CHILDREN'S MEDICAL FOUNDATION
兒童醫健基金會

NICU Evaluation Report

ZESHAN FOUNDATION

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Acronyms

CMF – Children's Medical Foundation

ICU – Intensive care unit

IMR – Infant mortality rate

LBW – Low birth weight

NICU – Neonatal intensive care unit

NMR – Neonatal mortality rate

Prem – Prematurity

RDS – Respiratory distress syndrome

SCMC – Shanghai Children's Medical Centre

U5MR – Under-5-mortality rate

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1. Preface

This is the evaluation report for the NICU Evaluation Project that was commissioned by the Children's Medical Foundation.

The result presented in this document is based on the collaborative efforts of Children's Medical Foundation and their advisors, and the School of Public Health, The Chinese University of Hong Kong. The NICU evaluation team includes: Ms. Estella Huang Lung, Mr. Norman Chen, Ms. Yan Chan and Ms. Winnie Wong of Children's Medical Foundation; Dr. Betty Young of China Medical Advisory Board, Children's Medical Foundation; Prof. Emily Chan and Dr. Kevin Hung of School of Public Health, The Chinese University of Hong Kong.

This evaluation project began in November 2008 and was completed in May 2009. It consisted of three phases:

(1)   Phase I: Literature review and background data collection from various project implementation sites. (November 2008 - February 2009)

(2)   Phase II: NICU site visits and on site stakeholder interviews. (January to March 2009)

(3)   Phase III: Data analysis, technical discussion and final report submission.

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2. Executive summary

2.1 Introduction

2.1.1 According to the World Health Organization (WHO) Child Health Epidemiology Reference Group, there has been a significant decline in under-5-mortality rate (U5MR) in developing countries. However, whilst the reduction has been mainly concentrated in mortality after the first month, neonatal (babies under 28 days old) mortality and especially mortality in the first week of life remains relatively static. According to available data, the main causes of neonatal deaths are pregnancy-related complications (prematurity and congenital anomalies), delivery-related complications (asphyxia and birth injury) and infectious diseases [1,2]. In China, neonatal mortality including prematurity, asphyxia and infection accounted for two-thirds of all infant deaths before the millennium. In recent years, despite a decrease of infant mortality rate (IMR) is observed, newborns still accounted for more than half of U5MR [3].

2.1.2 CMF recognizes the neonatal stage bears the brunt of childhood mortality, and has a lasting effect on child development. It has chosen to address the problem of intolerable neonatal mortality levels in China through establishing neonatal intensive care units (NICU) and training medical staff to serve areas where neonatal mortality rates are high. There are four main objectives of the CMF NICU program, namely: 1) Reduce neonatal mortality; 2) Maximize the number of neonates treated / lives saved; 3) Increase level of care for neonates & 4) Promote neonatal healthcare in sub-urban settings.

2.1.3 Since 2001, CMF has been working with their hospital partners (Shanghai Children's Medical Centre (SCMC) and Children's Hospital, Fudan University) to establish neonatal ICUs at hospitals in underprivileged cities in attempt to reduce neonatal mortality rates. Its program adopted two approaches: "train-the-trainer" and "resource empowerment". Through the "train-the-trainer" approach, CMF facilitated hospital collaboration between major hospital in Shanghai (Fudan and SCMC) to provide training for doctors and nurses in suburban settings. The training program aims to familiarize doctors and nurses with: how to set up an NICU facility and its admission criteria, general NICU cases management, utilization of relevant medical equipments and formulation of discharge plan after stabilization. The other major component of the program involved resource allocation for equipments acquisition (such as monitors and ventilators) to facilitate the set up of NICU in the recipient hospital. To date, 13 NICU sites have been established and 5 are underway. Another two NICUs are scheduled to launch in March 2009. A total of 20 funded NICUs will be resulted by the end of 2009.

2.1.4 This evaluation report was commissioned by CMF in November 2008 to assess and evaluate if established programs (as of January 2009) had achieved its original objectives. The goals were to understand whether the strategic direction took up by CMF had been effective. In addition, lessons learnt related to program implementation during the past seven years (2001-2008) will be reviewed to support further strategic development.

