ORIGINAL RESEARCH

Effects of Continuous Quality Improvement on Complication Rate and Treatment Outcome of Extremely Premature Infants

Yang Chen, PhD; Tingting Cheng, PhD; Huaping Zhu, PhD; Shiwen Xia, PhD

ABSTRACT

Background • Extremely premature infants (EPIs) are those less than 32 weeks of gestational age. Preterm birth is the leading cause of neonatal death and poor prognosis, accounting for 25% of neonatal deaths, with extremely premature births accounting for 50% of all premature deaths. Continuous quality improvement (CQI) improves patient outcomes by changing and optimizing clinical practice including increasing participation of neonatologists in prenatal consultation, maintenance of normal body temperature in preterm infants, early use of pulmonary surfactant, reduction of mechanical ventilation time and intensive breastfeeding to reduce clinically avoidable adverse events.

Objective • The risk of death and disability is high for very preterm infants, with a mortality rate of 30-50% and a risk of at least 20-50% for survivors. This study aimed to investigate the effect of CQI on the incidence of complications and treatment outcomes in very preterm infants.

Design • This was a retrospective study.

Setting • This study was conducted in the Maternal and Child Health Hospital of Hubei Province.

Participants • A total of 140 EPIs born in our hospital and transferred to the neonatal intensive care unit between August 1, 2020, and July 31, 2022, were enrolled. The EPIs were divided into two groups: before improvement (n=79, 56.4%) and after improvement (n=61, 43.6%) according to the week of birth, and the gestational age ranged from 26 weeks to 26 weeks 6 days into the 26 weeks group.

Interventions • From August 2021, the hospital implemented the CQI method, which included neonatologists' participation in consultations before birth, the care of a professionally trained resuscitation team after birth, and the introduction of transport heating tanks and ventilators during transport.

Primary Outcome Measures • (1) Apgar score (2) body weight (3) duration of invasive ventilation (4) length of stay (5) treatment expense (6) incidence of complications and (7) survival rate of EPIs.

Results • The application of CQI methods resulted in significant improvements in body weight (1305 g vs 1404 g) and duration of invasive ventilation (4.64 d vs 7.40 d) in EPIs (P = .036 and P = .040), reduced the time of invasive mechanical ventilation decreased significantly, from 7.4 days to 4.64 days (P < .01), increased the median temperature of newborn infants (36.2°C vs 35.7°C) (P = 0), increased the proportion of newborn infants with a temperature greater than 36°C (67.2% vs 35.4%) (P < .001), reduced the incidence of complications in EPIs (32.79% vs 45.57%) (P < .05).

Conclusion • The application of the CQI approach significantly increases the body temperature, improves the incidence of complications of EPIs, and is conducive to the survival of EPIs. Our study may provide a clinical reference for management of EPIs. (*Altern Ther Health Med.* 2025;31(1):227-233).

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INTRODUCTION

Preterm birth, defined as birth before 37 weeks of gestation, affects 5-18% of pregnancies. It is the leading cause of neonatal death and the second leading cause of childhood death below the age of 5 years, which brings harm and burden to the children themselves, their families and society.[1] Extremely premature infants (EPIs) are those less than 32 weeks of gestational age.[2] Despite technological advances and efforts of child health experts during the last generation, the extremely premature infant (less than 28 weeks gestation) and extremely low birth weight infant (ELBW) (<1000 g) remain at high risk for death and disability with 30–50% mortality and, in survivors, at least 20–50% risk of morbidity.[3] The transition period of the delivery room for extremely premature infants refers to the critical period of the transition from intrauterine to extrauterine, the establishment of spontaneous breathing, and the transition of fetal circulation to neonatal circulation. The standardized management during this period, as well as the postpartum measures such as increasing the rate of breastfeeding[4] and reducing the time of mechanical ventilation, are beneficial to protect the immature lungs, brain, and other organs of extremely premature infants,[5] improve the survival rate of extremely premature infants and reduce the incidence of serious complications.

