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Early essential newborn care is associated with improved newborn outcomes following caesarean section births in a tertiary hospital in Da Nang, Vietnam: a pre/post-intervention study

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ABSTRACT

Background To improve maternal and neonatal outcomes, Vietnam implemented early essential newborn care (EENC) using clinical coaching and quality improvement self-assessments in hospitals to introduce policy, practice and environmental changes. Da Nang Hospital for Women and Children began EENC with caesarean section births to inform development of national guidelines. This study compared newborn outcomes after caesarean sections pre/post-EENC introduction.

Methods Maternity records of all live in-born hospital caesarean births and separate case records of the subpopulation admitted to the neonatal intensive care unit (NICU) were reviewed pre-EENC (November 2013–October 2014) and post-EENC (November 2014–October 2015) implementation. NICU admissions and adverse outcomes on NICU admission were compared using descriptive statistics.

Findings A total of 16 927 newborns were delivered by caesarean section: 7928 (46.8%) pre-EENC and 8999 post-EENC (53.2%). Total NICU admissions decreased from 16.7% to 11.8% (relative risk 0.71; 95% CI 0.66 to 0.76) after introduction of EENC. Compared with the pre-EENC period, babies with hypothermia on admission to the NICU declined from 5.0% to 3.7% (relative risk 0.73; 95% CI 0.63 to 0.84) and cases of sepsis from 3.2% to 0.8% (relative risk 0.26; 95% CI 0.20 to 0.33) post-EENC implementation. While more than half of all newborns in the NICU were fed something other than breastmilk pre-EENC introduction, 85.8% were exclusively breast fed post-EENC (relative risk 1.86; 95% CI 1.75 to 1.98). Preterm newborns <2000 g receiving kangaroo mother care (KMC) increased from 50% to 67% (relative risk 1.33; 95% CI 1.12 to 1.59).

Conclusion The EENC quality improvement approach with caesarean section births was associated with reduced NICU admissions, admissions with hypothermia and sepsis, and increased rates of exclusive breast feeding and KMC in the NICU.

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INTRODUCTION

Newborn deaths accounted for more than 47% of under-5 mortality globally in 2018,[1] with 98% of these deaths occurring in low-income and middle-income countries.[2] In Vietnam, neonatal mortality declined from 24 to 11 per 1000 live births between 1990 and 2018 and now represents around 52% of under-5 deaths.[1] Common causes of neonatal deaths include complications of prematurity, infections, birth asphyxia and congenital malformations, the vast majority occurring in the first 3 days of life.[3] To address this challenge, the Vietnam Ministry of Health endorsed the *Action Plan for Healthy Newborn Infants in the Western Pacific Region (2014–2020)* in 2014. The core of the newborn programme is early essential newborn care (EENC), a package of evidence-based interventions demonstrated to prevent or manage the most common causes of newborn morbidity and mortality, including immediate and thorough drying, immediate and sustained skin-to-skin contact (SSC), delayed cord clamping, promotion of early and sustained breast feeding, resuscitation for non-breathing babies and appropriately timed hand-hygiene practices.[4] EENC interventions also include the adoption of kangaroo mother care (KMC) for management of preterm and low birthweight babies.[5]

Efforts to introduce and ensure routine practice of EENC have been complicated in Vietnam by an accelerating caesarean section rate, estimated at 28% nationally in 2014, with rates in some cities above 50%.[6] At the same time, rates of early breastfeeding fell nationally between 2011 and 2014 from 39.7% to 26.5%, with bottle feeding increasing in prevalence (from 38.7% to 44.1%) and continued breast feeding at 1 year declining (from 74% to 65.4%) during the same period.[7 8] Babies born by caesarean section are routinely separated from mothers, admitted to neonatal intensive care units (NICUs) or nurseries for observation and given infant formula before being returned to the mother. This practice has led to crowded NICUs, resulting in the number of babies exceeding bed capacity and increasing risks for newborn infections and other morbidities.[9] Reasons why SSC and early newborn care practices are not performed at caesarean section births include fears that it will compromise the procedure, concerns for the safety of mothers and babies, perceived additional work burden, physical organisation of the operating room, and lack of coordination and communication between anaesthesiology and obstetrics staff.[10–12] However, data show that SSC can be introduced successfully with caesarean section, is safe for both mothers and newborns, and can increase maternal satisfaction and rates of exclusive breast feeding.[13 14]

EENC was adopted in Vietnam in 2014 and first introduced in three national and regional teaching hospitals including Da Nang Hospital for Women and Children. Over the next 6 months, EENC was introduced through staff coaching, quality improvement assessments, and changes in hospital protocols and environments.[15] Recognition of the importance of early newborn care interventions prompted an early commitment to introducing EENC with operative as well as vaginal births. In a previous publication, we showed that EENC implementation was associated with improved care practices around delivery and newborn outcomes for all babies born at the hospital.[15] In this study, we examine if the same association holds for babies born by caesarean section.

