

**SHORT COMMUNICATION****The development and implementation of a newborn medicine program in a resource-limited setting**A. Hansen,¹ H. Magge,^{2,3,4} M. Labrecque,⁵ R. B. M. Munyaneza,⁶ E. Nahimana,⁴ M. Nyishime,⁶ A. Mwali⁷<http://dx.doi.org/10.5588/pha.14.0106>

The reduction in global neonatal mortality rates remains a challenge. Internationally recognized protocols for hospital care of sick and small newborns are limited, although this specialized area lends itself to standardization. An interdisciplinary team including international and local clinical experts worked with the Rwandan Ministry of Health and Rwandan professional associations to develop and implement a neonatal care program in a rural Rwandan district hospital that was ultimately accepted as the national standard for newborn medicine. Successful features and challenges are discussed. It is realistic to develop, implement and disseminate neonatal protocols for sick newborns.

Globally, 2.9 million neonates die each year, amounting to 43% of under-five mortality. Three quarters of these newborns die in their first week, one third on their first day.^{1,2} With 99% of neonatal deaths occurring in developing countries, sub-Saharan Africa and Southern Asia are the most greatly affected.

Significant progress has been made towards reducing the world's under-five mortality rate; however, the least reduction has occurred in neonatal mortality, resulting globally in a 17% rise in the neonatal component of under-five mortality from 1990 to 2012.¹ Extra care of infants with low birth weight (LBW) is estimated to reduce neonatal mortality by 20–40%.³

There are currently limited internationally recognized protocols for the subspecialized area of newborn medicine.^{4–7} Although there are wide variations in many aspects of medical care by location, the basic care of sick newborns can be relatively standardized. We describe the development and implementation of a newborn medicine program in a district hospital in rural Rwanda, and present a neonatal care package of protocols, medical records with order sets, and quality indicators. The package is designed to provide effective, feasible newborn health care tailored to resource-limited settings.

SETTING

Located in East Africa, Rwanda has a population of 10.5 million,⁸ 82% of whom live on less than US\$2 per day.⁸ The Rwinkwavu District Hospital (RDH) is located in Kayonza, a rural district in the south-east of the country with a population of 346 751.⁹ RDH has approximately 1875 deliveries and 460 neonatal ad-

missions annually coming from maternity or emergency wards, health centers or homes (source: Rwanda Health Maintenance Information System, 2008–2011).

In its mission to ensure universal access to affordable health service of the highest attainable quality the government of Rwanda has prioritized improving its population's health. Through these efforts, the Rwandan health care system has significantly reduced the under-five mortality rate, including the infant mortality rate (IMR), which fell by 41%¹⁰ from 2005 to 2010.¹¹ During this period, the neonatal mortality rate (NMR) fell by only 27%, from 37 to 27 per 1000,¹¹ causing the neonatal component of the IMR to rise by 11%.

Partners In Health (PIH), a Boston-based global health organization, began working in Rwanda at the invitation of the Rwanda Ministry of Health (MOH) in 2005 to strengthen the health care delivery system in selected remote and underserved districts in Rwanda. At the request of the MOH, a multidisciplinary team of specialists from PIH, Boston Children's Hospital (BCH), partner organizations, and Rwandan professional associations was established to develop and implement a neonatal package at RDH.

ASPECT OF INTEREST

First, the package was drafted by the interdisciplinary team. The package consisted of a protocol with 10 modules (Table 1, <http://www.childrenshospital.org/~media/research-and-innovation/divisions/newborn-medicine/neonatalprotocolsranda.ashx>), teaching materials, medical record/order sets (Appendix), and quality indicators. Over a 2-month period in 2010, specialist trainers taught weekly formal training courses to on-site MOH general practitioners and nurses, covering the most critical concepts in the protocol. The package was also introduced on the pediatric ward where trainers, acting as consultants, attended daily neonatal rounds with the staff. During this implementation phase, the neonatal care package was modified based on clinical, educational and system issues encountered to further adapt it to the local context.

The medical record form/order set was created for admission, daily progress, and discharge documentation. The forms included prompts for key protocol items. Quality indicators were initially drafted based on expert opinion and literature review, and later modified to address topics identified as challenging by hospital staff (Table 2).