Due to the influence of EPIs' low system function, the survival rate of EPIs fails to reach the expected ideal state. If the nursing intervention and support are not timely, in this case, the probability of complications during hospitalization will not only increase, but also affect children's physical growth and development indicators and intellectual improvement. The content of routine intervention is relatively simple, which can only meet the basic needs of premature infants, and the effect of promoting growth and development is not ideal, which may lead to backward growth, retarded intellectual development and the occurrence of risk events, and bring harm and burden to the children themselves, their families and society.[6] Studies have shown that high-quality nursing can reduce the incidence of serious diseases in premature infants, thus reducing disease-related mortality and disease burden, and is an effective method to improve the quality of treatment of premature infants in the neonatal intensive care unit further.[7] Continuous quality improvement (CQI) is a management approach that aims to improve the quality and performance of an organization through continuous improvement of products, services and processes.[8] In recent years, with the continuous optimization of nursing concepts, CQI nursing has been gradually applied to clinical nursing work and has become an important part of the work.[9] As reported previously, CQI interventions can improve long-term outcomes of antiretroviral therapy in women who initiated therapy during pregnancy or breastfeeding.[8] CQI nursing can improve life quality and reduce the incidence of adverse reactions in non-small cell carcinoma patients undergoing targeted therapy.[10]

Because very early infants are severely affected and have low resistance, they may be more susceptible to infection than healthy infants. CQI nursing focuses more on process management and quality control at all levels than basic nursing, emphasizing the continuous identification and improvement of problems and quality improvement in the work process. CQI nursing aims to fully engage the professionalism and creativity of staff through continuous improvement and refinement of the nursing process.[11]

This study aimed to investigate the effect of CQI on the incidence of complications and treatment outcomes in very preterm infants, in order to provide a clinical reference for management of EPIs.

MATERIALS AND METHODS

Studied patients

This retrospective study included 140 extremely premature infants (EPIs) born in our hospital and transferred to the neonatal intensive care unit (NICU) between August 1, 2020, and July 31, 2022, which might have bias and confounding factors. This retrospective study included 140 extremely premature infants (EPIs) born in our hospital and transferred to the neonatal intensive care unit (NICU) between August 1, 2020, and July 31, 2022. The EPIs were divided into two groups according to the week of birth, and the gestational age ranged from 26 weeks to 26 weeks 6 days into the 26 weeks group: before improvement (n = 79, 56.4%) and after improvement (n = 61, 43.6%). Inclusion criteria: (1) birth weight <1500 g and ≥1000 g, gestational age 28-32 weeks; (2) guardians with normal cognitive and comprehension ability. Exclusion criteria: (1) congenital malformations or genetic metabolic diseases affecting growth; (2) development, incomplete data; (3) transfer to our hospital after delivery from other hospitals. Parents of EPIs were aware of this study and voluntarily signed informed consent. This study was approved by the hospital Ethics Committee.

CQI method-specific content

From August 2021, the hospital implemented the CQI method, which included neonatologists' participation in consultations before birth, the care of a professionally trained resuscitation team after birth, and the introduction of transport heating tanks and ventilators during transport.[12] The aim of this implementation was to evaluate its effect on the survival and complication rates of neonates.

Diagnostic criteria and definition of complications

The diagnostic criteria for severe complications in this paper are as follows: severe brain injury in premature infants:[13] Around the periventricular intraventricular hemorrhage (PIVH) III ~ IV level/white matter around the premature periventricular leukomalacia (PVL); Over severe bronchopuldysplasia (s BPD):[14] when the gestational age is over 36 weeks, the breathing oxygen concentration is greater than 30% or the need for positive pressure ventilation or mechanical ventilation. necrotizing enterocolitis (NEC):[15] Bell stage II and above; early onset/ late onset sepsis (EOS/ LOS):[16] clinical sepsis with symptoms of clinical infection and abnormal blood cultures or clinical infection combined with two indicators of infection within 72 h after birth; Severe retinopathy of prematurity (ROP):[17] laser or anti-vascular endothelial growth factor treatment is required.