METHODS

Setting

The Da Nang Hospital for Women and Children is a tertiary hospital for obstetrics, gynaecology and paediatrics, serving three provinces with a population of 4 million. The hospital had 900 beds and approximately 14 000–15 000 annual births in 2014–2015. As a referral hospital for the central region of Vietnam, at least 30% of admissions are women with high-risk pregnancies and/or sick children.[16] In 2014–2015, the hospital had 13 standard delivery beds, 4 operative delivery beds, 45 obstetricians and gynaecologists, 90 midwives and 10 neonatologists; the caesarean section rate was around 61%. The NICU had 80 beds and level III capacity including mechanical ventilator support and care for extremely low birthweight newborns.

Introduction of EENC for mothers and newborns with caesarean sections

The process used to introduce EENC in the hospital is described in detail elsewhere.[15] EENC implementation for vaginal delivery began in July 2014 with 2-day practice-based clinical coaching for relevant hospital staff in delivery rooms, followed by formation of an EENC team, with representation from hospital leadership, obstetrics, neonatology, nursing, midwifery, hospital quality management and infection control staff. This team oversaw implementation and conducted periodical practice assessments using standardised checklists. In the NICU, more KMC beds, space and amenities were allocated for mothers and families, coupled with staff KMC training and improved education and counselling for parents and caregivers.[15]

By October 2014, most staff involved in deliveries (obstetricians, midwives and the neonatal team) had been coached in EENC and the protocol for EENC with caesarean section had been completed. 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.[17] November 2014 is considered the starting point of full EENC implementation for uncomplicated caesarean section births with stable mothers and newborns at the hospital.

The protocol for incorporating EENC into caesarean section deliveries was developed collaboratively with staff involved in patient management and included four important elements.

First, all staff involved with operative deliveries were coached in EENC for routine vaginal births to ensure that they met practice standards and were familiar with the clinical tasks required for effective early newborn care and understood the clinical rationale for these evidence-based practices.

Second, the EENC team worked with operating room staff to develop a protocol that enabled immediate newborn care practices with caesarean section births, based on the routine vaginal EENC protocol. EENC was considered feasible for all caesarean deliveries regardless of gestational age, without significant maternal or newborn complications requiring emergent care. The protocol included preparation of materials and supplies needed in scrub packs, possible staff roles, content of antenatal client counselling and the procedure for oral consent.[18]

Third, to clarify task delineation, simulation exercises were conducted in the operating room using a newborn manikin and one staff person playing the role of the mother. Hospital leaders, obstetric, anaesthesiology, neonatal staff and infectious control teams participated in these sessions, during which specific roles and responsibilities of each were clarified, tested and calibrated. Typically, 'scrubbed in' members of the team were the obstetrician, the first assistant, the surgical nurse and a staff-person responsible for transferring the baby to the mother's chest (usually a midwife caregiver). Members of the team not 'scrubbed in' were the anaesthesiologist or nurse anaesthetist, and a 'circulating' nurse or midwife. Specific tasks were discussed and assigned to team members including: pre-caesarean section preparation of mother and family, recording of the operating room temperature, drying the baby and placing under a dry cloth, clamping and cutting of the cord, timely administration of the uterotonic, transferring the newborn to the mother's chest area for SSC, monitoring of the newborn and mother while in uninterrupted SSC in the operating and recovery rooms or post-anaesthesia unit, and counselling and support for early initiation of exclusive breast feeding. Other routine procedures for caesarean section were practised as usual, with strict adherence to the maintenance of sterile fields. A neonatologist or a trained neonatal nurse was established as part of the team in the first 3 months to provide support if needed; later neonatal staff were made available in high-risk cases or on standby for emergencies. Spinal or regional anaesthesia was recommended in lieu of general anaesthesia when possible because it allowed the mother to help support the newborn on her chest; and because it reduced the need for intraoperative medications and decreased the amount of pain medication needed postoperatively. For EENC under general anaesthesia, the anaesthetist ensured that all equipment allowed clear access to the mother's chest for SSC and carefully monitored the depth of anaesthesia to ensure that women maintained pulse oximetry readings at ≥95% and were able to regain consciousness as quickly as possible postoperatively. Mothers and newborns were transferred to the recovery area in the SSC position, while the status of both mother and newborn was monitored by recovery room nurses every 15 min for the first hour and every 30 min for the second hour, with unstable newborns transferred for assessment if needed. SSC was applied without interruption for at least 90 min in the recovery area and until the first breast feed was completed.