2.2 Method of evaluation

2.2.1 The analysis adopted the Donabedian framework for service evaluation to guide the evaluation of training effectiveness. According to the framework, program effectiveness can be evaluated by examining the four major components of program implementation. This includes: input, process, output and outcome. The input for training included resource invested in the training program, and opportunity costs incurred by participating partner sub-urban hospitals (e.g. Staffing). Process elements were the content of the three to six months' technical NICU training and the curriculum organized by partner training institute (SCMC or Fudan University). Output was determined by percentage of trainee passing the relevant training assessment. Outcome was defined by an actual decrease of neonatal mortality as well as other associated pre-defined objectives.

2.2.2 Regarding resource/equipment investment, the input consists of funding and selection of relevant medical equipment suggested by the neonatal unit in the host hospital. The process would be if acquisition and operation of that particular piece of medical equipment were done in the most efficient manner. The output was regarded as the appropriateness in the utilization of that medical equipment. The outcome measurement would be the reduction in neonatal mortality.

2.2.3 Two pre-visit questionnaires were circulated to each NICU for data collection before the field visits. One of the questionnaires contained epidemiological data with basic description and capabilities of the province, the city, the hospital and NICU. The change in neonatal mortality and the change in volume of patients treated after the program were also obtained. The second questionnaire targeted program trainee and attempted to identify areas and issues for improvement related to the training sessions. The evaluation team performed three field visits to assess eight NICU sites from January to March 2009. Local project stakeholders were also interviewed during the site visit according to a pre-designed set of questions to identify the effectiveness of the program.

2.3 Results

2.3.1 Overall, a decrease of NMR was observed in all CMF intervening sites. Trained staff retention was almost 100% across all sites. Positive spillover effects

(staff morale, ripple effect of local training/technological empowerment) were also observed.

2.3.2 Positive spillover impacts such as health worker confidence in clinical management and performing neonatal care were reported in most sites. A decrease of tertiary hospitals referral was also found as a result of increased capacity in management of extreme low birth weight (LBW) neonates. Of note, a few sites mentioned they were able to manage 900g babies in-house after the training.

2.3.3 The evaluation team had visited the two partner training institutes in Shanghai (SCMC and Fudan). Whilst a comparison of the content of the "train-the-trainer program" showed differences between the programs but the main training for program participants is to perform routine NICU duties under supervision in tertiary sites.

2.4 Lessons Learnt

2.4.1 Program

2.4.1.1 _Neonatal Care units vs NICU_ With the exception of Children's Hospital of Fudan University, all of the NICUs we visited during the evaluation have mixed NNU and NICU beds, and some of the units prefer to be called neonatal units with NICU capabilities. Compared with the admission criteria in HK (see appendix), most cases in the four Zheijiang sites would have been admitted to the neonatal unit (NNU) and special care baby unit (SCBU) in Hong Kong. A minor proportion of patients required ventilatory intensive care. Yongkang receives around 30 ventilator cases per year, and Jiangshan only receives 10 per year. Heng Yang was the only unit with neonates on ventilator during the time of visit. It was beyond the scope of this study to assess if the limited use of ventilators was due to the lack of critically ill neonates, the reluctance to use ventilators by medical staff or other potential barriers including cost, the parent's decision to withdraw from treatment etc. Of note, probably due to different stages of program development, hospitals with different capacities were selected in different provinces and this inconsistency had made direct comparison difficult. If CMF's goal is to enhance hospital capacity to manage NICU cases as to decrease neonatal mortality, criteria for candidate partner hospitals should be at least a 3A-level capacity facility.

2.4.1.2 _The importance of site selection_ For the Zheijiang sites, although three of the four hospitals were in the same rank (2A), the technical capabilities and the volume of patients were widely varied, and thus affecting the effectiveness of the CMF NICU program. For an NICU program, since the target population is for critically ill neonates, a program candidate hospital should be at least be at a

referral level hospital to warrant caseload and the investments of facilities for the care provision and utilization of machineries. The hospital should also have the vision and capability to handle critically ill neonates, and the number of neonates transferred out should be kept at a low level. 3A-level hospitals we visited were more suited for the role of NICU development. Hospitals selected should also depend on the resources availability in the area and the commitment from the hospital.

