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Research Paper

Early Essential Newborn Care Is Associated With Reduced Adverse Neonatal Outcomes in a Tertiary Hospital in Da Nang, Viet Nam: A Pre- Post- Intervention Study

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ABSTRACT

Background: To accelerate reductions in neonatal mortality, Viet Nam rolled out early essential newborn care (EENC) using clinical coaching, quality improvement assessments in hospitals, and updated protocols. Da Nang Hospital for Women and Children, a tertiary referral hospital in central Viet Nam, compared outcomes pre- and post-EENC introduction.
Methods: Records of live births and NICU admissions were reviewed pre- (November 2013–October 2014) and post- (November 2014–October 2015) EENC implementation. Delivery room practices, NICU admissions and adverse outcomes on NICU admission were compared using descriptive statistics.
Findings: A total of 13,201 live births were delivered pre- and 14,180 live births post-EENC introduction. Post-EENC, delivery practice scores, rates of early and prolonged skin-to-skin contact and early breastfeeding rose significantly. There was a significant reduction in risk of NICU admissions (relative risk [RR] 0.68; 95% confidence interval [CI] 0.64–0.71; $p < 0.0001$), hypothermia on NICU admission (RR 0.72; 95% CI 0.65–0.81, $p < 0.0001$) and sepsis (RR 0.28; 95% CI 0.23–0.35, $p < 0.0001$). Exclusive breastfeeding rates in NICU increased from 49% to 88% ($p < 0.0001$) and of kangaroo mother care (KMC) from 52% to 67% ($p < 0.0001$). Reduced formula use resulted in decreased monthly costs.
Interpretation: EENC introduction, including staff coaching, quality improvement assessments and changes in hospital protocols and environments, were associated with improved clinical practices, reduced NICU admissions, admissions with hypothermia and sepsis and increased rates of exclusive breastfeeding and KMC in the NICU.
Funding: Data collection was funded by the World Health Organization Western Pacific Regional Office and Newborns Vietnam.
Outstanding Questions:

- What is the impact of the package of early essential newborn care interventions on newborn mortality?
- What are the total direct and indirect cost savings of early essential newborn care implementation?
- What is the cost effectiveness of kangaroo mother care for preterm and low birth weight babies?
- What strategies can help reduce unnecessary cesarean sections in hospitals?

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1. Introduction

Globally, an estimated 2.5 million newborns die each year accounting for 47% of deaths in children under the age of five [1]. In Viet Nam, where the neonatal mortality rate is 11 deaths per 1000 live births, neonatal deaths account for 52% of deaths in children under the age of five [1]. Two-thirds of neonatal deaths occur in the first three days of life, mainly from complications related to prematurity, birth asphyxia, and infection [2]. Studies in Viet Nam and throughout Asia have shown health workers often use outdated and harmful clinical practices during and after delivery which increases risk for newborn morbidity and mortality [3–5]. Quality of care is often limited by lack of clear policy

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Research in Context Panel

Evidence Before This Study

Studies in Asia have shown health workers often use outdated and harmful clinical practices during delivery and in the immediate newborn period, contributing to higher risks for newborn morbidity and mortality. Quality of care is compromised by the lack of clear policy guidelines, staff availability and allocation, and other health systems issues.

Added Value of the Study

This pre- and post-intervention study conducted in Da Nang Hospital for Women and Children, a regional hospital in central Viet Nam, reports changes in newborn health outcomes following introduction of early essential newborn (EENC). The hospital implemented EENC through on-the-job coaching for staff on appropriate childbirth and newborn care and establishment of a quality improvement process to support practice change. Here we report an improvement in newborn health outcomes in the post-EENC period, with risk of admissions to the neonatal intensive care unit (NICU), hypothermia on admission, and sepsis all significantly decreasing. The percentage of preterm and low birth weight newborns in the NICU receiving kangaroo mother care increased from 52% to 67% and those exclusively breastfed increased from 49% to 88%. These improvements occurred despite a significant increase in the proportion of babies born low birth weight and by cesarean section.

Implications of All Available Evidence

This study shows that adopting a systematic approach to implementing EENC improved clinical practices and newborn health outcomes. Newborn care situational analyses conducted in other low- and middle-income countries show that potentially harmful clinical practices remain widespread in health facilities. Hospitals in such settings can learn from the experience of Da Nang Hospital for Women and Children to improve newborn health outcomes.

guidelines, staff availability and allocation, and other health systems issues [6–7].

To redress this challenge, the ministry of health in Viet Nam endorsed the *Action Plan for Healthy Newborn Infants in the Western Pacific Region (2014–2020)* [8]. Focus was on improving the quality of care at health facilities where 95% of all deliveries occur using early essential newborn care (EENC) [9]. Implementation of EENC involves coaching health facility staff on appropriate childbirth and immediate newborn care practices using adult learning methodologies [10]. Subsequently, a quality improvement approach is used to address contextual factors that influence practice such as local policies, reorganization of work spaces, health worker roles, sequencing of tasks, and availability of supplies and equipment.