Finally, updated clinical roles were supported by changes in operating room and postnatal care environments, materials and supplies; and by concomitant changes in criteria for NICU admission. Additional drying cloths and baby hats were added in sterile packs and neonatal resuscitation warmers were brought into operating rooms. Changes in staff allocation and task definition were required to support EENC in operating rooms including the placement of at least one additional staffperson to transfer the baby and support them in the skin-to-skin position; and retraining of recovery and postnatal care staff to monitor both mother and baby and provide breastfeeding support. Routine newborn tasks, such as weighing and administration of vitamin K and hepatitis B vaccination, were delayed until at least 90 min after birth; vitamin K was given by staff in recovery areas and hepatitis B vaccination by staff in postnatal areas. Admission criteria for both NICU and neonatal nursery areas were updated to ensure that admission for stable babies born operatively was no longer permissible and to allow babies with transient respiratory distress to be managed in recovery areas with their mothers. Before EENC implementation, all babies born by caesarean section were routinely separated from mothers for 6 hours regardless of their clinical status. Stable newborns were transferred to a nursery in the postnatal wards. Unstable newborns and those with transient respiratory distress were transferred to the NICU. All were given formula feeding because the mothers were monitored in recovery rooms and breast feeding was not permitted. Revised admission criteria eliminated all routine separations to nursery for stable babies, and allowed babies with mild to moderate respiratory distress which could be resolved with oxygen <30% via nasal prongs or continuous positive airway pressure to be kept in SSC with their mothers and monitored in situ, rather than be admitted to the NICU.

Study design

A pre-intervention and post-intervention design was used to review NICU admissions, adverse outcomes on admission, and care practices for babies born by caesarean section before and after EENC introduction. Trained staff retrospectively reviewed maternity records of all live in-born hospital caesarean births and separate case records of the subpopulation admitted to the NICU in the 12 months before (November 2013–October 2014) and after (November 2014–October 2015) EENC introduction. Data on SSC and other EENC practices were extracted from EENC quality improvement assessments conducted using standard checklists and methods, beginning in August 2014 (before implementation) and repeated in March, May and November 2015. Details of the study design and practice data collection methods have been reported previously.[15]

Definitions

In-born newborn NICU admissions were defined as any baby born alive in the Da Nang Hospital for Women and Children admitted to the NICU at any time between birth and 28 days of life.

Caesarean section was defined as any operative delivery corresponding to International Statistical Classification of Diseases and Related Health Problems revision 10 codes 082.0–082.9.[19] Standard definitions used for gestational age and birth weight,[20] birth asphyxia, hypothermia, sepsis (confirmed and probable[9]), breastfeeding practices and KMC were used.[15]

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 CIs were calculated to compare outcomes of interest before and after EENC implementation. The Pearson's X^2 test of independence was used to determine if differences pre-implementation and post-implementation were statistically significant. Statistical analysis was carried out using the Intercooled Stata V.14.0 statistical package (StataCorp, College Station, Texas).

RESULTS

Live births and NICU admissions

Over the study period, 27 381 live births were registered in the hospital, 16 927 (61.8%) were delivered by caesarean section: 7928 (46.8%) pre-EENC and 8999 post-EENC (53.2%). Post-EENC introduction, a greater proportion of births were delivered by caesarean section (64% vs 60%;

