Tanzania

Despite some remarkable progress in the reduction of under-five mortality worldwide over the last decade, about 8.8 million children under five died in 2008 and 7.7 million in 2010, most of them due to infectious diseases, disorders in the neonatal period and malnutrition (Figure 1).^{1,2} While around 135 million neonates were born annually, 3.2 million pregnancies resulted in stillbirths.^{2,3} The vast majority of these deaths (> 95%) occurs in developing countries.¹⁻³ In addition, several million children survive, but suffer from complications of these diseases in the future.⁴ Some improvement in under-five mortality has been achieved, though. Back in 1990, 12.5 million children under five died. Since then, the average annual rate of decline has increased from 1.4 per cent in the 1990s to 2.3 per cent for the period 2000 to 2008.⁵ Nevertheless, mortality rates would have to decline much more sharply, in some regions more than 6 per cent annually, in order to reach Millennium Development Goal IV, which aims for a two-third reduction of under-five mortality between 1990 and 2015.^{5,6} Therefore it is anticipated that this goal will not be achieved globally by that latter date.

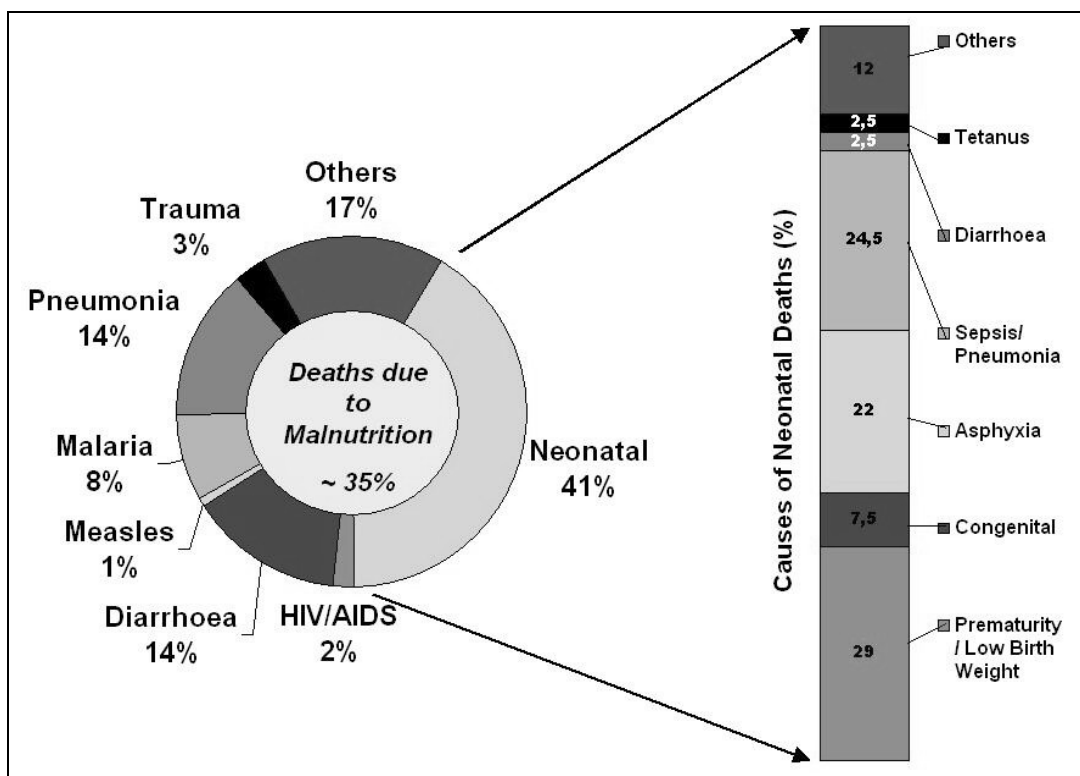


Figure 1: Causes of 8.8 million under-five deaths worldwide (2008)¹

The slowest progress has been in sub-Saharan African countries so far (under-five mortality rate (U5MR) 1990 – 184/1000 live births; 2008 – 144/1000 live births).⁵ Tanzania, located in East Africa with a population of 44.8 million in 2010, is one of these heavily affected countries.⁷ Over 22.9 million Tanzanians are under the age of 18 years, and 8.0 million under five years of age.⁷ The annual number of births is 1.862 million, the total fertility rate 5.5.⁷ According to the United Nations Development Program, Tanzania belongs to the 40 poorest and least developed countries in the world with a position of 152 out of 187.⁸ More than half of the population (68%) live on less than 1.25 US dollar per day in absolute poverty.^{7,8} About 18 per cent of the government budget is allocated to the national health services, which equates to 63 US dollars per capita per year.⁹ Besides the government, 40-50 per cent of the health services are provided by non-governmental organisations, most of them not-for-profit organisations like church health institutions.¹⁰

Recent national data indicate that the health situation of children may have improved to some degree. In 1990, the U5MR was 155/1000 live births and the infant mortality rate (IMR) 95/1000 live births; in 2010 the U5MR had dropped to 76/1000 live births, the IMR to 50/1000 live births, and the neonatal mortality rate (NMR) to 26/1000 live births (in 2008 it was 33/1000 live births).^{7,9} Mortality reduction has been particularly evident since 1999 and 2004/2005, the time of the two most recent Tanzanian health surveys.^{11,12} The major causes of under-five deaths in Tanzania are malaria (16%), pneumonia (13%), diarrhoea (11%), HIV/AIDS (9%), and neonatal disorders (34%).⁹ In 2010, the low birth weight (LBW) rate was 10 per cent, 16 per cent of the children under five were underweight, 5 per cent wasted, and 42 per cent stunted.⁷ While 160000 children were HIV infected, more than 1.3 million have already been orphaned due to HIV/AIDS.⁷

1.2. The State of Paediatric Health Services in Developing Countries and in Tanzania

Health services for children in developing countries, be them preventive or curative, are in a critical state.¹³⁻¹⁹ Availability of and access to high-quality care is often restricted. The seven-country study, conducted by WHO in Bangladesh, the

Dominican Republic, Ethiopia, Indonesia, Philippines, Tanzania and Uganda, provided a first systematic insight into this area.²⁰ Other studies from Africa, Eastern Europe and Asia followed, and all demonstrated severe constraints for the provision of good clinical care in children.²¹⁻²⁵ The main areas of concern were shortage of health staff, problems with motivation and skills, lack of essential equipment, poor organisation of services, also inadequate knowledge of health issues in the community and delayed or failing health care seeking.²¹⁻²⁷ But early recognition of illness and good clinical care are crucial for improving the health of children in developing countries, as 10-30 per cent of ill children being seen in outpatient departments or during outreach activities and suffering from severe illness, need curative care in health centres and hospitals.^{28,29} In reality, care-seeking on behalf of the children is delayed or does not take place at all quite frequently, as caregivers may not see the necessity, may fear or cannot afford possible expenses, transportation to the health institution may be erratic and uncoordinated, or health services are regarded as inadequate; thus children are denied the chance to receive potentially life-saving care.²⁶⁻²⁹ Preventive services like immunisation often fail to achieve their targets, thus vaccine-preventable diseases still occur in much of sub-Saharan Africa and elsewhere.¹⁹

The situation in Tanzania is not different from other developing countries. Several first-level health facility- and hospital-based studies on preventive and curative health care provision demonstrated similar failures as mentioned above.³⁰⁻³³ Mortality rates could be extremely high, staff shortage was severe, and lack of basic equipment was a constant concern.³¹⁻³³ During my clinical work at Haydom Lutheran Hospital, a rural first-level hospital in Tanzania, I encountered these shortcomings in paediatric health care right from the beginning. Many very sick children were brought too late to the hospital, the diagnostic and therapeutic approach was often uncoordinated and unstructured, and standards of good clinical care were not always followed. The same applied to outpatient care or the provision of preventive outreach services like immunisation.³⁴

1.3. The Rationale for this Analysis

The primary *aim* was to analyse the state of the provision of paediatric care at Haydom Lutheran hospital, thereby contributing to the scientific knowledge base

locally, in Tanzania and potentially beyond the country's own health system. Thus, the *objective* was to provide a solid database for analysis and any interventions and improvement at the hospital and beyond. The *research methods* consisted of collecting baseline demographic and quantitative data on the state of child health in the catchment area of the hospital and at the hospital itself, and of difficulties in the diagnostic and therapeutic approach in paediatric care provision, utilising the reproductive-and-child-health clinic records, ward and laboratory records and annual hospital reports in a partially retrospective approach. The next analysis assessed the effects of an intervention to improve the provision of paediatric (here neonatal) care within the hospital, considering the need for a sustainable approach without the support of significant external financial and human resources. The analysis of this intervention used a before-and-after design and consisted of demographic and quantitative data, again utilising the ward records and annual hospital reports. After my return to Germany, I continued to explore ways to support paediatric care at this and other rural hospitals in Tanzania. I got involved as a consultant in the Tanzania Telemedicine Network, which exactly serves this purpose.³⁵ After three years, I performed a retrospective analysis of the utilisation and impact of these consultations on child health services in the participating institutions by analysing the log files of the network.