EENC comprises a package of simple evidence-based interventions shown to prevent or treat the most important causes of newborn morbidity and mortality [5,8]. Interventions include: immediate and thorough drying to prevent hypothermia and stimulate breathing [11]; immediate and sustained skin-to-skin contact upon delivery to prevent hypothermia, distress and hypoglycaemia and promote early and sustained breastfeeding [11,12]; delayed cord clamping to reduce the risk of anemia in newborn infants and further complications in preterm infants [13,14]; elimination of routine suctioning of newborns which increases the risk for apnoea and bradycardia [15,16]; resuscitation for non-breathing babies which can prevent neonatal deaths [17]; and appropriately timed hand-hygiene practices by birth attendants to reduce sepsis risk [18]. EENC interventions also include the use of evidence-based criteria to limit unnecessary procedures such as cesarean sections, episiotomies and augmentation of labour, and unnecessary admissions to neonatal intensive care [8].

EENC was adopted in Viet Nam in 2014 and introduced in three national and regional teaching hospitals including Da Nang Hospital for Women and Children. Over the next six months, EENC clinical coaching was conducted for hospital staff. This study aimed to determine whether introduction of EENC resulted in changes in clinical practice, neonatal intensive care unit (NICU) admissions and adverse newborn outcomes.

2. Methods

2.1. Setting

The Da Nang Hospital for Women and Children has 900 beds and serves over 3 provinces with a population of 4 million. Approximately 14,000 births occur annually. As a referral center for the central region of Viet Nam, many of the admissions are complicated and high acuity [19]. The NICU has level III capacity including mechanical ventilator support and care for extremely low birth weight newborns. In 2015, the unit had an 80-cot capacity with bed occupancy exceeding 120%. A separate space with 40 beds is allocated for Kangaroo Mother Care (KMC) for preterm and newborns weighing less than 2000 g at birth. The neonatal mortality rate at the hospital in 2014 was 10 deaths per 1000 live births.

2.2. Introduction of EENC

In July 2014, WHO introduced a 2-day practice-based clinical coaching for relevant hospital staff [10]. The coaching was conducted in delivery rooms using a practice-based approach with no lectures or presentations. A facilitator to participant ratio of 1:6 was used to allow repeated practice and feedback for all participants. Coaching began with a large group roleplay of current routine practice, performed by a midwife, using a mannequin and usual delivery equipment and supplies. Facilitators then reviewed current practices systematically, asking about each step and facilitating group inputs on why practices were used, whether they were evidence-based and how they could be improved, until there was consensus on appropriate practices. Participants practiced revised delivery steps until mastery. Competence was assessed using EENC clinical practice checklists which include 21 sequential time-bound steps for the breathing baby and 30 for the non-breathing baby from delivery preparation until the immediate newborn period [10]. A pre- and post-coaching evaluation of clinical practice, knowledge, and hand hygiene was administered to ensure that participants met minimum standards at end-line (at least 80% score on written and 90% on practice assessments). A group of 20 staff were identified as facilitators for hospital expansion. To be accredited as facilitators, staff completed the 2-day EENC coaching, one day training in facilitation methods and then ran at least one 2-day coaching under supervision.

In September 2014, the hospital developed guidelines on skin-to-skin contact for newborns delivered by cesarean section. By October 2014, the majority of staff involved in deliveries (obstetricians, midwives and pediatricians) had been coached in EENC and these staff provided opportunistic on-the-job coaching for other staff using clinical practice checklists as part of their routine practice. Therefore, October 2014 is considered the starting point of EENC implementation at the hospital.

In December 2014, an EENC team, with representation from hospital leadership, obstetrics, pediatrics, nursing midwifery and infection

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control staff, was established to oversee implementation. The team initially focused on coaching of delivery staff. In March 2015, the hospital team was trained in a quality improvement approach involving self-assessments of routine childbirth and newborn care at the hospital [20]. Periodic assessments were conducted by team members using standardized checklists, including exit interviews and chart reviews of a systematic random sample of postpartum mothers who had delivered in the previous 24 h, observations of deliveries and reviews of medicines, supplies and environments [20]. Separate exit interviews with postpartum women were conducted to assess postpartum feeding practices prior to discharge. Data were summarized and used to identify practices requiring improvement and corresponding actions to improve care.