Table 1 Total live births delivered by caesarean section and admitted to NICU by 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 delivered by caesarean section	**7928**	**8999**		
Male	4271 (53.9)	4860 (54.0)	1.00 (0.97 to 1.03)	0.86
Gestational age				
<28 weeks	15 (0.2)	22 (0.2)	1.29 (0.67 to 2.49)	0.44
28–<32 weeks	68 (0.9)	84 (0.9)	1.09 (0.79 to 1.50)	0.60
32–<37 weeks	412 (5.2)	467 (5.2)	1.00 (0.88 to 1.14)	0.98
≥37 weeks	7433 (93.7)	8426 (93.6)	1.00 (0.99 to 1.01)	0.74
Birth weight				
<1000 g	16 (0.2)	26 (0.3)	1.43 (0.77 to 2.67)	0.25
1000–1499 g	75 (1.0)	54 (0.6)	0.63 (0.45 to 0.90)	0.01
1500–2499 g	501 (6.3)	699 (7.8)	1.23 (1.10 to 1.37)	<0.001
≥2500 g	7336 (92.5)	8220 (91.3)	0.99 (0.98 to 1.00)	0.005
Caesarean section births admitted to the NICU	**1324 (16.7)**	**1065 (11.8)**	**0.71 (0.66 to 0.76)**	**<0.001**
Male	653 (49.3)	556 (52.2)	1.06 (0.98 to 1.15)	0.16
Newborns by gestational age				
<28 weeks	6 (40.0)	7 (31.8)	0.80 (0.33 to 1.90)	0.6
28–<32 weeks	60 (88.2)	70 (83.3)	0.94 (0.83 to 1.07)	0.4
32–<37 weeks	360 (87.3)	355 (76.0)	0.87 (0.82 to 0.93)	<0.001
≥37 weeks	898 (12.1)	633 (7.5)	0.62 (0.56 to 0.68)	<0.001
Newborns by birth weight				
<1000 g	7 (43.7)	7 (26.9)	0.62 (0.27 to 1.43)	0.2
1000–1499 g	61 (81.3)	48 (88.9)	1.09 (0.95 to 1.26)	0.2
1500–2499 g	385 (76.8)	342 (48.9)	0.64 (0.58 to 0.70)	<0.001
≥2500 g	871 (11.9)	668 (8.1)	0.68 (0.62 to 0.75)	<0.001

EENC, early essential newborn care; NICU, neonatal intensive care unit.

relative risk 1.06; p<0.0001) and were low birth weight <2500 g (8.7% vs 7.5%, relative risk 1.16 (1.05 to 1.28) p=0.005) than pre-EENC introduction. Non-significant differences were seen in sex and gestational age (table 1).

Total NICU admissions of babies born by caesarean section decreased from 16.7% to 11.8% (relative risk 0.71; 95% CI 0.66 to 0.76; p<0.001) after introduction of EENC, with significant declines seen in term and normal birthweight babies (p<0.001) (table 1). In addition, the proportions of moderate to late preterm (32–37 weeks' gestational age) and low birthweight (1500–2499 g) newborn infants admitted decreased between the pre-EENC and post-EENC periods with relative risks of 0.87 (95% CI 0.82 to 0.93; p<0.001) and 0.64 (95% CI 0.58 to 0.70; p<0.001), respectively. The proportion of extremely and very preterm, and extremely low and very low birthweight newborns born by caesarean section admitted to the NICU over the study period showed no significant decline.

Adverse clinical outcomes

Compared with the pre-EENC period, babies born by caesarean section with hypothermia on admission to the NICU declined from 5.0% to 3.7% (relative risk 0.73; 95% CI 0.63 to 0.84; p<0.001) and cases of sepsis from 3.2% to 0.8% (relative risk 0.26; 95% CI 0.20 to 0.33; p<0.001) post-EENC implementation (table 2). The percentage of probable cases of sepsis decreased by more than five times post-EENC implementation (relative risk 0.18, 95% CI 0.13 to 0.24; p<0.001). Rates of asphyxia were low and not statistically different in both periods. No changes in rates of asphyxia requiring intubation or of hypoxic ischaemic encephalopathy were noted.

Care practices in the NICU

While more than half of all newborns born by caesarean section admitted to the NICU were fed something other than breastmilk before discharge pre-EENC introduction, 85.8% were exclusively breast fed before discharge in the