1.4. The “Continuum of Care” Model

To provide a framework for a systematic analysis of the papers in this work, I will follow the “Continuum of Care” model described in the World Health Report 2005 in general³⁶ and in more detail by Kerber et al. in 2007.³⁷ The authors of this model argue that too many breaks, fragmentations and interruptions exist on all levels of health care provision, owing to failures and shortcomings among the people in

Box 1: Proposed definition of the “Continuum of Care” model

“The continuum of care for maternal, neonatal, and child health requires access to care provided by families and communities, by outpatient and outreach services, and by clinical services throughout the lifecycle, including adolescence, pregnancy, childbirth, the postnatal period, and childhood. Saving lives depends on high coverage and quality of integrated service-delivery packages throughout the continuum, with functional linkages between levels of care in the health system and between service-delivery packages, so that the care provided at each time and place contributes to the effectiveness of all the linked packages.” (citation from reference 37, page 1359)

need of care (demand side), within the health system and among the providers of health care (supply side). Therefore, this framework (for its definition see Box 1 to the left) proposes that

provision of care must include the whole continuum of age (the life cycle) and places (or levels) of health care where (not only) *paediatric* patients may be encountered: from adolescence to motherhood, birth, infancy, childhood until adolescence again, and from the core family and the community, to mobile health services, first-line health institutions, hospitals to referral centres and back again. Services may be preventive or curative, may be family- or community-based, outreach activities or incorporate facility-based clinical care. Patients and their families may get into contact with the health system at any level and may pass across the different levels in no predictable order. At the same time, health services may meet with patients at any age phase and at any level of health care (Figure 2).

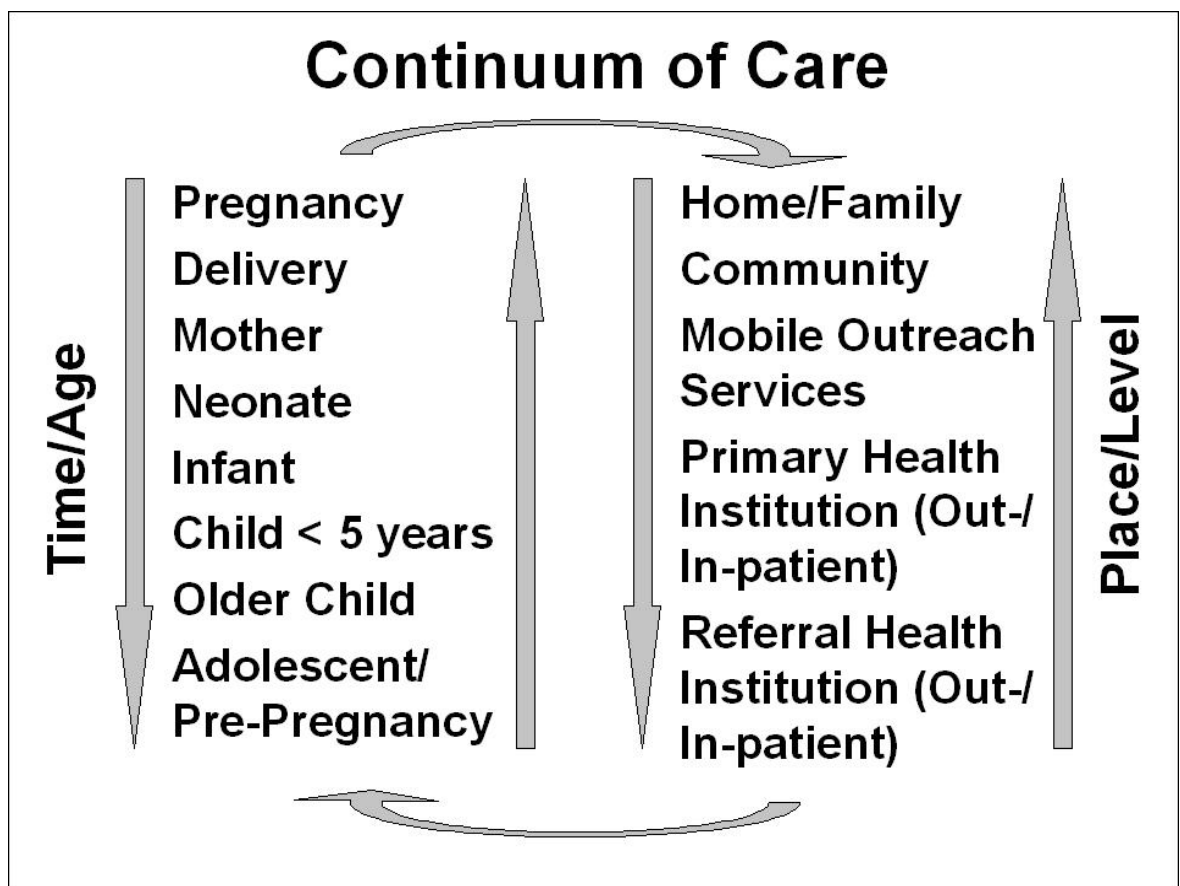


Figure 2: The "Continuum of Care" model (adapted from reference 37)

Connected to the different ages and places/levels of care are so-called integrated packages of interventions which cover the different aspects of health care provision: one package is located at the family and community level and promotes family and community care. Four packages are located at the level of outreach/outpatient activities and include reproductive health, antenatal care, postnatal care

and child health. The fifth package at this level (5A. Childbirth care) was added because the services around delivery can also be provided during outreach activities. Three packages are part of the clinical care level and include reproductive health, childbirth care and neonatal and child care (Table 1).³⁷

Despite its structured composition, the complexity of this framework is challenging, and also the packages of interventions which were proposed in the original article.³⁷⁻³⁹ These more than 190 interventions are mainly based on several review series which were published in the *Lancet* a few years ago, their inclusion being based on their efficacy and potential impact on neonatal, child and maternal health and survival.⁴⁰⁻⁴³ Several authors note that not all available interventions are included in the model, especially as it focuses very much on some common maternal, neonatal and child health problems like obstructed labour, birth asphyxia, pneumonia or diarrhoea, just to name a few; others, including the authors of the original article, argue that several of the proposed interventions may not be applicable in a given context or warrant further effectiveness studies.^{37-39,44} Furthermore, the framework assumes to a certain degree that a mere increase of coverage of the packages would lead to improved health and survival (see definition in Box 1), but does not propose in practical terms that health system changes, increases in number and quality of health staff and improved health behaviour and care seeking on the side of the patients and their caregivers are also essential to overcome the existing breaks and disruptions when applying this model to the real situation.³⁷⁻³⁹ Still Kerber and colleagues themselves acknowledge that it cannot be used as a universally applicable interventional blueprint for all health systems.³⁷ The main value of this model may not be the inclusion or exclusion of a special set of interventions then, but the pragmatic call for an inclusive approach towards the population at any stage of life and at all levels of health care. It is obvious that it is impossible at present to implement the whole model within all countries in all settings. But it is worth to work along the framework to try to improve demand for and provision of health care at all levels at each stage of life. This is exactly the reason why I chose this model to evaluate against it the research findings which are presented in this analysis. More arguments on the deficiencies and applicability of the model will be presented later in the discussion section.