2.4.1.3 *__Defined level of care and admission criteria__* For most of the visited sites, there was no standardized admission criteria and defined level of care for sick neonates received. A standardized admission criteria is recommended to maximize efficiency in patient management and can provide non-pediatric health care professionals with guidelines of when to transfer high-risk neonates to appropriate care facilities. The admission criteria can also enhance standardizing the level of care across different hospitals, and allow transparent systematic assessment of the volume of NICU admissions.

2.4.1.4 *__The importance of program monitoring and evaluation__* Routine data collection and program auditing are necessary to address problems arise from implementation. Many of the sites do not routinely record patient information for monitoring, and the responded questionnaire during this evaluation has demonstrated that information quality varied. Clinical audit, incident reporting, guidelines and continuing professional development are important aspects of quality assurance.

2.4.2 Training

2.4.2.1 *__Applicability in local settings__* Since technical training of this program occurs in state-of-the-art facilities in Shanghai, skills and the acquired technical knowledge might not be most applicable in sub-urban setting where equipments and technical support are limited. The evaluation team recommends training program should require partner training institutes to deploy trainers to visit trainee-home-hospital to ensure trainees' training are relevant to the technical challenges and issues likely to be encountered by trainees in their home setting.

2.4.2.2 *__Training content and training period__* There were feedbacks from doctors trained from SCMC that the training has not been focused enough on neonatal intensive clinical care. Some commented that their daily clinical works were only related to regular general pediatrics duties in outpatient clinic. For NICU training for nurses, it has been suggested that some units prefer to have two nurses trained for three months each. On the other hand, training for NICU management might also be necessary for more efficient operation of the unit. Training in public health, biostatistics and epidemiology would be helpful for development.

2.4.2.3 ***Guidelines on trainee recruitment and retention*** Whilst trainees provided good feedback about the program, there was a lack of guidelines on how trainees were selected. In most sites, it seemed selection criteria solely depends on the decision of the hospital administrator on who to undergo training. A more formally-defined selection criteria should be established to ensure fairness and promote effectiveness of service and staff retention strategy will be important to keep the technical expertise and investment in house. In addition, although the projects achieved high staff retention ratio, there was a general lack of systematic policy on how to retain trained staff.

2.4.2.4 ***Skill retention and continuous medical education*** Some of the staff have commented that while the six-month training provided them with the skills and knowledge to deal with patients, there have been problems with their skills retention due to the differences of case mix in their local setting. Continuous education in the form of refresher courses or distribution of updated reading material, with regular assessments could be considered.

2.4.2.5 ***Promotion of neonatal care in China and spillover effect*** It has been observed that many trained staff did provide hospital based neonatal resuscitation training for the health care workers in the hospital. However, the spillover effect and the objective for the promotion of neonatal care in China can be enhanced if training can be provided to nearby township hospitals. The benefits can be of three folds: firstly better trust would be formed between the city level and the township hospitals for forming a better referral network; secondly better awareness from the township hospitals of how to resuscitate a sick neonate and when to refer if necessary; thirdly more appropriate transport mechanism can be developed for transferal of these critically ill neonates.

2.4.3 Equipment

2.4.3.1 ***Need to have a policy regarding equipment support*** We found that the medical equipment provided by CMF has varied from a monitor to a CPAP machine and a ventilator. While we understand that different units may prefer different pieces of equipment, there needs to be a standardized range of equipments that should be provided. In the case of setting up an NICU in the primitive settings, machine for respiratory support would still be essential.

2.4.3.2 ***Need to build in funding and support for equipment maintenance and consumables*** There were feedbacks from the administrators in certain intervening sites that the cost for equipment consumables and maintenance has been a burden to their unit. In order to maximize utilization and effectiveness, the maintenance and the running cost must be taken into account.

2.4.4 Strategic

Neonatal Mortality Rate is highly associated with antenatal care and accessibility of health care. The choice of intervening sites and current program design might not address these issues. Further strategic discussion might be necessary to realign this operational mandate with field realities.

2.4.4.1 *Importance of antenatal care and skilled delivery and resuscitation* Neonatal mortality is known to be associated with antenatal care and the birth delivery process. It was found that across the different NICUs that the top five causes of death frequently included congenital anomalies, congenital heart diseases and asphyxia. With adequate antenatal care and skilled delivery most of these cases can be detected early or prevented. Strategically these are areas to be developed and supported to safeguard neonatal mortality. Training in delivery and neonatal resuscitation must be provided extensively to correct this problem.