The results of discharge included: (1) cured: weight ≥1800 g, stable vital signs, nooxygen inhalation, complete oral feeding, stable weight gain; (2) Improvement: patients who did not meet the above discharge criteria but were clinically assessed to be in no life-threatening condition, or patients who were transferred to hospital for treatment and followed up after follow-up; (3) Death: those who died despite treatment, serious complications, and poor prognosis, or died within one month after their family members gave up treatment due to social and economic factors. The study was approved by the Ethics Committee of the Maternal and Child Health Hospital, Tongji Medical College, Huazhong University of Science and Technology (2021IECXM015), and family consent was obtained before including all study subjects.

CQI methods

In this study, the main elements of our CQI approach for EPIs included several key elements, outlined below (Table 1):

Increasing participation of neonatologists in prenatal consultation: Research has shown that obstetricians focus on prenatal antibiotic use, maternal risk, and risk of cesarean section during prenatal consultation, while neonatologists focus on neonatal resuscitation, complications, and palliative care. Through prenatal consultation with neonatologists, parents can obtain more comprehensive and accurate information about the success rate and prognosis of neonatal treatment, which is convenient for parents to discuss with the doctor and make a more objective decision about whether to treat. Prenatal consultation should include intrauterine evaluation of the fetus, discussion of diagnosis and treatment plan with obstetricians (including prenatal glucocorticoid, timing of magnesium sulfate and delivery mode, etc.), communication with parents about the treatment and prognosis of EPIs, and reporting the treatment status of the institution (success rate of treatment for EPIs of corresponding gestational age, incidence of serious complications and short-term and long-term prognosis), in order to improve parents' awareness of treatment for EPIs and reduce the death caused by social factors.

A relatively fixed resuscitation team:[18] We regularly rehearse and effectively implement EPIs' transition support technologies. The vast majority of EPIs require circulatory support to transition from fetus to newborn. The transitional support strategy in the delivery room of EPIs is different from the resuscitation strategy for full-term infants. Support strategies for EPIs mainly include delayed umbilical cord ligation, continuous positive airway pressure (CPAP) as early as possible after birth, combined with delayed umbilical cord ligation, and intubation resuscitation when necessary to reduce the incidence of asphyxia. These jobs require multiple people to work together.[19] Therefore, a relatively fixed resuscitation team is needed to enhance proficiency and coordination through regular training and drills. This team strongly guarantees the successful transition from EPIs to neonatal respiratory circulation.

Maintenance of normal body temperature in preterm infants (≥36°C): The ventilation mode should be continued when using CPAP respiratory support to transport EPIs. If the expected transmission time exceeds 30 min, intravenous administration is recommended to maintain blood glucose stability. Studies have shown that hypothermia is the most prominent problem during neonatal transport (in/out of hospital),[20] so it is recommended to use a transport heating chamber (with electrical storage function) for transport. If a warm box is unavailable, a heated mattress, warm blanket, or a controlled temperature blanket for mild hypothermia treatment can be considered for transport to maintain a target body temperature of 36.5 to 37.5°C.[21] To reduce the movement of EPIs, institutions can choose to use multifunctional heating boxes with radiometer and heating box functions for transportation.

Early use of pulmonary surfactant (PS) (within 1 h postnatal):[22] When NCPAP is not routinely used after birth, prophylactic use of PS via tracheal intubation significantly reduces neonatal mortality, pneumothorax, and interstitial emphysema. Early use of PS can greatly reduce the proportion and duration of mechanical ventilation in EPIs.