Table 1: Intervention Packages at Different Levels of Health Care (modified from reference 37)

	1. Reproductive health		2. Childbirth care	3. Neonatal and child care	
Clinical care level	Case management for sexually transmitted infections, including HIV Safe (post-) abortion care Management of pregnancy-related complications Emergency medical care		Skilled obstetric care at birth and essential care for neonates Prevention of maternal to child transmission of HIV and other infectious diseases Emergency obstetric care and immediate emergency care for neonates (resuscitation)	Emergency medical care Case management (diagnosis and treatment) of neonatal and childhood illness Extra care for preterm and LBW babies, including kangaroo mother care Care of children with HIV/AIDS	
	4. Reproductive health	5. Antenatal care	5A. Childbirth care¹	6. Postnatal care	7. Child health
Outpatient/outreach services level	Family planning Abortion care Prevention and management of sexually transmitted infections and HIV Nutritional support (macro- and micronutrients)	Antenatal care integrated with malaria prevention, intermittent preventive treatment in pregnancy, and insecticide-treated bednets Tetanus immunisation Prevention of maternal to child transmission of HIV and other infectious diseases	Skilled obstetric care at birth and essential care for neonates and resuscitation, if skilled attendant present ¹	Promotion of healthy behaviours for mother and baby Early detection and referral of complications Extra visits for preterm babies Prevention of maternal to child transmission of HIV Family planning	Vaccinations Malaria insecticide-treated bednets Nutritional support Care of children with HIV/AIDS Integrated management of newborn and childhood illness
	8. Family and community care				
Family and community care level	Adolescent and pre-pregnancy nutrition Education Prevention of HIV and sexually transmitted infections Family planning	Healthy home behaviours for women in pregnancy: nutrition, reduction of workload, knowledge of labour signs, recognition of danger signs, emergency preparedness Community behaviours, organisation of emergency transport, and funding schemes	Where skilled delivery care is not available, education about clean delivery, recognition of danger signs, emergency preparedness, and simple early care for neonates, including warmth, cleanliness and immediate breastfeeding	Healthy home behaviours including: exclusive breastfeeding, hygienic care of cord and skin, extra care for preterm babies Water, sanitation, and hygiene for neonate and mother Promotion of demand for quality skilled care, recognition of danger signs, and care-seeking	Case management of diarrhoea with oral rehydration salts, of pneumonia, severe malnutrition, neonatal sepsis, and malaria, where use of facility care is low or facilities are unavailable
Life cycle	Adolescence and pre-pregnancy	Pregnancy	Birth	Postnatal (mother) Postnatal (neonate)	Maternal health Infancy Childhood

1: added by this author

1.5. Contribution to Scientific Knowledge

The papers which are included in this analysis examine some aspects of health care provision in a rather resource-poor health care setting in rural Tanzania, thereby contributing to a better knowledge base about the problems and possible solutions within such a context. Their results are discussed against the “Continuum of Care” model, in view of the capacity of the Tanzanian health services and some societal aspects in Tanzania. The papers relate specifically to the Tanzanian health system, hence most importantly they enhance scientific knowledge with regard to this national context. But as the Tanzanian health system is quite typical for most of Eastern and Southern Africa,⁴⁵⁻⁴⁸ several aspects may also be applicable to other countries in these regions and beyond.

II. OBJECTIVES OF THE RESEARCH

The contribution to knowledge described in this analysis is to provide an exploration of factors which facilitate or impede the improvement of paediatric care at a rural hospital setting in a resource-constrained environment like in northern Tanzania. The findings are then evaluated against the “Continuum of Care” model as a framework for maternal, neonatal and child health care in developing countries.

More specifically, the research objectives include:

1. Analysis of factors and determinants for seeking health care on behalf of the children – demand side (papers I and II)
2. Analysis of factors and problems of the diagnostic and therapeutic approach – supply side (papers III-VI)
3. Analysis of interventions to improve provision of high-quality paediatric (here neonatal) care with a focus on structured change management – supply side (paper VII)
4. Analysis of the applicability of modern telemedicine systems to the provision of paediatric care in a resource-constrained environment in rural small hospitals in Tanzania – demand and supply side (paper VIII)
5. Discussion of the value and the applicability of the “Continuum of Care” model in the Tanzanian health system in the light of the research findings

III. MATERIAL AND METHODS

III.1. The Setting

The studies for papers I-VII were conducted at the facilities and the reproductive-and-child-health (RCH) clinics of Haydom Lutheran Hospital (HLH), a rural church hospital in northern Tanzania. It is owned by the Mbulu diocese of the Evangelical Lutheran Church in Tanzania. HLH is located at the southern edge of the Mbulu district (Figure 3), 380 km south-west of Mount Kilimanjaro in the Manyara region and more than 1,000 km from the *de facto* capital Dar-Es-Salaam.⁴⁹⁻⁵¹ The 400-bed hospital serves a population of more than half a million people, and offers surgical, medical, tuberculosis, gynaecological/obstetric, and paediatric services in 6 wards, including the intensive care unit.⁴⁹⁻⁵¹ Each year, more than 12,000 inpatients are treated.⁵² The same services (except intensive care) are offered in an outpatient department to more than 70,000 patients per year.⁵² Children represent about 30-40 per cent of total patient numbers.⁵² Around 2,500-4,500 women give birth at the hospital each year,^{51,52} while more than 11,000 have their babies delivered at home, mostly without skilled attendance, in the total catchment area.⁴⁹⁻⁵¹ During 1996-1999, there were 20 mobile RCH clinics, located up to 100 km from HLH. In 2006 and 2007, this number had increased to 27 mobile RCH clinics.⁴⁹⁻⁵¹ The mobile RCH clinics were reached using either a four-wheel-drive vehicle or a light aircraft for the 6 most remote locations, and were held at fixed locations (like church buildings, schools or local dispensaries) at regular dates once per month which were made known to the local population in advance. In addition, one permanent RCH clinic was open daily at HLH. These clinics together conducted over 25,000 antenatal care examinations in more than 5,000 pregnant women and over 65,000 examinations (including immunisations) in more than 6,000 children under five per year.⁴⁹⁻⁵²

Paper VIII is based on data of the Tanzania Telemedicine Network, which was started in 2008 as a project of the Department of Health of the Evangelical Lutheran Church in Tanzania in order to support the provision of care at small rural hospitals.³⁵ This church runs 20 hospitals in the country which are mostly located in remote rural areas with only non-specialist staff available.¹⁰ In addition, the

III.2. The Study Area and Population Structure

The Mbulu area, including the southern Karatu district and the whole Mbulu district, is a rural, difficult-to-reach area with scarce road and transportation infrastructure.⁴⁹⁻⁵¹ HLH is located at the southern corner of this area (Figure 3). Its population is unique for sub-Saharan Africa in that it comprises 4 different language groups with remarkably differing ways of life: the Iraqw, the Datoga, the Hadzabe, and several Bantu tribes.^{49,50,53-60} The major tribes are the Cushitic Iraqw with a population of around 500,000, who are mainly subsistence farmers with some domestic cattle;^{49,50,53,54} and the Nilotic Datoga, who number 100,000-200,000 people and are nomadic pastoralists, moving around with their livestock over long distances.^{49,50,55-57} The third and smallest group, the Khoisan Hadzabe, numbers only 1,000-1,500 people. They are true hunters-gatherers with a non-sedentary lifestyle.^{58,59} The Iraqw mainly populate the highland plateau of the Mbulu and Karatu districts.^{49,50,53,54,59,60} The Datoga and Hadzabe reside in the Yaeda Valley between Lake Eyasi and the eastern escarpment of the Rift Valley,^{49,50,55-60} with the Datoga additionally occupying areas south of the HLH catchment area in the Basotu division of Hanang district.^{49,50,55-57} The remaining tribes belong to the Bantu who are typically subsistence farmers or small-scale traders.^{49,50,59} The Datoga and the Hadzabe are difficult to reach with any kind of social services, including health care provision by the RCH clinics of HLH.⁵⁵⁻⁵⁸ The Iraqw and Bantu communities, which have settled, are more easily accessible.^{53,54,59,60}

III.3. The Study Periods and Data Collection

Data for paper I were collected at the RCH clinics in 1998 and 1999 while working as a consultant paediatrician at the hospital (June 1997 – September 2000), and as a follow-up for the years 2006 and 2007 in summer 2009. Both periods were the basis for my master's thesis on immunisation rates in the catchment area of Haydom Lutheran Hospital.³⁴ The specific data which were used for paper I were collected from the RCH records during that time, but were not included in the master's thesis.

Data for papers II-VI were collected from the ward and laboratory records and the annual hospital reports during the time when I was consultant paediatrician and

head of the Department of Paediatrics at HLH from June 1997 to September 2000. Data collection started on January 1st, 1998 and was continued until August 31st, 2000. Not all publications covered this whole period.

Data for paper VII were collected retrospectively covering the period from January 1996 to December 2002. While data until the end of August 2000 were taken from the annual reports and hospital records during the time of my clinical work at HLH, the remaining three-year period was analysed by extracting data from the annual hospital reports after 2002.

Data for paper VIII covered the period March 2008 to February 2010 and were collected retrospectively from the log files of the password-protected internet platform iPath (www.ipath-network.com/ipath/), which hosts the Tanzania Telemedicine Network, in the beginning of 2011.

III.4. Data Processing

All data were entered manually in data collection sheets, re-checked for inconsistencies against the original records and annual reports and then entered into SPSS v15.0 (SPSS Inc., Chicago, IL, USA) (paper VI: Stata 8 for Mac OSX (Stata Corporation, College Station, TX)) for analysis. Random checks were conducted to minimise errors from data entry.