Actions included issuance of new policies and protocols to reduce newborn separations and increase breastfeeding rates including enforcement of the code on marketing of breastmilk substitutes, modification of existent protocols to allow phototherapy to be applied for neonates with physiological jaundice whilst staying with their mothers in the postnatal ward, development of restricted criteria for NICU admissions, reorganization of the operation theater to enable skin-to-skin contact post-cesarean section, and location of continuous positive airway pressure (CPAP) machines in delivery, recovery and postnatal wards to allow babies with respiratory distress to receive CPAP whilst in skin-to-skin contact with their mothers. Nurses were trained on infection control and aspects of NICU clinical care, and the number of KMC beds in the NICU increased to be consistent with EENC recommendations. Hospital policy and systems changes were supported by the Ministry of Health Hospital Policy Directive 4673, issued in November 2014, which set national EENC standards that all hospitals must follow.

2.3. Study Design

A pre-and post-intervention design was used to review NICU admissions, adverse outcomes on admission, and care practices in the NICU before and after EENC introduction. Trained staff retrospectively reviewed records of in-hospital births and admissions to the NICU in the 12-months before (November 2013–October 2014) and after (November 2014–October 2015) EENC introduction. Data on skin-to-skin contact and other EENC practices were extracted from EENC quality improvement assessments done in March and November 2015 and feeding assessments done in August 2014 and May 2015 for hospital routine nutrition monitoring. Neonatal outcomes of interest, focusing on those influenced by immediate care after birth, included total number of NICU admissions, mode of delivery, gestational age, birth weight, hypothermia (measured on NICU admission), sepsis and birth asphyxia, and care practices in the NICU (KMC for newborns <2000 g and breastfeeding). Data on amount of infant formula purchased for NICU and postnatal wards were obtained from pharmacy records.

2.4. Definitions

World Health Organization categorizations were used for gestational age: <28 weeks (extremely preterm), 28 to <32 weeks (very preterm), 32 to <37 weeks (moderate to late preterm), and ≥37 weeks (term); and birthweight: <1000 g (extremely low birthweight), 1000–1499 g (very low birthweight), 1500–2499 g (low birthweight) and ≥2500 g (normal birthweight). Overall, preterm was defined as a gestational age of <37 completed weeks and low birthweight as <2500 g [21].

Case definitions applied in the NICU in the year before and year after implementation began were as follows:

Birth asphyxia was defined as a normally formed term or preterm neonate that fails to initiate and sustain breathing and requires positive pressure ventilation at birth.

Hypothermia was defined as a body temperature (axillary measurement) less than 36.5 °C.

Sepsis was defined as:

(i) confirmed sepsis with bacterial pathogens isolated from culture, or
(ii) probable sepsis [22] with:

- clinical signs of suspected sepsis (one or more of fever, hypothermia, mottling skin, respiratory distress, which cannot be explained by respiratory conditions such as the respiratory distress syndrome or meconium aspiration, poor feeding, diminished activity, and lethargy or seizures); and
- increased procalcitonin or anomalies of white cell count and antibiotics given (for at least 7 days or shorter if the patient died).

Breastfeeding practices were categorized as: exclusive breastfeeding (fed only breastmilk with the exception of medication), predominant breastfeeding (breastmilk is the predominant source of nutrition, with water and water-based fluids or formula also given in comparatively small amounts), mixed feeding (breastmilk, formula, water and water-based fluids are given in comparable amounts), and formula only.

2.5. Statistical Analysis

All data collected were entered and stored in a password-protected Microsoft Access 2007 database, accessible only by two members of the research team. Relative risk and corresponding confidence intervals were calculated and the Pearson's chi-squared test of independence used to compare outcomes of interest before and after EENC implementation. Statistical analysis was carried out using the Intercooled Stata 11.0 statistical package (StataCorp, College Station, Texas).

2.6. Ethical Considerations

The study was reviewed and approved by the Da Nang Hospital for Women and Children's Scientific & Ethics Committee.

3. Results

3.1. Introduction of EENC

By October 2014, 52% (195/372) hospital staff providing childbirth and newborn care services were coached in EENC. Of 195 staff coached, median pre- and post-coaching written test scores increased from 72% (13) to 97% (17.5). All participants scored above 90% on the post-coaching clinical practice assessments.

Before coaching, skin-to-skin contact was not practiced. Babies born vaginally were routinely separated from their mothers for at least 20 min and those delivered by cesarean section for six or more hours [23]. Follow-up practice data from interviews with randomly selected postpartum mothers revealed a 70–100% improvement in babies receiving immediate and prolonged skin-to-skin contact and early initiation (within 15–90 min after birth) of breastfeeding, and an increase from 27% to 60% in exclusive breastfeeding before discharge (Fig. 1a) [24,25]. Babies receiving skin-to-skin contact following cesarean section increased from 2% (159/7928) of babies pre-EENC to 93% (8383/8999) of babies delivered by cesarean section post-introduction of EENC. By March 2015 average observed clinical practice observation scores for randomly selected routine deliveries were 98% (41/42) and these scores were repeated in November 2015 (Fig. 1b) [26].