Reduction of mechanical ventilation time:[23] Invasive mechanical ventilation refers to positive pressure ventilation with an endotracheal tube or tracheostomy tube, which is a common life support technology in neonatal intensive care units. However, long-term tracheal intubation may lead to ventilator-associated pneumonia, diaphragmatic atrophy, and bronchopuldysplasia (BPD).[24] Delayed withdrawal also increases the risk of neurodevelopmental disorders and delayed sepsis in newborns. With the early use of PS, the invasive mechanical ventilation time of EPIs can be significantly reduced.

Table 1. Summary of continuous quality improvement methods

Intervening measure	Before improvement	After improvement
Prenatal counseling	The obstetrician communicated with the family about EPI prognosis situation	Doctors with titles above deputy high in neonatal department routinely participated in prenatal consultation, and communicated with family members about complications and complications Prognosis, etc.
Resuscitation team	No professional resuscitation team was available	Set up a relatively fixed resuscitation team and perform regularly Practice and effectively implement transitional support technology for premature infants
Temperature management	After the bag is wrapped, the cot is pushed into the NICU. Mask or intubation positive pressure ventilation	The transfer process is maintained by the transfer warm box normal body temperature.
Pulmonary surfactant	Selective use of pulmonary surfactant reduces the incidence of pneumothorax and interstitial emphysema	Increase the proportion of early use of alveolar surfactant (<1h)
Improvements in invasive mechanical ventilation	Invasive mechanical ventilation was given to improve respiratory status	To reduce the proportion of invasive mechanical ventilation and shorten the duration of invasive ventilation
Breast feeding	Choose the feeding method as appropriate	Set up a family ward and pumping room and equipped with a special mother. Breastfeeding quality improvement measures such as milk storage and delivery facilities

Intensive breastfeeding: Intensive breastfeeding has become an international consensus. Reasonable nutrition support is one of the key links to improving the survival rate of EPIs, which is not only related to short-term growth and disease outcome but also directly affects long-term prognosis. Adequate and balanced nutrition is the material basis to ensure the healthy growth of extremely premature infants.

Evaluation Indicators

(1) The Apgar score was developed primarily to assess term infants during a time when neonatal mortality was very high among preterm infants.[25] The Apgar score consisted of five components (heart rate, respiratory effort, muscle tone, reflex irritability, and color), each given a value from 0 to 2. Thus, total scores ranged from 0 to 10, with higher scores indicating a better physical condition. A low Apgar score, commonly defined as less than 4 or less than 7, was associated with an increased risk of neonatal death among term infants (≥37 weeks).[26]

(2) Body weight, duration of invasive ventilation, length of stay and treatment expense of EPIs before and after improvement was compared.

(3) Incidence of complications including pulmonary hemorrhage, severe neonatal brain damage, bronchopulmonary dysplasia, septicemia, necrotizing enterocolitis and severe retinopathy of prematurity before and after improvement was counted.

(4) The survival rate of EPI before and after improvement was compared.

Data processing and statistical analysis

SPSS 23.0 statistical software (IBM Corp., Armonk, NY, USA) was used for data processing. The measurement data were tested for normality, conforming to a normal distribution

Figure 1. Age grouping of extremely premature infants at birth weeks.

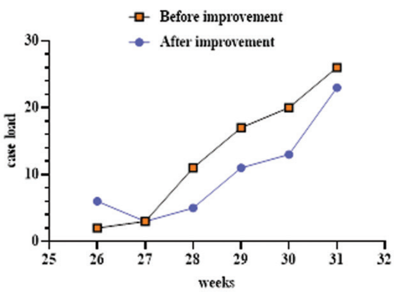


Table 2. Comparison of EPI before and after continuous quality improvement

	Gestational age	Body weight (g)	Percentage of male infants	Percentage of singleton births	Percentage of vaginal birth	Use of glucocorticoid and magnesium sulfate	Rate of neonatologist consultation	Recovery team participation rate
Before improvement	30^{+1} (median)	1404 (average) 1400 (medium)	57.0% (45/79)	86.1% (68/79)	35.4% (28/79)	55.7% (44/79)	0%	6.3% (5/79)
After improvement	30^{+2} (median)	1305 (average) 1390 (medium)	55.7% (34/61)	77.0% (47/61)	32.8% (20/61)	59.0% (36/61)	80.3% (49/61)	96.7% (59/61)
Z or X^2 P value	0.199 0.842	2.097 0.036	0.021 0.885	1.912 0.167	0.108 0.743	0.155 0.694	97.629 <0.001	113.33 <0.001