III.5. Statistical Analyses

Descriptive statistics (mean, median, range, rates, quartiles) were calculated with standard programs using SPSS v15.0 (paper VI: Stata 8). For mortality rates, 95% confidence intervals were calculated using the standard error of the observed proportions. Differences in rates were analysed using the chi-square test. In order to correlate dependent categorical variables with possible underlying factors, both univariate and multivariate logistic regression analyses were performed. Odds ratios with 95% confidence intervals were calculated by these analyses. The level of significance (two-sided) was defined as $p < 0.05$.

III.6. Ethical Considerations and Research Clearance

None of the studies included an experimental part. Paper I utilised data which were collected during a study on immunisation rates in the catchment area of Haydom Lutheran Hospital. Ethical approval for the main study was obtained from the National Institute of Medical Research and the Commission for Science and Technology in Tanzania and the Human Research Ethics Committee at Curtin University of Technology in Australia, while permission to use the RCH records was obtained from HLH.

The papers II-VII arose from observational data during my clinical work at Haydom Lutheran Hospital and within its catchment area. Paper VI was prepared in collaboration with the Institute of Medicine and the Centre for International Health at the University of Bergen, Norway. Permission for publication was granted by the hospital management.

Paper VIII is based on the log files of the consultations which were posted on the iPath platform of the Tanzania Telemedicine Network. Permission to analyse these data anonymously was granted by the telemedicine network management.

III.7. Conflict of Interest

For all the study periods and the resulting publications, there is no conflict of interest to declare.

IV. RESULTS AND CONTRIBUTION TO KNOWLEDGE

IV.1. Main Findings

The research was conducted to evaluate the state of child health services and the effects of supporting and improving paediatric care in a rural health service setting in a resource-constrained environment in northern Tanzania. In this rural area, the majority of deliveries takes place at home in the community without the presence of a skilled birth attendant. The finding applies especially to the nomadic Datoga tribe who live in the more remote areas. Given this fact, many neonates and children who fall seriously ill need to be brought to health centres in order to receive care. Contrary to the need, the data demonstrate that especially this age group does not benefit from the provision of emergency transport facilities if urgent treatment is required during the course of a serious illness. But pregnant women who are about to deliver benefit from such a service as they utilise it most. When it comes to the diagnostic approach at the health institution, which is essential for an effective and efficient use of therapeutic interventions, the results show that, despite severe constraints like lack of appropriate diagnostic means (here ultrasound and laboratory), valuable information can be obtained for the patient management by skilled staff. In certain infant groups, even technically poor ultrasound devices can provide important details for the prognosis and treatment. And ethnological information can direct scarce diagnostic resources towards those patient groups where the highest diagnostic yield is to be expected. As on the diagnostic side, treatment options, here exemplified by the disease entities congenital syphilis and meningitis, are often limited. The fact that a disease like congenital syphilis is still diagnosed also points to failures in the public health system as this is, in principle, a preventable disease. The analysis of unexpected resistance patterns of the causative micro-organisms in neonatal meningitis demonstrates that basic microbiological services are important for health institutions world-wide. But even if the diagnostic tools are at hand, effective management implies the availability of the necessary drugs. The analysis of provision of actual obstetric and neonatal care in the hospital reveals that considerable improvement can be achieved with little changes and structured change management only, but these need to be followed and supervised for prolonged periods. The findings of this study also demonstrate that the health

system fails to some degree when judged by the large number of stillbirths. Finally we demonstrate that a telemedicine approach is feasible in terms of supporting medical paediatric care, but it has not yet shown any impact on hard outcome parameters like mortality.

IV.2. Synopsis of the Papers

Following the “Continuum of Care” model which was presented in chapter I.4, this section will place the published papers into this framework and will evaluate the results against this model in more detail. At the end of each assessment, a brief classification will inform which of the three levels and which of the eight (nine when including 5A.) intervention packages are represented by the respective paper. Thereby, the results contribute to the scientific global debate on the continuum of neonatal, child and maternal care.

Paper I: Where do women give birth in rural Tanzania?

Skilled birth attendance and place of birth determine the chances of survival for the neonates (and their mothers) significantly.⁶¹ In addition, the time of delivery is the first opportunity for the neonate to be seen and attended by a health care professional.^{37,61} In this first paper, we analysed the rates of skilled birth attendance and place of birth in the rural, remote population in the catchment area of HLH in northern Tanzania. We could show that more than 70 per cent of the 3,851 women who were registered at 8 RCH clinics of the hospital delivered their babies at home. This situation changed only slightly over the years. The main factor which determined the rate of skilled birth attendance was affiliation to the nomadic Datoga tribe, which adheres strongly to traditional customs and social structures.^{55,56} Among these women, rates of deliveries with skilled attendance could be as low as 5-10 per cent. They were also those living farthest away and being least accessible. These findings imply that new approaches have to be developed to serve nomadic and remote societies. Static, institutional delivery services are not sufficient to reach them. Probably, the most promising approach would be to increase awareness about pregnancy-, birth- and newborn care-related issues and to have skilled birth attendants (like midwives or trained traditional birth attendants) living close to or with these communities.⁶² This

approach would imply that organised transportation services were in place in case of an obstetric or neonatal emergency.

When evaluating these findings against the “Continuum of Care” model, it shows that there were severe shortcomings on the family and community level and within outreach services. Pregnant women did not seek the assistance of skilled birth attendants, the health system was not prepared to provide this cadre of staff on the community level, and a critical gap existed with regard to early postnatal skilled care for the mothers and their infants.

Levels: Family and community; outreach services; Packages: 4, 5, 5A, 6, 8

Paper II: Inequities among the very poor: effect of young age on care-seeking

Seeking care during the course of illness is one of the basic pre-requisites for receiving health care. In the case of children, their caregivers, typically the parents or adult members of the extended family, have to bring them to the attention of medical staff. Therefore in this second paper, we examined the effect of young age on using emergency ambulance services run by the hospital, thereby determining children's chances to receive care in emergency situations. The ambulances could be called 24 hours a day from the surrounding villages, using publicly accessible VHF radios which were placed with reliable people in these villages. Although infants and young children carry a high risk of morbidity and mortality in resource-poor settings compared to older age groups,⁶³ in this study of 798 transported individuals, infants (less than one year) were four times and children younger than fifteen years were even eleven times less likely to benefit from the ambulance emergency services than patients older than fifteen years, and had higher mortality rates (20% vs. 9%). The highest number of transports was arranged for pregnant women. One may argue that at least neonates benefited indirectly as 36 per cent of all transports were related to obstetric complications (Table 2). But as children under five carry a high risk of mortality, potentially life-saving interventions should be used more frequently. We could not explore reasons for this low utilisation rate in our retrospective study, but parents possibly did not recognise the severity of illness correctly, thought they were able

to bring the children themselves or decided in the interest of the household not to use ambulance services which required a user fee.^{26,27,64}

This study clearly demonstrates the break between community practices and seeking clinical care as proposed in the “Continuum of Care” model. Despite the provision of emergency transport, this is not utilised by a high-risk group, thus clinical services do not reach the potential patient groups. In addition, knowledge of vital health issues may be absent in the local population which impedes the utilisation of health services further.

Levels: Family and community; outreach services; clinical care; Packages: 1, 2, 4, 5, 5A, 6, 7, 8

Table 2: Reasons for emergency ambulance transportation (1999)

	< 15 years (n = 79 (%))	Deaths < 15 years (n = 10)	> 15 years (n = 719 (%))	Deaths > 15 years (n = 63)
<i>LBW</i>	2	1	-	-
<i>Meningitis</i>	3	3	3	-
<i>Pneumonia</i>	11 (14)	2	27 (4)	3
<i>Sepsis</i>	2	1	2	1
<i>Rabies</i>	1	1	-	-
<i>Malaria</i>	37 (47)	2	170 (24)	22
<i>Tuberculosis</i>	3	-	41 (6)	12
<i>AIDS</i>	-	-	5	2
<i>Gastroenteritis</i>	4	-	23 (3)	2
<i>Pregnancy-related</i>	-	-	290 (36)	5
<i>Cardiac Failure</i>	-	-	10	6
<i>Lung Disease</i>	-	-	15	2
<i>GIT Disease</i>	3	-	37 (5)	4
<i>Stroke</i>	-	-	3	1
<i>Cancer</i>	1	-	5	2
<i>Burns/Injuries</i>	3	-	32 (4)	1
<i>Intoxication</i>	3	-	5	-
<i>Epilepsy/</i>	2	-	6	-
<i>Neurology</i>				
<i>Abscess/</i>	3	-	10	-
<i>Osteomyelitis</i>				
<i>Diabetes mellitus</i>	-	-	4	-
<i>Gynaecology</i>	-	-	11	-
<i>Urology</i>	-	-	9	-
<i>Miscellaneous</i>	1	-	11	-