3.2. Live-births and NICU Admissions

Over the study period, 27,381 live births were registered in the hospital: 13,201 (48%) pre-EENC and 14,180 post-EENC (52%). Post-EENC introduction, a greater proportion of births were delivered by cesarean

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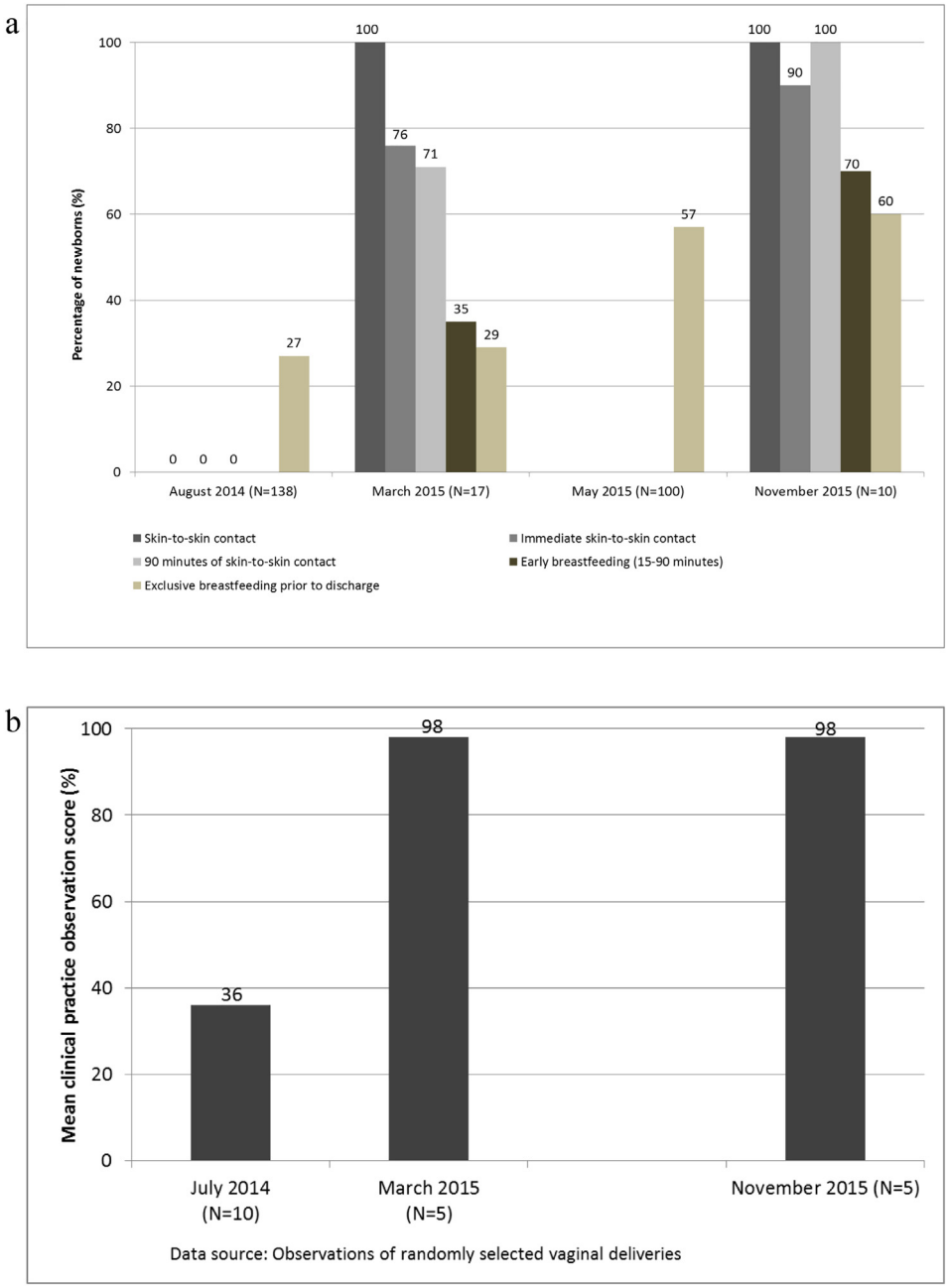

Fig. 1. Change in immediate newborn care practices (1a) and mean clinical practice observation scores (1b), Da Nang Hospital for Women and Children, July 2014–November 2015.

section (64% versus 60%; relative risk, 1.06; $p < 0.0001$) and were low birth weight (9.4% versus 8.5%, relative risk 1.11; $p < 0.01$) than pre-EENC introduction. Non-significant differences were seen in sex and gestational age (Table 1).