AFFILIATIONS

- 1 Division of Newborn Medicine, Boston Children's Hospital, Boston, Massachusetts, USA
- 2 Division of General Pediatrics, Boston Children's Hospital, Boston, Massachusetts, USA
- 3 Division of Global Health Equity, Brigham and Women's Hospital, Boston, Massachusetts, USA
- 4 Partners In Health/Inshuti Mu Buzima, Kigali, Rwanda
- 5 Neonatal Intensive Care, Nursing Patient Services, Boston Children's Hospital, Boston, Massachusetts, USA
- 6 Rwanda Ministry of Health, Kigali, Rwanda
- 7 Rwanda Family Health Project, Kigali, Rwanda

CORRESPONDENCE

Anne Hansen
Division of Newborn Medicine
Boston Children's Hospital
300 Longwood Ave
Hunnewell 4
Boston, MA 02115, USA.
e-mail: Anne.Hansen@childrens.harvard.edu
Tel: (+1) 617 355 6027
Fax: (+1) 617 730 0486

ACKNOWLEDGEMENTS

The authors would like to thank F Ngabo, Director of Maternal Child Health at the Rwanda Ministry of Health (MOH; Kigali, Rwanda), and V Mivumbi, Rwanda MOH Neonatal Focal Point, for their invaluable guidance throughout the implementation process and ongoing leadership in advancing neonatal health. We would also like to thank S Stulac for her assistance with neonatal care package content. This work was supported by the Harvard University Milton Fund, Cambridge, MA, USA. Competing interests: none declared.

KEY WORDS

newborn medicine; global health; implementation

Received 25 November 2014
Accepted 23 January 2015

PHA 2015; 5(1): 17–22
© 2015 The Union

TABLE 1 Neonatal protocol modules

1	Neonatal resuscitation
2	Respiratory care <ol style="list-style-type: none"> i. Apnea and bradycardia
3	Hypoglycemia
4	Fluid and nutrition <ol style="list-style-type: none"> i. Feeding support ii. Intravenous hydration
5	Hyperbilirubinemia
6	Infection/infection control
7	Neurologic issues <ol style="list-style-type: none"> i. Asphyxia and seizures ii. Pain prevention and management
8	Thermoregulation <ol style="list-style-type: none"> i. Kangaroo mother care ii. Incubator management
9	Routine health care maintenance
10	Discharge planning

After this initial formative phase, the package was presented and further adapted by other key stakeholders, including the Rwanda Pediatric Association, prior to validation, national adoption and scale-up.¹²

Ethics approval

The study was approved by the Institutional Review Board of Boston Children's Hospital, Boston, MA, USA, and Rwanda National Ethics Committee, Kigali, Rwanda.

DISCUSSION

To reduce the number of neonatal deaths, early care of sick newborns in resource-limited settings should be addressed. Neonatal care requires specialty training to address specific clinical and patient safety issues that are distinct from general pediatric care. Based on our collaboration, we developed and implemented a standardized, evidence-based package of protocols for sick newborns that was aligned with a medical record format that prompted better choices in medical care, and quality indicators allowing for gap identification and improvement efforts.

The partnership between the Rwanda MOH, PIH and BCH has continued, enabling us to identify and address challenges encountered through ongoing training and mentorship, and observe adherence to the protocols and increased optimism and staff morale.

Successful features

Creating a multidisciplinary team that combined committed local physicians and nurses with technical experts enabled us to learn together and adapt the package locally. The effort encouraged system-based changes, such as procuring critical medications and equipment at the national level. Specifically, the program led to national advocacy for caffeine citrate, incubators, warming lights, glucometers with strips, and alcohol-based hand sanitizers to be added to the hospital supply chain. The introduction of the neonatal care package pushed advancement in necessary systems to achieve high-quality care at scale.

Implementation challenges

Although we were able to retain a consistent and dedicated core team, staff turnover and internal transfers led to ongoing training needs for new staff; on-site mentorship was critical in meeting this need. Competing clinical demands made it difficult to assemble all providers for classroom training simultaneously; flexible solutions such as make-up classes and private tutorials were therefore necessary. Strong local partnerships providing ongoing clinical and educational support after this initial implementation have helped provide this ongoing training and mentorship.