Paper III: Cranial ultrasound in neonates and infants in rural Africa

The diagnostic approach to childhood diseases is often very different in resource-poor settings compared to developed countries. This is frequently due to limited resources and lack of health workers' skills. The third paper used cranial ultrasound in infants as an example to illustrate how difficult and different the use of diagnostic aids, which are standard procedures in industrialised settings, is in resource-poor health services. Whereas cranial ultrasound is commonly applied in developed health systems, especially in preterm infants, it is rarely used in rural hospitals in developing countries.⁶⁵ Including 293 patients, we found that the focus of interest is in older infants, mainly with hydrocephalus, spina bifida and after meningitis, to a lesser degree in birth asphyxia, seizures and developmental delay. Despite all shortcomings, it is essential to use scarce diagnostic resources to a maximum, as their results may guide the application of therapeutic interventions, e.g. in this case the insertion of shunt systems to relieve intracranial pressure in hydrocephalus. Moreover, we could demonstrate that it is possible to teach new diagnostic techniques in a short time which enhances local health workers' skills.

With regard to the "Continuum of Care" model, this diagnostic approach, not yet included in the model, will improve the case management of neonatal and childhood illness at the clinical care level, although results and outcome may not be comparable to industrialised countries, and the health services will benefit from improved health workers' skills.

Levels: Clinical care; Packages: 3

Paper IV: When ethnology informs clinical medicine: non-Bantu peoples without apparent sickle cell disease in the Mbulu area in Northern Tanzania

The fourth paper described how with restricted diagnostic resources ethnographic information could assist in achieving a diagnosis and directing scarce resources towards selected patient groups in greatest need. Sickle cell anaemia is a life-threatening inherited disease which is unevenly transmitted in different ethnic groups in Africa.⁶⁶ Bantu tribes are much more affected than non-Bantu tribes. As the major tribes in the catchment area of the hospital were non-Bantu tribes (Cushitic and Nilotic), we could demonstrate that only anaemic children from the

Bantu tribes had a risk of suffering from sickle cell anaemia. Thus diagnostic work-up in children with severe anaemia was directed towards this group which facilitated correct diagnosis and treatment and reduced expenditure for the hospital and the patients.

Despite this interesting observation that ethnographic information could guide diagnosis and treatment in a special population, the severe constraints in clinical case management (here insufficient diagnostic tools) cannot be ignored. This is reflected in the “Continuum of Care” model which concentrates very much on common conditions, but does not consider the need for diagnostic tools and therapeutic options for other, not so common disease entities.

Levels: Clinical care; Packages: 3

Paper V: Congenital syphilis: still a serious, under-diagnosed threat for children in resource-poor countries

The fifth paper serves as an example how difficult to control diseases can be if diagnostic and therapeutic resources are scarce and public health strategies fail. During a 32-month period we diagnosed fourteen patients less than one year of age with congenital syphilis who presented to the hospital, mainly based on clinical signs and symptoms, basic laboratory testing and maternal history. Correct diagnosis required a high degree of clinical suspicion, as no confirmatory testing for congenital syphilis was available. Although treatment with penicillin was initiated in all patients, two of them died. Based on data of other studies in the area,⁶⁷ syphilis sero-prevalence in pregnant women was high (7%), and most likely many more cases were missed.

The diagnosis of congenital syphilis pointed to a major deficiency in the public health services. In principle, congenital syphilis is a completely preventable disease as testing pregnant women routinely and treating affected women and their partners during pregnancy would avert congenital syphilis.⁶⁸ Reliable on-the-spot-test systems are available to facilitate testing and the decision process for treatment.⁶⁹ This study revealed that seemingly routine screening for syphilis was not applied universally and that many women missed the opportunity to get tested

and treated. Hence many infants were at risk to be born with congenital syphilis, and most likely many of these pregnancies resulted in stillbirths.

This paper is an example for failures along all levels and packages of the “Continuum of Care”, starting from the family and community care level and extending up to the clinical care level, incorporating also the different stages of the life cycle. The application of the “Continuum of Care” model to these findings provides a promising tool to improve the utilisation and quality of the health service.

Levels: Family and community; outreach services; clinical care; Packages: 1, 2, 3, 4, 5, 5A, 6, 7, 8

Paper VI: Nosocomial outbreak of neonatal Salmonella enterica serotype Enteritidis meningitis in a rural hospital in northern Tanzania

The sixth paper demonstrates that clinical care can become extremely difficult if resources for diagnosis and treatment are inadequate. At the hospital, a very high case-fatality rate (> 60%) was noted in neonates with meningitis and septicaemia. As microbiological facilities were not available locally, it was unclear whether the treatment regimen with ampicillin and gentamicin (and chloramphenicol as a second-line drug), all standard drugs for this condition in developing countries, was adequate (e.g. resistance) or if the causative bacteria were different from the suspected common strains (Streptococci, E. coli). Only by setting up a provisional laboratory in collaboration with a university hospital in Norway, it could be proven that the organisms were Salmonella strains which were resistant against the common drugs (ampicillin and chloramphenicol) and which were probably transmitted within the hospital setting. These findings supported other reports that Salmonella is a frequent cause of septicaemia and meningitis in African populations.⁷⁰ The resistance to multiple antimicrobial agents which was observed increases the risk that empirical treatment will fail, especially in resource-constrained settings where modern antibiotics (e.g. cephalosporins) and microbiological laboratories are not available. Without the support of the foreign laboratory, correct diagnosis and treatment of bacterial meningitis and septicaemia in neonates and children would have remained an insurmountable challenge.

This paper demonstrates that the composition of the different intervention packages at the different levels of the “Continuum of care” model is far from optimal. Standard case management, including diagnostic work-up and routine treatment which are directed towards the common childhood diseases in developing countries, would not have been successful in this particular situation without changes in hospital hygiene, external support and improved diagnostic and therapeutic facilities.

Levels: Clinical care; Packages: 2, 3

Paper VII: The effects of standardised protocols of obstetric and neonatal care on perinatal and early neonatal mortality at a rural hospital in Tanzania

Using the seventh paper as an example, we examined how it is still possible to improve medical care for children, here neonates, in resource-poor settings without large additional input, but with a focussed effort on quality-of-care improvement. At the beginning of the seven-year retrospective study in 1996, quality of obstetric and neonatal care was judged as being too low when assessed by the high maternal, perinatal and neonatal death rates at the hospital. After guidelines for obstetric and neonatal care had been developed and disseminated to the staff over more than two years, the outcome of 18,026 deliveries at the hospital was analysed for the seven-year period. The death rates began to drop slowly during the following years, but with considerable fluctuations. Perinatal and early neonatal mortality rates decreased over time (from 54.5 to 42.8 and from 21.9 to 14.8/1,000 live births, respectively) and were similar to or lower than in most studies from Tanzania and other African countries,^{31,49,71-73} but the decline was not significant. Stillbirth rates did not change very much, and throughout the years most neonatal deaths occurred during the first three days of life. Only the maternal mortality ratio dropped significantly. Partial non-adherence to the protocols, staff fluctuation and changes in the composition of the patients were thought to be responsible for the differing results. Hence the data supported our assumption that only long-term investment in quality-of-care management would achieve significant changes, but that this is possible without large external input.

This paper is a good example how clinical care can be changed and improved, but also how closely the clinical care level is linked to the outreach services and family/community care as high stillbirth rates can point to failures in antenatal and childbirth care as well as lack of knowledge about pregnancy and birthing issues within the families and communities. Furthermore, it demonstrates the close linkage between maternal, neonatal and child health which is at the heart of the “Continuum of Care” model.

Levels: Family and community; outreach services; clinical care; Packages: 1, 2, 3, 4, 5, 5A, 6, 7, 8

Paper VIII: A telemedicine network to support paediatric care in small hospitals in rural Tanzania

The final paper describes a more recent development, namely the application of modern telecommunication technology to improving paediatric care in rural hospitals without specialists on site in Tanzania. In a country like Tanzania, health workers are constantly in need of support in their daily clinical activities. This is due to the severe staff shortage, but also to some degree due to problems with quality and motivation of staff and structural problems of the health system.⁷⁴⁻⁷⁶ This study examined the feasibility and utilisation of a simple, internet-based store-and forward telemedicine network in small rural hospitals in Tanzania. The technical infrastructure was managed well, but its utilisation rate was low (< 1%) when judged by the potential number of patients at these institutions over the three years of study. Most of the 159 consultations were sent in connection to actual patient care, but sometimes general issues like hygiene or immunisation were discussed as well. The speed of providing responses was encouraging, with 50 per cent being given in the first 6 hours after the consultation. The majority of responses was provided by the voluntary paediatric consultants. The support was appreciated very much by the local staff, but the feedback on the actual patients was too infrequent (13%) to judge the impact of the telemedicine advice on the actual outcome. This aspect needs to be evaluated in another study.