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

	Pre-EENC (Nov 2013–Oct 2014), n (%)	Post-EENC (Nov 2014–Oct 2015), n (%)	Relative risk (95% CI)	P value
Live births born by caesarean section—adverse outcomes	N=7928	N=8999		
Hypothermia on admission	399 (5.0)	331 (3.7)	0.73 (0.63 to 0.84)	<0.001
Sepsis*	256 (3.2)	75 (0.8)	0.26 (0.20 to 0.33)	<0.001
Confirmed	36 (0.5)	31 (0.3)	0.76 (0.47 to 1.23)	0.257
Probable	220 (2.8)	44 (0.5)	0.18 (0.13 to 0.24)	<0.001
Asphyxia requiring bag and mask	99 (1.2)	111 (1.2)	0.99 (0.75 to 1.29)	0.929
Asphyxia requiring Intubation	27 (0.3)	38 (0.4)	1.24 (0.76 to 2.03)	0.391
Hypoxic ischaemic encephalopathy	10 (0.1)	13 (0.1)	1.15 (0.50 to 2.61)	0.747
Live births born by caesarean section admitted to NICU—feeding outcomes	N=1324	N=1065		
Exclusive breast feeding	610 (46.1)	914 (85.8)	1.86 (1.75 to 1.98)	<0.001
Predominant breast feeding	518 (39.1)	119 (11.2)	0.29 (0.24 to 0.34)	<0.001
Mixed breast feeding	162 (12.2)	7 (0.6)	0.05 (0.03 to 0.11)	<0.001
Formula only	13 (1.0)	4 (0.4)	0.38 (0.13 to 1.17)	0.08
Live births born by caesarean section admitted to NICU <2000 g	N=198	N=162		
Receiving kangaroo mother care	99 (50.0)	108 (66.7)	1.33 (1.12 to 1.59)	0.002

*Confirmed and probable sepsis using the NICU case definition (see the Methods section).
EENC, early essential newborn care; NICU, neonatal intensive care unit.

post-EENC phase (relative risk 1.86; 95% CI 1.75 to 1.98; p<0.0001). Those predominantly breast fed declined from 39% to 11% (relative risk 0.29; 95% CI 0.24 to 0.34; p<0.001) and those receiving mixed feeding declined from 12% to 0.6% (relative risk 0.05; 95% CI 0.03 to 0.11; p<0.001) after EENC implementation (table 2). Preterm newborns <2000 g receiving KMC increased from 50% to 67% (relative risk 1.33; 95% CI 1.12 to 1.59; p=0.002).

DISCUSSION

Among all live births delivered by caesarean section, EENC implementation was significantly associated with reductions in NICU admissions, hypothermia on admission and sepsis. Of all babies born by caesarean section admitted to the NICU across the same period, there was a significant increase in the proportion exclusively breast fed (46%–86%) and the proportion <2000 g receiving KMC (50%–67%). Newborn health outcomes improved despite an increasing proportion of low birthweight newborns.

Before EENC coaching, SSC was rarely practised. Babies born vaginally were routinely separated from their mothers for at least 20 min and those delivered by caesarean section for 6 or more hours. Follow-up practice data from interviews with randomly selected postpartum mothers and reported in our previous study show that health worker EENC delivery practice scores remained high in the year post-coaching and that the proportion of babies receiving SSC following caesarean section increased from 2% (159 of 7928) to 93% (8383 of 8999) post-introduction of EENC.[15] These data suggest that immediate newborn care practices were applied to an increased proportion of all caesarean section births after EENC implementation.

Reductions in admissions to NICU and paediatric wards are consistent with findings in other settings after introduction of SSC with caesarean section deliveries including neonates at risk of hypoglycaemia.[21–23] Reductions in NICU admissions were most significant for larger babies closer to term, suggesting that at least a proportion of this reduction was due to revised NICU admission criteria which eliminated unnecessary admissions of clinically stable babies. In addition, there is evidence that significant reductions in newborn morbidity occurred following EENC introduction. Rates of hypothermia on admission declined from 5.0% to 3.7%, which has been previously associated with application of immediate SSC.[24] Hypothermia is present in up to 50% of NICU admissions and is the most common contributing factor to neonatal deaths in many low-resource settings.[25 26] Risk factors for hypothermia include prematurity, low birth weight, delayed initiation of breast feeding, early bathing and lack of SSC, all of which are targeted by EENC interventions. SSC alone has been demonstrated to stabilise the temperature in newborns better than incubators for preterm and low birthweight babies.[27 28]

The significant reduction in the proportion of neonates born by caesarean section with sepsis is also consistent with previous findings.[22] Sepsis is one of the most common neonatal problems in low-resource settings, leading to high admission rates, long hospitalisations and high mortality.[9 16 29] Risk of sepsis is expected to be reduced by EENC interventions, including elimination of unnecessary suction, improved handwashing practices around birth and better temperature control. Microbial colonisation of the newborn with maternal skin microbiota is facilitated by SSC and may reduce the risk of infections from the hospital environment.[30] Furthermore, non-separation promoted by immediate newborn care practices keep newborns out of crowded NICU spaces which in many low-resource settings are a high risk for transmission of infection due to crowding, bed sharing, poor handwashing compliance by staff, and gaps in infection prevention and control resources.[31]