CONCLUSION

Our experience demonstrates that it is realistic to develop, implement and disseminate a newborn medicine program in a resource-limited setting. National prioritization and strong local and global partnerships were essential to this success. Components of the neonatal care package and lessons learnt could be of relevance to policy makers and health care professionals in similar settings. We have subsequently introduced continuous positive airway pressure (CPAP) to selected district hospitals. A second edition of the protocol is underway, including the use of CPAP; more advanced material necessitated by the survival of smaller, sicker newborns; and modifications based on user feedback. Continued prioritization of newborn care services at health care facilities is essential to improving neonatal outcomes.

TABLE 2 Quality indicators

General	Percentage of patient records in which vital signs are documented on average every 3 h during the first 48 h of admission
Respiratory	Percentage of premature infants who had methylxanthine treatment (caffeine or aminophylline) prescribed by day of life 2 if birth weight <2 kg and gestational age <33 weeks
Fluid and nutrition	Percentage of infants admitted to neonatal unit within first 48 h of life, remained in unit until at least 2 weeks of age, and who regained their birth weight by <2 weeks of age
Infectious disease	Percentage of infants who remained on antibiotics beyond 72 h (excluding 'negative sepsis evaluations') who completed at least 7 days of both a gram-positive (ampicillin) and a gram-negative (gentamicin or third generation cephalosporin) antibiotic
Thermoregulation	Percentage of infants with <30 min time interval between admission to neonatal unit and documentation of first temperature
Neurologic	Percentage of patients diagnosed with asphyxia who never had temperature documented at >37.5 °C in first 72 h of life
Hyperbilirubinemia	Percentage of infants with elevated bilirubin per WHO guidelines and who were prescribed phototherapy
Hypoglycemia	Percentage of infants with documented blood sugar <40 mg/dl (2.2 mmol/l), who had blood sugar >40 mg/dl (2.2 mmol/l) within 1 h

WHO = World Health Organization.

References

- 1 Lawn J E, Blencowe H, Oza S, et al, for The Lancet Every Newborn Study Group. Every newborn: progress, priorities and potential beyond survival. *Lancet* 2014; 384: 189–205.
- 2 Save the Children. State of the world's mothers 2013: surviving the first day. Westport, CT, USA: Save the Children USA, 2013.
- 3 Paul V K. The current state of newborn health in low-income countries and the way forward. *Semin Fetal Neonatal Med* 2006; 11: 7–14.
- 4 World Health Organization. Pocket book of hospital care for children: guidelines for the management of common illnesses with limited resources. Geneva, Switzerland: WHO, 2005.
- 5 World Health Organization. Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice. Geneva, Switzerland: WHO, 2006.
- 6 Beck D, Ganges F, Goldman S, Long P. Saving newborn lives: care of the newborn reference manual. Washington, DC, USA: Save the Children US, 2004.
- 7 World Health Organization. Managing newborn problems: a guide for doctors, nurses and midwives. Geneva, Switzerland: WHO, 2003.
- 8 National Institute of Statistics of Rwanda. The NISR Home Page. <http://statistics.gov.rw>.
- 9 National Institute of Statistics of Rwanda. 2012 Population and Housing Census. Kigali, Rwanda: NISR, 2012. <http://www.statistics.gov.rw/publications/2012-population-and-housing-census-provisional-results>. Accessed January 2015.
- 10 Farmer P E, Nutt C T, Wagner C M, et al. Reduced premature mortality in Rwanda: lessons from success. *BMJ* 2013; 346: f65. Erratum in: *BMJ* 2013; 346: f534.
- 11 National Institute of Statistics of Rwanda. Rwanda Demographic and Health Survey 2010: Preliminary Report. Kigali, Rwanda: NISR, 2010. <http://statistics.gov.rw/publications/rwanda-demographic-and-health-survey-2010-preliminary-report>. Accessed January 2015.
- 12 Rwanda Ministry of Health. National neonatal protocols. Kigali, Rwanda: MOH, 2011.

La réduction des taux de la mortalité néonatale dans le monde reste un défi. Les protocoles internationalement reconnus en matière de soins hospitaliers aux nouveau-nés malades et petits sont limités, bien que ce domaine spécialisé se prête à la standardisation. Une équipe interdisciplinaire comprenant des experts cliniques internationaux et locaux a travaillé avec le Ministère de la Santé du Rwanda et des associations professionnelles rwandaises afin

d'élaborer et mettre en œuvre un programme de soins néonataux dans un hôpital de district Rwandais ; celui-ci a finalement été accepté comme standard national en matière de médecine du nouveau-né. On discute des caractéristiques qui ont fait le succès du programme et des défis restants. Il est réaliste d'élaborer, de mettre en œuvre et de diffuser des protocoles néonataux pour les nouveau-nés malades.