This approach has the potential to improve clinical case management in the health institutions, but this has not been proven yet in a formal assessment. The network

could be used also for teaching in the hospitals, in the outreach services or in the communities, but this would require considerably more human, financial and technical resources. In Tanzania, this telemedicine network could support staff in their work along the “Continuum of Care”, but its potential has not been explored fully.

Levels: At present clinical care; Packages: 2, 3

V. DISCUSSION

As seen in the previous chapter, the papers which are part of this analysis cover the wide spectrum of health services for children (and their mothers) at different levels and age groups. Although by no means comprehensive, they do serve as examples along the “Continuum of Care” model. Here I shall discuss the results against the capacity of the Tanzanian health system in the light of the “Continuum of Care” model, thereby contributing to the scientific debate; then I shall evaluate the “Continuum of Care” model in more detail; and finally I shall consider methodological issues.

V.1. The Tanzanian Health System and the “Continuum of Care” Model

The low levels of deliveries with skilled birth attendants (paper I) resemble the findings of studies from Tanzania and other countries.^{7,9,12,77-80} In developing countries, on average 66% of women give birth with skilled attendance, in Tanzania only 43-49%.^{7,9} The fact that especially nomadic Datoga women gave birth without skilled attendants in the vast majority of deliveries points to the unsolved problem that rural, remote, difficult-to-access populations have the highest risk for unattended deliveries and subsequent maternal and neonatal complications.⁷⁷⁻⁸³ But even for the peasant Iraqw women, delivery rates with skilled attendance were only higher when living closer (< 30 km) to functioning obstetric services, resembling findings from Burkina Faso and Vietnam.^{78,79} Hence a critical break exists in the continuum of care in this and other populations as attendance rates at antenatal care clinics are typically close to 90 per cent or even higher in most developing countries (as it was the case at the RCH clinics of HLH and in Tanzania in general).^{7,9,12,49,50,77} Thus a systematic problem seems to exist which impedes the continuation from antenatal care to skilled delivery services which cannot just be solved by an increased quantity of services.⁸⁴ Gabrysch and Campbell⁸⁵ presented an extended three-step framework for these breaks and delays, based on previous work:⁸⁶ the *first* delay occurs in deciding to seek care, the *second* in reaching a treatment facility, and the *third* in receiving adequate care at the facility. Although our paper did not report specifically on the reasons, possible explanations could be the specific Datoga culture which adheres to certain seclusion practices around birth, the so-called Metida complex,⁸⁷ and the

inaccessibility of a functioning institution with obstetric services.⁷⁸⁻⁸⁰ As long as the majority of pregnant women deliver without skilled care in these settings, it seems that one functioning approach to improve this situation at present is to train local people like traditional birth attendants, village midwives or community health workers as skilled birth attendants who can attend the mothers and the neonates at the same time, reducing thereby neonatal and maternal mortality and morbidity.^{37,62,88,89} So far, such an approach has not been official Tanzanian policy and may be difficult to implement despite its incorporation in recent national health strategy papers.^{90,91} Although maternal health is high on the national agenda and the government subscribes to the framework of the “Continuum of Care” for maternal, neonatal and child health,^{90,92} practical changes from a strong reliance and trust on antenatal care services to a high peripartal coverage with skilled birth attendants have not occurred on a larger scale.^{7,9,12} Uncertainties about the definition and roles of skilled birth attendants, staff shortage and weak organisation of services are central factors in this regard.^{80,84,90,91,93} In addition, quality of obstetric care is not always sufficient in these institutions which may deter women from seeking help there.^{72,84,94-97}

In a situation with high rates of unattended deliveries, it is essential to provide emergency transportation before, during or after delivery in case the women and/or their infants need emergency treatment to ensure the continuum of care.³⁷ For the pregnant women, this could be demonstrated in our (paper II) and other studies from the Mbulu area.⁹⁸ But neonates and older children did not benefit from these services despite a higher mortality risk. The high proportion of stillbirths seen at the hospital (especially of macerated stillbirths which occur quite some time before the actual delivery) (see paper VII) and in community studies conducted in the catchment area of the hospital⁴⁹ and other parts of Tanzania and sub-Saharan Africa^{71,99,100} points into the same direction. It will be essential to analyse why caregivers do not utilise emergency transportation services according to the need in order to alleviate this situation. Do they not recognise the severity of illness, are there cultural reasons to stay at home or to seek care from other providers, or can they not access or afford these services?^{26,27,64,101-104} Depending on the results, the organisation of emergency transportation may need to be changed. In the past, user-fees had to be paid for this service after the transportation to HLH.⁵² These days pregnant women are transported for free, and

this exemption may have to be extended to children as well.¹⁰⁵ Another solution could be to involve the community more into the planning and ownership of such emergency transport schemes.¹⁰⁶⁻¹⁰⁸ Increased utilisation could be observed in another project in Tanzania then.^{106,107} Still it will be essential to ensure that caregivers are able to recognise severe illness in their children and decide to utilise these ambulance services.^{26,27,101,102} Studies in Tanzania demonstrated that timely and correct recognition of severe diseases is often not the case.^{103,104} Emergency transportation schemes are not part of the official Tanzanian health policy, and the state cannot provide this service on a national level at present.⁹⁰ Thus local community-based solutions are needed to improve the situation for the time being. The Integrated Management of Childhood Illness (IMCI) strategy, developed by WHO and partners some 15 years ago, provides specific criteria for referral from first-level health facilities to higher-level institutions like hospitals, but referral is often not possible for various reasons, and the gap between the community and the first-level health facility is not covered either.^{29,30}

The lack of diagnostic and therapeutic means at each level is a well-known problem of health services in developing countries (papers III-VI).^{13,21-23,25} This is one of the major reasons that the quality of clinical care at Tanzanian and other countries' health institutions is often sub-optimal. But there is strong evidence that patients and their caregivers prefer health institutions which provide care with high quality.^{33,51,75,84,109-112} At the same time, health facilities like hospitals are the place where many severely ill patients are treated and, due to risk selection and an increased rate of emergency cases, mortality rates are high.^{13,113-115} Therefore, good-quality clinical care would reduce mortality rates substantially in hospitals, but also on the population level, and would thereby contribute to an improved care-seeking behaviour.^{13-17,116,117}

As the burden of infectious diseases is very high in these settings,^{1,2} appropriate microbiological laboratory facilities are extremely helpful to arrive at the correct diagnosis and to monitor the effects and failures of treatment.¹¹⁸⁻¹²¹ This became obvious when the data of patients with congenital syphilis and bacterial meningitis were analysed (papers V and VI). Congenital syphilis had to be diagnosed mainly clinically, and the *Salmonella* strain in the patients with meningitis was resistant to two of the three first-line antibiotics. Ready-to-use tests are one option to improve

diagnostic practices in infectious diseases,¹²² but basic microbiological facilities with an opportunity for staining and cultures, including testing of anti-microbial resistance, are also essential.¹¹⁸⁻¹²¹ As a consequence, the hospital started a basic microbiological laboratory after our study results had been disseminated. These findings demonstrate that the clinical care packages as supposed in the “Continuum of Care” model are often neither sufficient nor appropriate in certain settings. Especially the need for improved diagnostic facilities is covered only minimally in this framework. Qualified laboratory staff in sufficient numbers has to be available within the health system to improve laboratory performance which is one of the major problems in Tanzania and other African countries.^{90,91,121,123} In addition, more diagnostic tests cause higher expenditure which is often difficult to cover either by the government or by the patients, but would improve quality and outcome.^{121,124}