The increased rate of exclusive breast feeding among newborns admitted to NICU in this study is likely to be the result of improved lactation support promoted by EENC, including non-separation, rooming-in, counselling on feeding cues, positioning and attachment, and an emphasis on exclusivity, including use of expressed breastmilk. This finding is consistent with previous studies that have found that introduction of SSC after operative births increases rates of both early and exclusive breast feeding at discharge and up to 6 months.[32] Babies born by caesarean section are also significantly more likely to be breast fed exclusively at 6 months if they are breast fed early.[33] Similarly, the increased proportion of newborns in NICU receiving KMC was likely the result of protocol and environmental changes introduced with EENC.

Although this study was focused on newborn outcomes, non-separation of mother and baby after caesarean section is expected to have a number of benefits for the mother including improved bonding, satisfaction, comfort and positive birth experiences. In mothers, SSC also supports more rapid physiological stabilisation, and reduced pain, shivering, physiological stress and depressive symptoms in the postpartum period.[34–38]

The potential benefits of early and exclusive breast feeding to babies, mothers and their families are numerous, including reduced morbidity, mortality and non-communicable diseases.[39]

The reduction in NICU admissions from 16.7% to 11.8% of all caesarean section births represented a decline in 438 annual admissions. This amounts to a saving of at least US$162 060 for the hospital in the year post-EENC, using the estimated average cost of one NICU admission at Da Nang Hospital for Women and Children (US$370). In contrast, a single EENC clinical coaching for six staff in operating room is estimated to cost around US$100. Other costs associated with incorporation of EENC with caesarean births are believed to be minimal because existing staff, environments, equipment and supplies were used. A formal costing analysis is needed to properly identify all costs associated with implementation. While EENC promotes use of evidence-based criteria to reduce unnecessary procedures, the proportion of babies delivered by caesarean section increased from 60% pre-EENC to 64% post-EENC. This trend is believed to be a result of the 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. Nonetheless, the caesarean section rate is high and warrants further investigation.

Study findings highlight that introduction of EENC into operative deliveries requires a collaborative process. Key to adoption was use of the EENC systems approach which includes clinical coaching and other changes in hospital policies, environments and routine self-monitoring.[15] The formation of operative teams was essential for ensuring engagement of staff from different disciplines who often do not communicate or work together very effectively. Changes in operative rooms required that all staff involved received coaching in EENC for vaginal delivery so they could understand the clinical rationale. Senior staff from different specialty areas were all involved in development of protocols. Importantly, operation room staff practised together as teams to develop and allocate responsibilities before beginning introduction with real patients. Each of these developmental steps was important for not only ensuring that procedures were safe and manageable, but also for gaining staff buy-in and commitment. Further, changes in work environments, equipment, supplies and revised job roles and tasks were required to support practices. The process of routine data collection and monitoring using checklist-based maternal interviews and observations of practice was also critical for identifying when practices were not used, barriers and actions needed to solve problems. In postnatal care areas, family members sometimes promoted the use of formula and this has to be continuously monitored and addressed. In addition, all new staff joining surgical teams have to be coached in EENC and routinely instructed in caesarean section protocols.

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. However, 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.

Classification error may have occurred when categorising 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-EENC and post-EENC was 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. We did not examine whether there were differences in rates of early-onset newborn sepsis (<72 hours after birth) and late-onset newborn sepsis (more than 72 hours after birth). Further examination of this association may be useful to determine whether the decline in sepsis associated with EENC differed by time of onset. Mortality impact could not be assessed using this study design because the time required to obtain the required sample size would have risked secular bias.[15]

As reported previously, 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 KMC practices) for a large proportion of babies admitted to the NICU.[15] 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 birthweight babies and caesarean 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.

The experience of the Da Nang Hospital for Women and Children, an EENC early implementation hospital, informed subsequent national scale-up in Vietnam. Staff from the hospital facilitated EENC coaching in other hospitals in the Central Region of Vietnam and hosted study visits to demonstrate EENC application in the clinical environment including with caesarean section and NICU-based KMC. SSC was applied following caesarean section births at 100% of national hospitals and 89% of subnational hospitals in 2019.[40] These findings suggest that EENC can be applied widely with caesarean sections when integrated into the broad-based EENC systems approach.