2.4.4.2 *Raising awareness and education for mothers* The awareness and perception of the mother will affect the chance of survival of the neonate. Proper caring techniques, promoting early breastfeeding and raising awareness of when to seek help should be provided for all mothers to allow early detection of neonatal illness and prevention of deaths. Apart from the cost issue, another noticed barrier to NICU treatment is the mother's awareness and perception. In Fuyang, there were 35 cases in 2007 that gave up treatment, with the reasons being severe illness, perceived poor outcome and financial issues.

2.4.4.3 *Migrants* Migrant population is reported to be a consistent concern across many different hospitals. This population subgroup has limited or no antenatal care due to education level, cost or access to service, and they may deliver their baby at home without a skilled attendant. For example, several cases of neonatal tetanus were reported after delivery at home. Unfortunately, current program was not able to reach disadvantaged or "invisible" groups. In Yongkang, it was estimated that 30-40% of the pregnancies are from migrant mothers. Limitation in data has curtailed the possibility to examine issues in migrants. In order to address the needs of this group of migrant children, collaboration with the local health department to develop a transparent system for collection of statistics is very important. From the evaluation trip, we were aware that there are ongoing projects by the local health authorities in Zhejiang looking into the health problem of local migrants and there could be possibilities for future collaborative work or projects.

2.4.4.4 *Cost* There is also the problem of affordability among the migrants and rural villagers. Entry to the hospital required a deposit of RMB 3000-4000. With the current levels of fees, in-hospital normal spontaneous delivery will cost around RMB 2000 in Zheijiang, birth-requiring cesarean section will cost RMB 4000 and

neonates that require NICU admission will cost at least RMB 1000-2000 for a short period of stay in NICU, depending on the situation. The cost for the stay in NICU for neonates requiring ventilator support can be as high as RMB 20,000, equivalent to the whole year earning for the national average. An option would be for CMF to set up a fund for providing subsidies for these families.

2.4.4.5 *__Rehabilitation centre and terminal care__* With improved resuscitation skills and equipments, there will be expected to have more children surviving with disability. There needs to be strategic planning for the rehabilitation for these children. Terminal care should also be developed for children with terminal illness.

2.5 Recommendations

2.5.1 Revisiting strategic planning regarding objectives

In addition to the lessons learnt, as previously highlighted, there are definitely gaps in the health service delivery for neonates in China, reflected by the national statistics. The question then arises as to how best to deliver neonatal care and at what level. There is a need for revisiting strategic planning regarding objectives. In general, the NICU should be set up in a 3A-level hospital in area with higher than average NMR. The referral network should be established and the local capability should be understood to prevent duplication of services. The neonatologist should provide local township training for health care professionals concerning early identification and referral of high-risk mothers and neonates, as well as skills involved in neonatal resuscitation.

2.5.2 Networking of the NICU services

If CMF aims to continue to roll out the NICU program throughout China, there needs to be a systematic way for the program development so as to support the successful development of individual NICU and to prevent duplication of services. Whilst the development of NICU network integrates with government healthcare policy, the conceptual model has to be built so that the development can be better planned. An example for NICU service networking would be from the National Health Service in England. There were 24 Neonatal Networks across England, with at least one level 3 hospital within 1 network. The level 3 hospitals work closely with other level 1 and 2 hospitals within network to offer families access to appropriate care as close to home as possible. It also reduces unnecessary transfers to units further away from home to receive intensive care, and ensures that groups of hospitals and neonatal units provide various levels of care locally [4]. Similar networking could be a theoretical model for China, with city level hospital leading the nearby township hospitals.