The occurrence of a preventable disease like congenital syphilis (paper V) points to the fact that serious problems exist at antenatal clinics and between these preventive services and the hospital level in Tanzania.^{50,67,90,91} Although good diagnostic tools are available like on-the-spot tests, they are not applied universally and not offered to all women.^{69,125-127} Hence large numbers of infants with a preventable infectious disease are born and suffer from severe complications or may even die. Congenital syphilis is just one prominent example, as is the vertical transmission of HIV from the mother to the infant. Although HIV/AIDS is high on the public agenda and large resources are allocated to this area, the magnitude of congenital syphilis outnumbers the vertical transmission of HIV to the neonate by far.¹²⁸ In many developing countries (and even industrialised countries), contrary to the concept of a continuum of care preventive strategies fail to a considerable extent, thereby increasing the burden of disease in the clinical care setting.¹²⁹⁻¹³¹ Service quality cannot be assumed to be of uniform standard either as shown by our results which implies that a mere increase of coverage is not sufficient.^{84,109,110,112} Hard work on the ground and strong political support are needed to reduce these system failures not only in Tanzania significantly.^{90,91} Knowing that diagnostic tools are often sub-optimal, health workers have to use the available ones at the best. Ultrasound is a very useful diagnostic method and applicable in virtually all settings in developing countries.¹³²⁻¹³⁶ The study on cranial ultrasound, one of the largest series from developing countries, could demonstrate

that even with inappropriate probes important information can be obtained which may guide the patient's future management (paper III). In paediatrics, ultrasound of the heart and the abdomen are also extremely useful and can support the diagnostic and therapeutic process substantially (not only) in a developing country setting.¹³⁷⁻¹⁴⁰ Although this technique depends on the examiner's skills, it is possible to learn it reasonably well in a short period.¹⁴¹⁻¹⁴³ Therefore, its application should be promoted in paediatric care in developing countries, including Tanzania, strongly, especially as it is a non-invasive method with virtually no side-effects. This technique is a good example that diagnostic procedures are only minimally considered in the "Continuum of Care" model which weakens its applicability, and also that the Tanzanian (and other developing countries') health services lack essential elements for good diagnostic work-up.^{121,132}

In some settings, non-medical information is useful in arriving at or excluding a probable diagnosis. In a recent study, the molecular basis for a hereditary eye disease could be established in a genetically isolated North African Jewish community in Israel based on its anthropological background.¹⁴⁴ The study on sickle cell disease (paper IV) was based on a similar, albeit much simpler concept. As children of certain tribes were highly unlikely to suffer from this disease due to their ethnic background, the hospital could re-direct the scarce diagnostic resources towards those patient groups where the disease was much more prevalent. This approach would be applicable in Europe and the United States as well where almost all patients with sickle cell disease are of non-European origin.^{145,146} Therefore, selective testing would be possible and justifiable. Policy makers still decided in these industrialised countries to introduce a universal screening, but mainly due to the larger availability of resources and concerns about equity and missed cases.¹⁴⁶ In developing countries, such a diagnostic approach is certainly specific to a given setting like the cultural background in the Mbulu area⁵³⁻⁶⁰ which highlights the fact that the "Continuum of Care" model must be adapted locally. Hence, this finding is difficult to generalise to the Tanzanian health services as a whole.

On the clinical care level, major improvements have to be achieved in order to reduce neonatal, paediatric and maternal mortality rates world-wide.^{13-17,147} At HLH, the situation was no different, but there was a strong will to change the situation.

Despite a lack of equipment and scarce human resources, it could be shown that a simple, structured reorganisation of obstetric and neonatal health care services without major external input could improve neonatal/child and maternal outcome as a thorough analysis of the local factors and problems was undertaken before (paper VII).^{13,147} It was anticipated that only a multi-faceted long-term intervention would change the situation significantly, and that continuous training and supervision would be needed. Other important determinants of success were strong leadership and commitment.^{13,147} Similar results were reported from a hospital project in Ghana with reductions in maternal mortality and stillbirth rates, and a large-scale, multifaceted intervention in Kenyan district hospitals with considerable improvement of paediatric care.^{72,148} In recent systematic analyses all these factors mentioned above were identified as key components for improving the quality of hospital care in developing countries.^{13,147} But the examples from HLH, Ghana and Kenya^{72,148} also show that the intervention packages of the “Continuum of Care” model always need local adaptation and must be offered in a comprehensive, not isolated manner, accompanied by changes in organisation and leadership.

Nevertheless, progress was less than expected in the reduction of neonatal mortality at HLH, and non-adherence to the guidelines was most likely one of the major reasons.^{149,150} Staff motivation is always an issue in these settings, and only continuous support may improve this situation.^{13,76,150} Here again, quality of care cannot be assumed to be provided permanently on a high level. This aspect needs to be observed when intervention packages like in the “Continuum of Care” model are introduced. It was felt that the lack of mortality audits contributed to the non-optimal results as it could be shown in other settings that such an audit system can contribute significantly to the reduction of mortality rates within a hospital setting.¹⁵¹

The large number of macerated stillbirths pointed to difficulties at the family and community level, failures in the antenatal care system and the connection with the clinical care level as these intrauterine deaths occur some time before the actual delivery.^{71,96,99,100} Pregnant women would need to be informed in order to recognise problems like lack of foetal movements, outreach services would have to refer these women to health institutions, and emergency obstetric care would have to

be available immediately. As already discussed in connection with papers I and II, these pre-requisites for success are not available in much of Tanzania and many other countries in sub-Saharan Africa.^{80,96,152,153}

The provision of telemedicine networks may be an additional way of support in these resource-constrained settings (paper VIII). This and other studies could prove that a technologically simple system is feasible and sustainable.¹⁵⁴⁻¹⁵⁷ But there were major problems, too. This system does not allow for consultations in case of an emergency as it would be possible with real-time tele-consultations. The analysis was not designed to examine the effect of telemedicine consultations on the actual quality of care and the patient outcome as this would have required an analysis of all patients at the respective participating centre. Although not formally assessed, the motivation of staff to use this additional support system was quite low when judged by the number of potential patients.^{76,150,158} This is one of the major problems which health systems face all over the world. How can health workers be motivated to use the few resources which are available to their fullest? What are the factors that distract them to use the additional support? Is it even justified to introduce such a system as long as there are not sufficient numbers of health workers on the ground?^{159,166} These are not easy-to-answer questions but they must be examined in the future. In addition, a regulatory framework would be needed to implement such a network (for which the technical standards are in place) on a nation-wide scale, but neither Tanzania nor many other developing countries have such a system in place.¹⁶⁰ Experience from other Tanzanian telemedicine projects is not available as this is the first large-scale network in the country.³⁵

V.2. Evaluating the “Continuum of Care” Model

In principle, the “Continuum of Care” model is a linear model which divides the health system into three hierarchical levels (family/community, outreach/outpatients, clinical care) and places the patients into these levels along their life cycle.³⁷ Its potential for non-linearity is characterised by the fact that patients can get into contact with the health system at any level and any stage of life and may move from one to another level and place in an unpredictable order (Figure 2).³⁷

Basically, the model evolved from the origins of primary health care (see the Alma Ata declaration) over many decades.^{39,161} Following the intense and often controversial debate on selective vs. comprehensive primary health care,^{162,163} which was dominated by the selective, mainly vertical approach over a long period, a new comprehensive approach, the so-called Integrated Management of Childhood Illness (IMCI) strategy, was developed by WHO and its partners.¹⁶⁴ In theory, this covers already the different levels of health services, but does not include a view on the whole life cycle.¹⁶⁴ Thus the “Continuum of Care” model can be viewed as a further refinement of the IMCI approach.^{36,37}

Despite the clear theoretical structure of this model which was used as the framework in this analysis, it is by far not ideal, at present neither fully applicable in Tanzania nor in other developing countries.^{39,165-167} In each setting, its composition and effectiveness needs to be studied carefully.⁴⁴ Especially the intervention packages deserve further consideration. They are mainly based on reviews of efficacious health interventions which cover the common childhood and maternal problems in developing countries.⁴⁰⁻⁴³ But the proposed interventions are not exhaustive for all areas of maternal, neonatal and child health, and many packages (either complete or in part) are not implemented at a sufficient level now and in the foreseeable future.^{37,165-167} Still the basic notion seems to be that just achieving a higher coverage of interventions will diminish the burden of disease and mortality rates of women and children substantially (see Box 1).³⁷ And the packages do not explicitly address the need for high-quality provision of care, but instead the framework seems to assume that the services will be provided at a standard level of quality throughout the country over long periods.³⁷ Unfortunately practical experience from surveys in developing countries repeatedly shows that very often this assumption is neither realistic nor sustainable, be it for single interventions or packages.^{74,75,84,149,167-170} Quality of health care does not automatically follow when health services are provided in sufficient quantity.¹⁶⁸

Strategies for health system changes, including financial issues, the balance between maternal and neonatal/child health, institutional and community-based interventions, vertical and horizontal approaches, and between supply, demand and need are not addressed either in sufficient depth.^{38,39} This aspect is especially true for the critical shortage of health staff on all levels in almost all developing

countries, as it is the case in Tanzania, which impedes the implementation of even basic interventions seriously.^{90,91,123,171} The need for the reliable availability of appropriate diagnostic methods and therapeutic interventions is not addressed either.^{37,121}

In addition, the package system does not consider thoroughly the need to analyse the families' and communities' knowledge and chance/potential to recognise signs and symptoms of disease, to see the necessity and to decide to seek care, and to actually access and afford health care.^{85,86,101-104,172} It does not take into account patients' experience with health care provision, be it quality of care or staff behaviour.^{109-112,170-172} All these factors are critical for the success of such packages, and research in Tanzania and elsewhere has shown that severe constraints exist on all levels and sides.^{26,27,33,109-112,170-172} As claimed by Kahabuka et al. and Obrist et al.,^{111,172} the five dimensions of health services – availability, accessibility, affordability, adequacy and acceptability – not only determine access to health services, but also the care-seeking process and quality of care.