As caesarean section births in Vietnam and elsewhere in the world become increasingly prevalent, it is critical that babies born operatively receive high-impact interventions to improve outcomes.[41] As a next step, a cost–benefit analysis is required to compare costs of introducing EENC with caesarean section with cost-savings and improvements in newborn outcomes. An examination of why caesarean section delivery rates at Da Nang Hospital for Women and Children are high to identify whether evidence-based criteria are universally applied and strategies for reducing rates is needed. In the longer term, as more data become available, post-caesarean section newborn mortality data are needed to identify whether expected mortality reductions follow improvements in early newborn care practices.

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REFERENCES

1 United Nations Inter-agency Group for Child Mortality Estimation (UN IGME). 'Levels & Trends in Child Mortality: Report 2019, Estimates developed by the United Nations Inter-agency Group for Child Mortality Estimation'. New York United Nations Children's Fund; 2019.
2 Hug L, Alexander M, You D, *et al*. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. *Lancet Glob Health* 2019;7:e710–20.
3 Liu L, Oza S, Hogan D, *et al*. Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet* 2015;385:430–40.
4 WHO. World Health organization action plan for healthy newborn infants in the Western Pacific region (2014–2020); 2014.
5 WHO. World Health Organization Introducing and sustaining EENC in hospitals : kangaroo mother care for pre-term and low-birthweight infants; 2018.
6 Giang HTN, Ulrich S, Tran HT, *et al*. Monitoring and interventions are needed to reduce the very high caesarean section rates in Vietnam. *Acta Paediatr* 2018;107:2109–14.
7 General statistics office and UNICEF. Viet Nam multiple indicator cluster survey 2014, final report. HA NoI, Viet Nam; 2015.
8 General statistical office (GSO). Viet Nam multiple indicator cluster survey 2011, final report, 2011. HA NoI, Viet Nam; 2015.
9 Tran HT, Doyle LW, Lee KJ, *et al*. A high burden of late-onset sepsis among newborns admitted to the largest neonatal unit in central Vietnam. *J Perinatol* 2015;35:846–51.
10 Haxton D, Doering J, Gingras L, *et al*. Implementing skin-to-skin contact at birth using the Iowa model: applying evidence to practice. *Nurs Womens Health* 2012;16:220–30.
11 Hung KJ, Berg O. Early skin-to-skin after cesarean to improve breastfeeding. *MCN Am J Matern Child Nurs* 2011;36:318–24.
12 Elliott-Carter N, Harper J. Keeping mothers and newborns together after cesarean: how one hospital made the change. *Nurs Womens Health* 2012;16:290–5.