2.5.3 Collaboration and integration of services

According to a paper from World Bank published in Seminars in Fetal & Neonatal Medicine 2006, the delivery of neonatal care interventions involves: continuum of care by strengthening the care before and during pregnancy, childbirth and after delivery, in the crucial early years of life and during adolescence; intervention packages by combining single interventions into care packages instead of providing them in a vertical manner; and integration between existing programs by offering neonatal interventions as part of other health programs, in particular Safe Motherhood and Child Survival/IMCI strategies. [2]

2.5.3.1 *Collaboration with antenatal screening programs* According to the figures from UNICEF in 2002-2006 the coverage of antenatal care in China is 90% [4], but level of AN care is largely varied and it has been found that prematurity and congenital anomalies are still major problems in the areas we have visited. The most simple and effective antenatal care involves tetanus toxoid immunization, adequate diet, iron and folate supplement, syphilis detection and treatment, breast-feeding counseling and birth preparedness. [2] These services would mostly be covered with the existing antenatal service from Maternal and Child Health (MCH) centers in China and collaboration with the local MCH centers would enhance early transferal of high-risk pregnancies.

2.5.3.2 *Collaboration with neonatal resuscitation programs* According to the 2000-2006 statistics from UNICEF, 83% of the deliveries are institutionalized in China and skilled attendant were present in 98% of the deliveries [4]. However, training has shown to be inadequate for the birth attendants in China because of the high rates of delivery-related complications including birth asphyxia. Currently many NGOs like UNICEF, Save the Children and One Heart are providing neonatal resuscitation training to village birth attendants in China. By collaborating with these NGOs, a better referral system and network can be provided to reduce the neonatal mortality in the rural settings.

2.5.4 Development of training manual and protocols

With the development of the NICU network and comprehensive roll out of the NICU program, the training material would need to be standardized in order to ensure quality and to enhance communication between the different NICUs. It would be a good idea to develop a set of training manual and protocol including admission criteria and disseminated to all NICUs. By exchanging knowledge and skills, the manual can be updated and more applicable to different settings in China.

2.5.5 Development of indicators and monitoring systems

It is important for the NICUs to collect data and regularly review and compare with their counterparts to reflect on the success of individual NICU and identify problems. Suitable indicators have to be developed and agreed by all NICUs so that a fair comparison can be made across the different NICUs in China. Save the Children has developed a comprehensive set of indicators for review of its neonatal resuscitation program, collecting data from outcomes, community practice, skills of community and facility based health workers, health system to coverage of newborn and maternal care.

2.5.6 Addressing coverage

2.5.6.1 The enabling environment for neonatal care development suggested by Mangiaterra from the World Bank includes: political commitment with government authorities support at national, local and community level; strengthening the health system with focus on care at the family and community level, and strengthening the clinical care services; cultural, social, and economic changes including the barriers that inhibit women's and other disadvantaged groups' access to information and services need to be addressed; improving education has the strongest impact in the status and empowerment of women. [2]

2.5.6.2 Apart from the coverage by the healthcare system from the government, the role of NGO service to address coverage needs to be explored in conjunction with the issue of sustainability and independence.

Acknowledgements

Important references:

1. WHO Child Health Epidemiology Reference Group. WHO estimates of the causes of death in children. Lancet 2005; 365(9465):1147-52

2. Mangiaterra V. Why and how to invest in neonatal health. Seminars In Fetal & Neonatal Medicine 2006; 11(1):37-47

3. Chan EY. Addressing disparities in children's health in China. Archives of Disease in Childhood 2008; 93:346-352

4. National Health Service Neonatal Network. Available at http://www.neonatal.org.uk/healthcare_professionals/about_the_networks (accessed on 9 April 2009)

5. Joy Lawn. 4 million neonatal deaths: When? Where? Why? Lancet 2005; 365:891-900

6. UNICEF China statistics. Available at http://www.unicef.org/infobycountry/china_statistics.html/ (accessed 14 January 2009)

7. World Health Statistics 2008, World Health Organization. Available at http://www.who.int/whosis/whostat/EN_WHS08_Full.pdf (accessed 17 April 2009)

8. Territory-wide Obstetrics and Gynaecology Audit (2004) by Hong Kong College of Obstetricians and Gynaecologists. Available at http://hkcog.obg.cuhk.edu.hk/public/docs/audit/audit_og_2004.asp/ (accessed 14 January 2009)

9. Uxa F. Essential newborn care training activities: 8 years of experience in Eastern European, Caucasian and Central Asian countries. Seminars In Fetal & Neonatal Medicine 2006; 11(1): 58-64