La disminución de la mortalidad neonatal mundial sigue planteando dificultades. Existen pocos protocolos de tratamiento hospitalario de los recién nacidos enfermos y pequeños para la edad gestacional que sean reconocidos internacionalmente, pese a que esta esfera de especialización se presta a la normalización. Un equipo interdisciplinario conformado por expertos clínicos nacionales e internacionales trabajó en colaboración con el Ministerio de Salud de Rwanda y las asociaciones ruandesas de profesionales, con el objeto

de establecer un programa de atención neonatal en el hospital distrital de una zona rural del país. En último término, este programa se aceptó como la norma nacional en materia de atención médica del recién nacido. En el presente artículo se analizan los aspectos que han dado buenos resultados y las dificultades que se encontraron durante la ejecución del programa. El proyecto de elaboración, ejecución y difusión de protocolos de tratamiento de las enfermedades de los recién nacidos constituye una intervención realista.

APPENDIX: NEONATAL UNIT MEDICAL RECORD ADMISSION FORM FOR INFANTS < 1 MONTH OF AGE

Admit date ____/____/____

Admit time _____

Patient name _____ Male Female ID # _____

Date of birth ____/____/____ Time of birth _____

Day of life on admission _____ Note: Day of birth = Day of Life 0

HISTORY:Maternal history: Age: _____ Gravida _____ Para _____ UnknownProblems in previous pregnancies _____ Prior premature infant UnknownProblems with this pregnancy _____ UnknownNumber of prenatal visits _____ UnknownLMP ____/____/____ UnknownHIV status Negative Positive UnknownIf positive, PMTCT received: Triple ART NVP x 1 Other _____ NoneMalaria during pregnancy? No Yes: Treated Treatment in course Not treated Unknown**Birth history:**Location Hospital Health center Home Unknown Other: _____ Vaginal birth Caesarian, reason: _____

Risk factors for infection

 Absent Present Rupture of membranes > 18 h prior to delivery Intrapartum fever; temperature, if known _____ Foul-smelling fluid Intrapartum antibiotics given Preterm labor Unknown Problems during delivery _____ Unknown Meconium-stained fluidAPGAR scores: 1 minute _____ 5 minutes _____ 10 minutes _____ UnknownResuscitation None O₂ Positive pressure ventilation (bag/mask) Chest compressions Adrenalin UnknownBirth weight: _____ kg Unknown

Gestational age

 Full term Preterm

Gestational age by LMP _____ weeks Gestational age by Ballard: _____ weeks

Selected gestational age: _____ weeks * Use LMP unless differs from Ballard by ≥2 weeks

 Vitamin K received Treatment presumed Unknown Eye ointment received Treatment presumed Unknown

Reason for admission _____

NAME: _____ SIGNATURE _____

NAME: _____ SIGNATURE _____

Continue to Daily Assessment and Orders page

NEONATAL UNIT MEDICAL RECORD DAILY ASSESSMENT AND ORDERS

Patient Name: _____ Date: ____/____/____ Day of Life (DOL): _____

Full term Preterm: Selected gestational age at birth _____ Postmenstrual age _____ (=gest. age + DOL)

EVENTS in past day _____

PHYSICAL EXAM Room air O₂ ____ L/min CPAP ____ VS Normal Abnormal : _____

Weight: _____ kg Weight change from yesterday: _____ grams Weight used for calculations: _____ kg

	Normal	Abnormal	Comments if abnormal:
General appearance			
Head: fontanelles			
Ears, eye, nose, mouth			
Chest, lung auscultation			
Heart: rate, rhythm, murmur			
Abdomen, umbi, genitalia			
Extremities			
Skin: capillary refill, jaundice			
Neuro: tone, reflexes			

PERTINENT LAB/TEST RESULTS _____

PROBLEM & PLAN 1. _____
2. _____
3. _____
4. _____

ORDERS: = Ordered = Not ordered

Temperature. If < 36°C, see **THERMOREGULATION PROTOCOL** Kangaroo Mother Care (KMC) Incubator

Respiratory: O₂ sat goal: 90-97% in oxygen, 90-100% in room air

O₂ sat < 90%: oxygen ____ l/min concentrator tank
 nasal cannula CPAP ____ cm H₂O