13 Moore ER, Bergman N, Anderson GC, *et al*. Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database Syst Rev* 2016;11:CD003519.
14 Zauderer C, Goldman S. Cesarean Mothers' Perception of Benefits Associated With Skin-to-Skin Contact. *Journal of Obstetric, Gynecologic & Neonatal Nursing* 2012;41:S150–1.
15 Tran HT, Mannava P, Murray JCS, *et al*. 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. *EClinicalMedicine* 2018;6: :51–8.
16 Tran HT, Doyle LW, Lee KJ, *et al*. Morbidity and mortality in hospitalised neonates in central Vietnam. *Acta Paediatr* 2015;104:e200–5.
17 Viet Nam Ministry of health. guidelines on early essential perinatal care for women and newborns 2014.
18 Da Nang Hospital for women and children. early essential newborn care for caesarean section births: Hospital guidelines 2014.
19 World Health Organization. International statistical classification of diseases and related health problems 10th revision 2019, 2019
20 Who: recommended definitions, terminology and format for statistical tables related to the perinatal period and use of a new certificate for cause of perinatal deaths. modifications recommended by FIGO as amended October 14, 1976. *Acta Obstet Gynecol Scand* 1977;56:247–53.
21 Schneider LW, Crenshaw JT, Gilder RE. Influence of immediate Skin-to-Skin contact during cesarean surgery on rate of transfer of newborns to NICU for observation. *Nurs Womens Health* 2017;21:28–33.
22 Posthuma S, Korteweg FJ, van der Ploeg JM, *et al*. Risks and benefits of the skin-to-skin cesarean section–a retrospective cohort study. *J Matern Fetal Neonatal Med* 2017;30:159–63.
23 LeBlanc S, Haushalter J, Seashore C, *et al*. A quality-improvement initiative to reduce NICU transfers for neonates at risk for hypoglycemia. *Pediatrics* 2018;141. doi:10.1542/peds.2017-1143. [Epub ahead of print: 08 02 2018].
24 Safari K, Saeed AA, Hasan SS, *et al*. The effect of mother and newborn early skin-to-skin contact on initiation of breastfeeding, newborn temperature and duration of third stage of labor. *Int Breastfeed J* 2018;13:32.
25 Ukke GG, Diriba K. Prevalence and factors associated with neonatal hypothermia on admission to neonatal intensive care units in Southwest Ethiopia - A cross-sectional study. *PLoS One* 2019;14:e0218020.
26 Muhe LM, McClure EM, Nigussie AK, *et al*. Major causes of death in preterm infants in selected hospitals in Ethiopia (SIP): a prospective, cross-sectional, observational study. *Lancet Glob Health* 2019;7:e1130–8.
27 Chi Luong K, Long Nguyen T, Huynh Thi DH, *et al*. Newly born low birthweight infants stabilise better in skin-to-skin contact than when separated from their mothers: a randomised controlled trial. *Acta Paediatr* 2016;105:381–90.
28 Bergman NJ, Linley LL, Fawcus SR. Randomized controlled trial of skin-to-skin contact from birth versus conventional incubator for physiological stabilization in 1200- to 2199-gram newborns. *Acta Paediatr* 2004;93:779–85.
29 Ho BT*et al*. Low neonatal mortality and high incidence of infectious diseases in a Vietnamese Province Hospital. *Biomed Res Int* 2016.
30 Dominguez-Bello MG, Costello EK, Contreras M, *et al*. Delivery mode shapes the acquisition and structure of the initial microbiota across multiple body habitats in newborns. *Proc Natl Acad Sci U S A* 2010;107:11971–5.
31 Mannava P, Murray JC, Kim R, *et al*. Status of water, sanitation and hygiene services for childbirth and newborn care in eight countries in East Asia and the Pacific. *J Glob Health* 2019;9:020430.
32 Conroy CC, Cottrell BH. The influence of Skin-to-Skin contact after cesarean on breastfeeding rates, infant feeding responses, and maternal satisfaction. *Journal of Obstetric, Gynecologic & Neonatal Nursing* 2015;44:S61–2.
33 Prior E, Santhakumaran S, Gale C, *et al*. Breastfeeding after cesarean delivery: a systematic review and meta-analysis of world literature. *Am J Clin Nutr* 2012;95): :1113–35.
34 Stevens J, Schmied V, Burns E, *et al*. Immediate or early skin-to-skin contact after a caesarean section: a review of the literature. *Matern Child Nutr* 2014;10:456–73.
35 Horn E-P, Bein B, Steinfath M, *et al*. The incidence and prevention of hypothermia in newborn bonding after cesarean delivery: a randomized controlled trial. *Anesth Analg* 2014;118:997–1002.
36 Yuksel B, Ital I, Balaban O, *et al*. Immediate breastfeeding and skin-to-skin contact during cesarean section decreases maternal oxidative stress, a prospective randomized case-controlled study. *J Matern Fetal Neonatal Med* 2016;29:2691–6.
37 Brubaker LH, Paul IM, Repke JT, *et al*. Early maternal-newborn contact and positive birth experience. *Birth* 2019;46:42–50.
38 Bigelow A, Power M, MacLellan-Peters J, *et al*. Effect of mother/ infant skin-to-skin contact on postpartum depressive symptoms and maternal physiological stress. *J Obstet Gynecol Neonatal Nurs* 2012;41:369–82.
39 NEOVITA Study Group. Timing of initiation, patterns of breastfeeding, and infant survival: prospective analysis of pooled data from three randomised trials. *Lancet Glob Health* 2016;4:e266–75.
40 World Health Organization, Western Pacific Regional Office. Meeting Report: Third meeting of the independent review group on validation of early essential newborn care progress. Report Series Number:RS/2019/GE/48(PHL). Manila, Philippines WHO/WPRO; 2019. https://apps.who.int/iris/handle/10665/331386
41 Betrán AP, Ye J, Moller A-B, *et al*. The increasing trend in caesarean section rates: global, regional and national estimates: 1990-2014. *PLoS One* 2016;11:e0148343.