Total NICU admissions decreased from 18.3% to 12.3% (relative risk 0.68; 95% CI 0.64–0.71; $p < 0.0001$) after introduction of EENC. Cesarean sections, term and normal birthweight babies admitted to the NICU also declined ($p < 0.0001$) (Table 1). The proportions of moderate to late preterm and low birthweight newborn infants admitted decreased between the pre-EENC and post-EENC periods with relative risks of 0.78 (95% CI 0.74–0.82; $p < 0.0001$) and 0.65 (95% CI 0.60–0.69; $p < 0.0001$), respectively. The proportion of extremely and very preterm, and extremely low and very low birthweight newborns admitted to the NICU increased over the study period, but non-significantly.

3.3. Adverse Clinical Outcomes

Compared to the pre-EENC period, babies with hypothermia on admission to the NICU declined from 5.4% to 3.9% (relative risk 0.72; 95% CI 0.65–0.81; $p < 0.0001$) and cases of sepsis from 3.2% to 0.9% (relative risk 0.28; 95% CI 0.23–0.35; $p < 0.0001$) post-EENC implementation (Table 2). The percentage of probable cases of sepsis decreased by more than five times post-EENC implementation among all live births (relative risk 0.18, 95% CI 0.14–0.23; $p < 0.0001$) and live births >28 weeks of gestational age (relative risk 0.17, 95% CI 0.13–0.22; $p < 0.0001$). Rates of asphyxia were low and not statistically different in both periods. Among babies more than 28 weeks gestation, rates of asphyxia requiring bag and mask ventilation showed a non-significant downward trend. No changes in rates of asphyxia requiring intubation or of hypoxic ischaemic encephalopathy were noted.

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Table 1
Total live births and NICU admissions by mode of delivery, sex, gestational age and birth weight before and after EENC introduction, Da Nang Hospital for Women and Children, 2013–2015.

Characteristic	Pre-EENC (Nov 2013–Oct 2014), n (%)	Post-EENC (Nov 2014–Oct 2015), n (%)	Relative risk (95% CI)	*p* value
All live births	13,201	14,180		
Delivered by cesarean section	7928 (60.0)	8999 (63.5)	1.06 (1.04–1.08)	<0.0001
Male	7032 (53.3)	7560 (53.3)	1.00 (0.98–1.02)	0.9394
Gestational age				
<28 weeks	104 (0.8)	139 (1.0)	1.24 (0.97–1.60)	0.0898
28–<32 weeks	147 (1.1)	156 (1.1)	0.99 (0.79–1.24)	0.9156
32–<37 weeks	710 (5.4)	779 (5.5)	1.02 (0.93–1.13)	0.6743
≥37 weeks	12,240 (92.7)	13,106 (92.4)	1.00 (0.99–1.00)	0.3536
Birth weight				
<1000 g	102 (0.8)	132 (0.9)	1.20 (0.93–1.56)	0.1553
1000–1499 g	137 (1.0)	105 (0.7)	0.71 (0.55–0.92)	0.0086
1500–2499 g	882 (6.7)	1096 (7.7)	1.16 (1.06–1.26)	0.0008
≥2500 g	12,080 (91.5)	12,847 (90.6)	0.99 (0.98–1.00)	0.0085
In-born NICU admissions	2410 (18.3)	1748 (12.3)	0.68 (0.64–0.71)	<0.0001
Cesarean section births admitted to the NICU	1324 (16.7)	1065 (11.8)	0.71 (0.66–0.76)	<0.0001
Males admitted to the NICU	1192 (17.0)	904 (12.0)	0.71 (0.65–0.76)	<0.0001
Newborns by gestational age admitted to the NICU				
<28 weeks	33 (31.7)	53 (38.1)	1.20 (0.84–1.71)	0.3020
28–<32 weeks	132 (89.8)	139 (89.1)	0.99 (0.92–1.07)	0.8444
32–<37 weeks	661 (93.1)	566 (72.7)	0.78 (0.74–0.82)	<0.0001
≥37 weeks	1576 (12.9)	984 (7.5)	0.58 (0.54–0.63)	<0.0001
Newborns by birth weight admitted to the NICU				
<1000 g	28 (27.5)	45 (34.1)	1.24 (0.84–1.84)	0.2770
1000–1499 g	121 (88.3)	96 (91.4)	1.04 (0.95–1.13)	0.4312
1500–2499 g	692 (78.5)	555 (50.6)	0.65 (0.60–0.69)	<0.0001
≥2500 g	1561 (12.9)	1046 (8.1)	0.63 (0.58–0.68)	<0.0001