Apnea of prematurity: See **APNEA AND BRADYCARDIA OF PREMATURETY PROTOCOL**

Caffeine Aminophylline dose: _____
 Discontinue stimulant if ≥ 33 weeks postmenstrual age or 3 days prior to discharge and no evidence of apnea x 2 days

Infectious disease:

NFS (complete blood count) with differential CRP CXR urine for urinalysis/gram stain

Negative sepsis eval: 48 hours Pneumonia/sepsis: 1 week

Meningitis, gram-positive, 2 weeks Meningitis, gram-negative, 3 weeks

Ampicillin dose: _____ Discontinue ampicillin

Gentamicin dose: _____ Discontinue gentamicin

Other (céfotaxime, ceftriaxone, NVP) _____ Discontinue: _____

Fluids and nutrition: See **FLUIDS AND NUTRITION PROTOCOL**

Total fluids (IV + Enteral): _____ ml/kg/day

Maintenance IV fluids _____ ml/day Discontinue IVF
 G10% G10%¼ LR G10%¼ NS Discontinue IV catheter

Enteral feeds NPO ad lib PO _____ ml every: 3 hours ____ hours

Milk: Breast milk (preferred) Artificial milk Oral Nasogastric

Calories: Standard: 20 calories/30ml 24 calories/30ml (reduce cals to 20 when near discharge)

Glucose regulation If blood glucose < 45 mg/dl (2.5 mmol/l) see **HYPOGLYCEMIA PROTOCOL**

G10% bolus, 2 ml/kg = _____ ml repeat G10% bolus _____ ml

Repeat blood glucose after _____ hours

Hyperbilirubinemia/jaundice: See **HYPERBILIRUBINEMIA PROTOCOL**

Bilirubin level, total and direct Blood type and Rh status Start phototherapy Discontinue phototherapy

Additional orders _____

NAME: _____ SIGNATURE: _____

NEONATAL UNIT MEDICAL RECORD

DAY OF DISCHARGE ORDERS

Date: ___/___/___

Patient Name: _____

ID # _____

CRITERIA FOR DISCHARGE: All must be met and documented

- Fully oral feeding: breastfeeding \geq 8 times/day (If bottle feeding, taking \geq 100 ml/kg/day)
- Off antibiotics with no ongoing infectious disease concerns
- Urinating and stooling several times per day
- No contraindications to discharge (Danger signs: hypothermia, fever, respiratory distress, RR>70, inadequate PO intake, jaundice, vomiting, diarrhea or convulsions)
- Discharge teaching material given to family

If <2 kg

- No apnea x3 days off caffeine or aminophylline
- Weight gain for past 3 days (average \geq 15 g/day or 100 g/week)
- Discharge weight within 10% of birth weight
- Able to maintain temperature with Kangaroo Mother Care for past 3 days

If mother HIV-positive:

- Enrolled in HIV-free Child Survival Program (HFCSP)
- Date of RDV in PMTCT/HFCSP: ___/___/___
- NVP _____ ml oral twice daily
- Community health worker/accompagnateur notified of discharge

Documentation

- Hospital Discharge Form
- Note written in infant's book

DISCHARGE ORDERS: = Ordered = Not ordered

- Discharge infant to home
- Transfer infant to maternity

RDV: ___/___/___ Location: _____

Reason: LBW (birth weight < 2 kg)

- Seizures during this admission
- Concern for adequate weight gain
- Other: _____

Transfer infant to referral hospital Consider transfer if: Referral hospital: _____

Reason Profoundly LBW (birth weight < 1.25 kg)

- Profoundly preterm (<28 weeks gestation)
- Severe sepsis
- Severe respiratory distress
- Other: _____

NAME: _____ SIGNATURE _____

LMP = last menstrual period; HIV = human immunodeficiency virus; PMTCT = Prevention of Mother-to-Child Transmission; ART = antiretroviral therapy; NVP = nevirapin; CPAP = continuous positive airway pressure; NFS = numération formule sanguine; CRP = C-reactive protein; CXR = chest X-ray; IV = intravenous; IVF = IV fluids; G10% = glucose 10%; LD = lactated Ringer's solution; NS = normal saline; NPO = nil per os (nil by mouth); PO = per os (by mouth); RR = respiratory rate; RDV = rendez-vous (follow-up visit); LBW = low birth weight.