Thus its main strength is the structured approach towards the analysis of all levels of health care along the life cycle. Especially the latter aspect is extremely important as this model rightly emphasises that the needs of children, women and other caregivers cannot be separated from each other.^{36-39,92} Each health system needs to be analysed whether it can provide sufficient and appropriate structural, financial, social and human resources to alleviate and improve the breaks and disruptions within its services, and whether it serves the local and national population across all ages and facilitates utilisation according to the needs. In this sense, it has to be viewed more as a background theory which has to prove its applicability and value in each single setting.⁴⁴

V.3. Methodological Considerations

The first seven papers are based on data which were generated around the activities of one rural hospital which in terms of governance, service quality and composition, staff, infrastructure and the population in the catchment area may not be easily comparable to other health institutions in Tanzania and East Africa.^{51,173} This selection bias and the personal involvement of the author in the practices and

interventions cannot be neglected when intending to generalise the results to other settings. But the results present a fairly accurate picture about the state of health services in this region, thus at least some results can be applied to other settings.

The retrospective approach in data collection is another limitation. Data quality may have been sub-optimal in some areas, but the hospital management had a good reputation in keeping its records. Other scientific studies used this data source as well and considered it reliable.^{49,50} One weakness of this approach was that no prospective, randomised controlled trials could be planned and analysed. If this analysis was to analyse new interventions this would have been a major limitation. But the main aim was to analyse the current situation of the health services on which possible changes could be developed and applied. Therefore, it was felt that it was first necessary to collect baseline data, and then to plan future intervention projects.

The senior hospital staff did not initiate a randomised trial for the obstetric and neonatal care project, but rather used a before-and-after design to study its effects, being aware of the fact that a causal relationship could not fully be proved by this design. This research project was not intended to test the efficacy of any new interventions, but to explore the effectiveness of this approach on the quality of care in the daily setting over a long period of time. This approach is in line with the Gadchiroli project in India which employed a similar before-and-after design over prolonged periods of time (more than 20 years by now) and could demonstrate significant improvements in child health in its area.^{174,175} Randomised trials are essential for testing new interventions of any type, be them biomedical, social, political or policy-related.¹⁷⁶ But when it comes to effectiveness, only longitudinal studies over long periods in the natural environment will give the answer whether interventions work on the ground and can lead to a change for the better.¹⁷⁶ This was the purpose of the study.

The telemedicine project depended very much on the health staff in the respective hospitals how they utilised the service, and the willingness and availability of the voluntary consultants. Thus it does not represent the true magnitude of the need for such a support, and it does not provide data on the actual impact of care at the institutions. Instead, it describes more the potential and practicability of this

approach in a resource-constrained setting and therefore must be viewed as a preliminary report.

VI. CONCLUSION

The findings of the eight papers contribute to the scientific knowledge base as they depict obstacles to and opportunities for achieving a sufficient degree of provision of good-quality care for neonates, infants, children and adolescents in a developing country setting like Tanzania at the different levels of the health system and over time. The difficulties identified in the studies not only relate to the health institutions, their staff and infrastructure, but also to the patients, their caregivers and the wider community, respectively.

Families and communities may not recognise the need for seeking preventive antenatal services, skilled attendance at delivery and high-quality care, or may not be able or willing to utilise services in case of emergency (papers I, II, V, VII). Health facilities may suffer from a lack of diagnostic and therapeutic means, may not implement preventive services sufficiently, and do not always seek all available support (papers III-VI, VIII). But it is possible by re-organising and utilising all skills, knowledge, equipment, financial and human resources to achieve continuing, recognisable progress in the provision of neonatal and obstetric care even in such a resource-constrained setting (paper VII). The “Continuum of Care” model, although being far from perfect, proves as a valuable tool against which different sectors of the complex health system can be analysed, and may serve as a generic guideline where changes need to be implemented.

The findings from the studies on the utilisation of skilled attendance at birth, emergency ambulance and antenatal services (papers I, II, in parts V and VII) resemble the situation in many parts of sub-Saharan Africa and Asia. The task remains for the local communities and the respective health services how to increase acceptance, accessibility and availability of these services under the prevailing circumstances in order to close the gaps between the different components of the continuum of care, e.g. the community, outreach and clinical levels. Research on how patients and their caregivers view illness episodes, how they recognise symptoms, why or why not they use the traditional or allopathic health services, what barriers exist towards the utilisation of health services, how

health services can utilise scarce resources in a sustainable way, and how staff can provide high-quality care could provide evidence-based solutions then.

As observed in several of the studies (papers III-VI), lacking diagnostic facilities are one of the major obstacles to good-quality care in a resource-constrained setting. This finding is representative of many developing countries in sub-Saharan Africa, Asia and Southern America. Especially basic laboratory facilities and simple imaging techniques like ultrasound are essential parts of a functioning health service. Thus policy makers and administration should ensure that these facilities are available throughout the health system, and research could further refine the role of these essential diagnostic elements in resource-constrained settings and its contribution to evidence-based treatment.

The results of paper VII show that progress in clinical care can be achieved without major external human and financial resources, but with a focus on the available human resources, training, leadership, the dissemination of evidence-based clinical treatment guidelines and long-term commitment. This approach holds a large potential for other resource-constrained settings as it relies more on the reorganisation of the internal factors and quality improvement than on major external input. Research could identify and analyse remaining gaps between community, outreach and clinical care, and investigate additional appropriate diagnostic and therapeutic strategies. These results could inform the clinical care setting how to best provide sustainable, long-lasting high-quality care even in resource-constrained settings.

Paper VIII provides an example of an innovative approach how to support clinical care in remote, low-resource settings which has demonstrated its practicability in similar, albeit smaller settings before. In principle, such tele-medicine networks have the potential to enhance the quality of health systems of whole countries with modern telecommunication technology. But before widespread dissemination and adoption, there is ample opportunity and a need for research to identify barriers towards utilisation, problems of sustainability, legal aspects and its impact on clinical outcome as well.

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VIII. PAPERS

72 pages (due to copyright issues the papers are not included in this version, but can be ordered from the author)

PAPER I

C. Krüger, O.E. Olsen, E. Mighay, M. Ali (2011) Where do women give birth in rural Tanzania? *Rural and Remote Health* 11: 1791

PAPER II

C. Krüger, O.H. Evjen Olsen (2003) Inequities among the very poor: effect of young age on care-seeking. *Lancet* 361: 1744-1745

PAPER III

C. Krüger, N. Naman (2010) Cranial ultrasound in neonates and infants in rural Africa. *South African Journal of Child Health* 4: 83-87

PAPER IV

C. Krüger (2010) When ethnology informs clinical medicine: non-Bantu peoples without apparent sickle cell disease in the Mbulu area in Northern Tanzania. *Rural and Remote Health* 10: 1620

PAPER V

C. Krüger, I. Malleyeck (2010) Congenital syphilis: still a serious, under-diagnosed threat for children in resource-poor countries. *World Journal of Pediatrics* 6: 125-131

PAPER VI

H. Vaagland, B. Blomberg, C. Krüger, N. Naman, R. Jureen, N. Langeland (2004)
Nosocomial outbreak of neonatal *Salmonella enterica* serotype Enteritidis
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PAPER VII

C. Krüger, M. Niemi, H. Espeland, N. Naman, I. Malleyeck (2012) The effects of standardised protocols of obstetric and neonatal care on perinatal and early neonatal mortality at a rural hospital in Tanzania. *International Health* 4: 55-62 (+ 2 webappendices)

PAPER VIII

C. Krüger, M. Niemi (2012) A telemedicine network to support paediatric care in small hospitals in rural Tanzania. *Journal of Telemedicine and Telecare* 18: 59-62