3.4. Care Practices in the NICU

Whilst half of all newborns in the NICU were fed something other than breastmilk pre-EENC introduction, 88% were exclusively breastfed in the post-EENC phase (relative risk 1.80; 95% CI 1.72–1.88; $p < 0.0001$). Those predominantly breastfed declined from 39% to 11% (relative risk 0.28; 95% CI 0.24–0.32; $p < 0.0001$) and those receiving mixed feeding declined from 10% to 0.4% (relative risk 0.04; 95% confidence interval 0.02–0.09; $p < 0.0001$) after EENC implementation (Table 2). Preterm newborns <2000 g receiving KMC increased from 52% to 67% (relative risk 1.28; 95% CI 1.14–1.44; $p < 0.0001$). Review of pharmacy registers revealed the average monthly amount of formula used after EENC introduction declined from 157 to 35 tins of formula in the NICU and from 640 to 37 tins of formula in postnatal wards. This corresponds to a 78% and 96% reduction in monthly expenses for formula in NICU and postnatal wards respectively after EENC implementation (Fig. 2).

Table 2
Adverse clinical outcomes, feeding practices and kangaroo mother care for inborn newborns admitted to the NICU pre- and post-EENC implementation, Da Nang Hospital for Women and Children, 2013–2015.

Characteristics	Pre-EENC (Nov 2013–Oct 2014), n (%)	Post-EENC (Nov 2014–Oct 2015), n (%)	Relative risk (95% CI)	*p*-Value
Adverse outcomes – all live births	N = 13,201	N = 14,180		
Hypothermia on admission	707 (5.4)	549 (3.9)	0.72 (0.65–0.81)	<0.0001
Sepsis[1]	429 (3.2)	131 (0.9)	0.28 (0.23–0.35)	<0.0001
Confirmed	62 (0.5)	60 (0.4)	0.90 (0.63–1.28)	0.5635
Probable	367 (2.8)	71 (0.5)	0.18 (0.14–0.23)	0.0000
Asphyxia requiring bag and mask	171 (1.3)	173 (1.2)	0.94 (0.76–1.16)	0.5760
Asphyxia Requiring Intubation	39 (0.3)	52 (0.4)	1.24 (0.82–1.88)	0.3058
HIE[2]	29 (0.2)	27 (0.2)	0.87 (0.51–1.46)	0.5922
Adverse outcomes – live births >28 weeks	N = 13,097	N = 14,041		
Hypothermia on admission	675 (5.2)	511 (3.6)	0.71 (0.63–0.79)	<0.0001
Sepsis	415 (3.2)	109 (0.8)	0.24 (0.20–0.30)	<0.0001
Confirmed	55 (0.4)	42 (0.3)	0.71 (0.48–1.06)	0.0956
Probable	360 (2.7)	67 (0.5)	0.17 (0.13–0.22)	<0.0001
Asphyxia requiring bag and mask	146 (1.1)	127 (0.9)	0.81 (0.64–1.03)	0.0828
Asphyxia requiring intubation	35 (0.3)	32 (0.2)	0.85 (0.53–1.38)	0.5141
Feeding practices – all admissions	N = 2360	N = 1701		
Exclusive breastfeeding	1157 (49.0)	1501 (88.2)	1.80 (1.72–1.88)	<0.0001
Predominant breastfeeding	912 (38.6)	184 (10.8)	0.28 (0.24–0.32)	<0.0001
Mixed breastfeeding	236 (10.0)	7 (0.4)	0.04 (0.02–0.09)	<0.0001
Formula only	55 (2.3)	9 (0.5)	0.23 (0.11–0.46)	<0.0001
Kangaroo mother care – babies <2000 g	N = 372	N = 429		
Receiving KMC	194 (52.2)	287 (66.9)	1.28 (1.14–1.44)	<0.0001

[1] Confirmed and probable sepsis using the NICU case-definition (see Methods).
[2] Hypoxic ischaemic encephalopathy.

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4. Discussion

Compared to the pre-EENC period, risk of NICU admissions, hypothermia on admission, and sepsis all significantly decreased following implementation of EENC in Da Nang Hospital for Women and Children. Across the same period, the percentage of preterm and low birth weight newborns in the NICU receiving KMC increased from 52% to 67% and those exclusively breastfed increased from 49% to 88%. These improvements occurred despite a significant increase in the proportion of babies born low birth weight and by cesarean section. Newborns admitted with birth asphyxia did not significantly change over the study period, although the proportion of babies over 28 weeks gestation needing bag and mask resuscitation showed a downward trend.