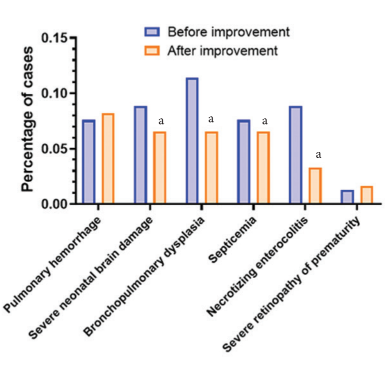
	Rate of tracheal intubation resuscitation	Utilization rate of pulmonary surfactant (<1h)	Invasive mechanical ventilation (<72h)	Invasive mechanical ventilation Time (d)	Rates of participation in breastfeeding (>50%)	Length of stay (d)	Treatment expense
Before improvement	41.8% (33/79)	15.2% (12/79)	84.8% (67/79)	7.40 (average) 3 (median)	50.6% (40/79)	47.4 (average) 41 (median)	122796 (average) 112601 (median)
After improvement	47.5% (29/61)	77.0% (47/61)	80.3% (49/61)	4.64 (average) 3 (median)	67.2% (41/61)	51.6 (average) 48 (median)	123481 (average) 112143 (median)
Z or X^2 P value	0.464 0.496	54.02 < 0.001	0.487 0.485	2.052 0.040	3.881 0.049	-0.765 0.444	-0.062 0.950

Table 3. Changes in Apgar score after improvement

	Apgar score (1 minute)			Apgar score (5 minute)		
	1-3	4-7	8-10	1-3	4-7	8-10
Before improvement	5.1% (4/79)	30.4% (24/79)	64.5% (51/79)	1.3% (1/79)	6.3% (5/79)	92.3% (73/79)
After improvement	1.6% (1/61)	21.3% (13/61)	77.0% (47/61)	0% (0/61)	1.6% (1/61)	98.4% (60/61)
Z or X^2 P value	0.388 0.533	1.456 0.228	2.558 0.110	0.258 0.593	0.879 0.348	1.469 0.225

		Apgar score (1 minute)	Apgar score (5 minute)	Body temperature	Percentage (≥36°C)
Before improvement	average	7.59	8.69	35.76°C	35.4% (28/79)
	median	8	9	35.7°C	
After improvement	Average	8.03	9.31	36.17°C	67.2% (41/61)
	median	8	9	36.2°C	
Z or X^2 P value		-1.639 0.101	-1.745 0.081	-4.807 0	13.9 < 0.001

Figure 2. Changes in invasive mechanical ventilation duration after improvement.



[a]$P < .01$

of $\bar{x} + s$, and compared between groups using the t-test; non-normally distributed data were expressed as M (P25 to P75) and compared between groups using the Mann-Whitney U test. Statistical data were described by frequency and percentage, and the χ^2 test was used for comparison between groups. $P < .05$ was considered statistically significant.

RESULTS

In our study, 140 EPIs were grouped according to the week of birth, and the gestational age ranged from 26 weeks to 26 weeks 6 days into the 26 weeks group. After grouping statistics, it was found that the birth proportion of EPIs in different weeks of age groups before and after the improvement was roughly the same. The overall age distribution was similar (Figure 1). It was suggested there was no significance in the birth proportion of EPIs in different weeks of age groups before and after the improvement ($P > .05$), indicating comparability.