Significant reductions in NICU admissions, hypothermia and sepsis cases, and increased rates of exclusive breastfeeding in NICU occurred concomitant with introduction of EENC. Data collected across 12 months after EENC implementation began suggest that core practices had been adopted and were sustained. Skin-to-skin contact was not practiced prior to introduction of EENC and is a good indicator of uptake. Exit interviews with mothers and practice observations in March 2015 revealed that 100% of babies received immediate skin-to-skin contact regardless of route of delivery, with three-quarters receiving uninterrupted skin-to-skin contact for at least 90 min. This was maintained or improved through November 2015. These improvements were noted for babies delivered by cesarean section as well, with 2% of babies delivered by cesarean section pre-EENC receiving skin-to-skin contact compared to 93% post-EENC. High clinical practice observation scores reflect application of 21 delivery tasks, including appropriate hygiene practices, immediate skin-to-skin contact, delayed cord clamping, elimination of routine suctioning, and counseling on newborn feeding cues.

Maintaining uninterrupted skin-to-skin contact along with counseling on feeding cues (also not done pre-EENC) reduce hypothermia and promote early and effective initiation of breastfeeding [11,12]. Additionally, introduction of delayed cord clamping, elimination of routine suctioning, and improved hand hygiene which are core to EENC, improved following EENC introduction and are associated with various improved clinical outcomes [13–16,18]. Although improvements in immediate and thorough drying might be expected to reduce rates of non-breathing babies, significant declines in rates of asphyxia requiring bag and mask resuscitation were not seen. This may be because the rates were very low in the year before the intervention began.

The short and long-term benefits of early and exclusive breastfeeding to babies, mothers and their families are innumerable including reduced morbidity, mortality, and non-communicable diseases [26]. Improved breastfeeding rates in the hospital were associated with more than 78% to 96% reduction in NICU and postnatal ward expenditures on infant formula. Other savings are expected for reduced antibiotic use, and for reduced staff workload associated with reduced NICU admissions. The reduction in NICU admissions from 18.3% to 12.3% of all live births represented a decline in 846 annual admissions. This represents a saving of at least US$ 313,020 for the hospital, using the estimated average cost of one NICU admission at DHWC (US$ 370). Other direct and indirect savings are expected from reduced family costs associated with hospital stays, time off work, child care, travel and emotional impact. In comparison, the cost of conducting a 2-day EENC coaching session at DHWC was only US$ 150. Cost and time savings from beneficial interventions provide powerful information for convincing senior managers and policymakers to consider adopting new approaches. The average length of stay in NICU did not change pre- and post-EENC implementation. We believe this may be because relatively heathy babies were excluded from NICU after changing admission criteria, with the remaining population more likely to be smaller, less mature and sicker, therefore requiring longer NICU stays.

Whilst EENC promotes use of evidence-based criteria to reduce unnecessary procedures, the proportion of babies delivered by cesarean section increased from 60% pre-EENC to 63% post-EENC. The primary reason for this trend is believed to be a high proportion of high-risk pregnancies received by Da Nang Hospital for Women and Children as a tertiary referral hospital, a factor that is independent of EENC implementation. In addition, as the first hospital in Viet Nam implementing skin-to-skin for babies delivered by cesarean section, pregnant women with a scheduled or high likelihood of having a cesarean section may opt to deliver at the hospital. Nonetheless, the cesarean section rate is high and warrants further investigation in the next phase of EENC implementation.

Study findings highlight that changing practice is a process that requires continuous self-monitoring. Improvements in sustained skin-to-skin contact and exclusive breastfeeding occurred more slowly and required continued facilitation. Changes in delivery room practices required support of managers, pediatricians and neonatologists, and the hospital store (who put thicker cloths for drying and covering babies into routine delivery packs). Exclusive breastfeeding postpartum for newborns not admitted to NICU (where exclusive breastfeeding rates reached 88% post-EENC) was slower to improve because pressure to give formula came from family members and was tacitly allowed by staff. Without periodic interviews with postpartum mothers, this problem would not have been identified.

Whilst the results are promising, they also show room for improvement remains especially for introduction of KMC for preterm and low birth weight babies. Efforts to increase the proportion of babies kept in KMC and reducing the amount of time babies are separated from

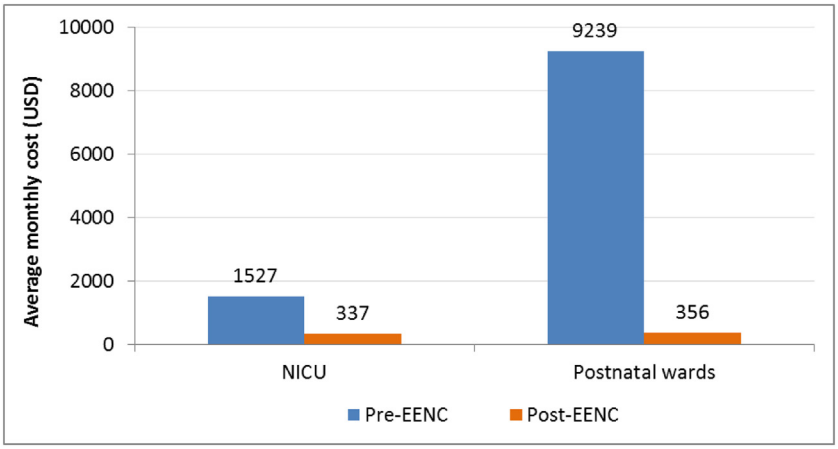

Fig. 2. Average monthly cost of infant formula, NICU and postnatal wards, pre- and post- EENC introduction, Da Nang Hospital for Women and Children, 2013–2015.

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their mothers are ongoing. A costing analysis would help determine overall cost effectiveness.

This study is limited by its pre-post design and the possibility that results may have been biased by secular trends, or the introduction of other interventions affecting care practices and unrelated to EENC. A randomized controlled trial, the gold standard for determining causality, would not have been suitable for ethical reasons: evidence-based interventions included in EENC have individually been shown to reduce newborn mortality and morbidity. The significant changes in outcomes seen over the short follow up period of 12 months post-EENC introduction suggest effects above those expected from secular trends.

We were unable to undertake multivariate analyses due to recording practices at Da Nang Hospital for Women and Children which mean that data maintained by the maternity ward (such as newborn demographics) cannot be linked with data maintained by the NICU (adverse outcomes, feeding and kangaroo mother care practices) for a large population of babies admitted to the NICU. Such limitations in information systems have been observed across hospitals in Viet Nam as well as in other settings of East Asia and Pacific [27]. Our findings therefore do not account for the potential effects that factors such as birth weight and gestational age may have had on adverse outcomes and feeding practices. However, given that the proportion of low birth weight babies and cesarean section deliveries increased over the study period, the likelihood that we have overestimated the decrease in adverse outcomes or improvement in feeding practices is low.

Periodic practice reviews using observations of deliveries were subject to the Hawthorne effect. To minimize the problem of observation bias, exit interviews of postpartum mothers were added to assess delivery practices. It is also possible that periodic cross-sectional practice reviews are not representative of routine practice which may vary with time of day, case-loads, and case-complexity. Although this problem cannot be entirely eliminated, it was mitigated by using a systematic random sample of postpartum women delivering in the previous 24 h, to include women delivered at different times and by different staff, and by measuring practices in two different time periods (March and November 2015), both of which showed improvements for key EENC practice outcomes. Separate exit interviews with larger samples of randomly selected postpartum mothers for nutrition monitoring also provided evidence of improved breastfeeding practices across the intervention period.

Classification error may have occurred when categorizing gestational age and birth weight, however no changes in classification criteria occurred during the study period. The proportion of babies by gestational age and birth weight pre- and post- EENC were very similar, suggesting that classification error was not a significant problem. Similarly, NICU case-definitions were not changed in the year before and after implementation began.

Lastly, newborn mortality was not included as a study outcome because a sample size of around 72,000 births pre- and post-EENC implementation would have been necessary to detect a 20% reduction in neonatal mortality (from 10 to 8 deaths per 1000 live births) with 80% power. With annual hospital births of 14,000, this would have increased the study period to six years, increasing the likelihood of confounding factors or secular trends interfering with results.

To achieve the Sustainable Development Goal target on newborn mortality, low and middle-income countries need to identify approaches to improving the quality of delivery and immediate newborn care. Limited data are available on strategies that can work at scale in low and middle-income countries using routine systems [28,29]. This pre-post study suggests that introducing evidence-based EENC through practical coaching focused around building skills and implementation of a quality improvement approach in hospitals can improve newborn health outcomes and care practices. This was achieved through routine systems, using existing staff, and locally adapted and developed methods. This contributes substantially to local applicability and sustainability. Findings from this study informed subsequent hospital-wide scale-up of EENC in Viet Nam. By April 2017, 88% of national, regional, provincial, and district hospitals had begun implementing EENC with over 8000 maternity and pediatric staff coached. At EENC implementing facilities, 94% of all babies received immediate skin-to-skin contact and 57% breastfed before separation [30]. These data suggest that sustained scale-up and practice change is possible, even in countries such as Viet Nam with a very high number of health facilities and supports similar early findings from Philippines [31], Lao PDR and Cambodia. There is now a need to build on early experiences and to document methods used, changes in newborn health outcomes, and ultimately newborn mortality at both hospitals and lower level health facilities on a wider scale.

Disclosure of Interests

The authors declare no conflicts of interest.

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Contributions to Authorship

HTT, NDV, HAT, LTMT, PPTN, HLS, JM, and PTQN contributed to introduction of early essential newborn care in Da Nang Hospital for Women and Children. HTT, HLS, and JM conceptualized the study. HTT and PPTN collected the data. HTT, PPTN, and PM conducted the data analysis. HTT, HLS, JM, and PM drafted the manuscript. All authors reviewed and commented on the manuscript prior to finalization.

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