Comparison before and after improvement measures

In this paper, the general statistics of 140 cases after grouping were made through gender, body weight, body temperature, and other aspects (Table 2). The average and percentage of samples were analyzed, and the p-value proved to be statistically significant. After improvement, the main measures included increasing the participation rate of neonatologist consultation, prenatal treatment of glucocorticoids and magnesium sulfate, selection of natural delivery, professional resuscitation team, tracheal intubation, auxiliary ventilation, early use of surfactant, mechanical ventilation, an increase of breastfeeding rate, etc. We found that the application of CQI methods resulted in significant improvements in body weight and duration of invasive ventilation in EPIs ($P = .036$ and $P = .040$), with approximately the same age, sex, length of stay, and treatment expense and of the EPIs ($P = .842$, $P = .885$, $P = .444$ and $P = .950$). It was suggested that the application of CQI methods resulted in significant improvements in body weight and duration of invasive ventilation in EPIs.

Apgar score before and after improvement measures

The proportion of PS used in the early stage increased, and the time of invasive mechanical ventilation decreased significantly, from 7.4 days to 4.64 days ($P < .01$, Figure 2). At the same time, the Apgar score is shown in Table 3. The data suggested that after the improvement of the intervention measures, the physical conditions of the preterm infants showed a trend of improvement but with no significance ($P > .05$). The proportion of newborn infants with hypothermia was significantly decreased, and the overall physical condition at birth was significantly improved.[25] After the improvement of intervention measures, the hospital used a transport heating box and transport ventilator at the same time. Comparing the temperature data of newborn infants before and after the improvement, it could be seen that the median temperature of newborn infants increased from 35.7°C to

36.2°C after the improvement of transport measures ($P = 0$). What is more noteworthy was that the proportion of newborn infants with a temperature greater than 36°C increased from 35.4% to 67.2% ($P < .001$). It was suggested that the application of CQI methods could reduce the time of invasive mechanical ventilation and increase the temperature of EPIs.

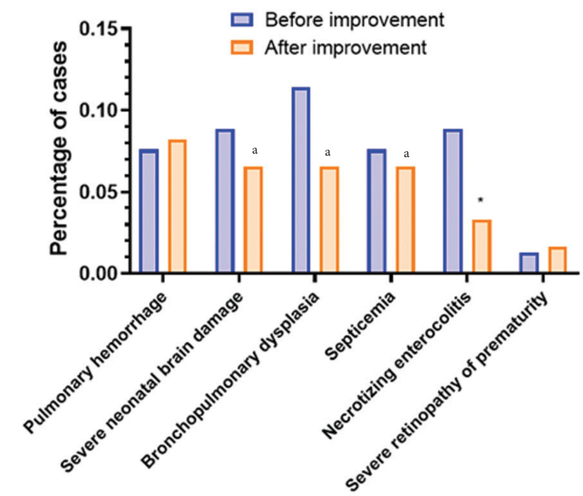
Comparison of complication rate of EPIs before and after improvement

After statistical analysis, we systematically summarized pulmonary hemorrhage, periventricular-intraventricular hemorrhage, severe bronchopulmonary dysplasia, and sepsis, necrotizing enterocolitis, and severe retinopathy of extremely premature infants before and after intervention improvement. We found that after the improvement of the intervention, the probability of multiple complications decreased significantly ($P < .05$). It was noted that the incidence rates of cerebral hemorrhage and severe pulmonary dysplasia, which are important for neonatal prognosis, were significantly improved, decreasing from 8.9% to 6.6% and 11.4 to 6.6%, respectively. In addition, the incidence of necrotizing enterocolitis decreased from 8.9% to 3.3%. The above statistics indicated that the incidence of severe neonatal complications could be significantly improved after applying a CQI method (Figure 3). It was suggested that applying CQI methods could reduce the incidence of complications in EPIs.

Comparison of survival rate of EPIs before and after improvement

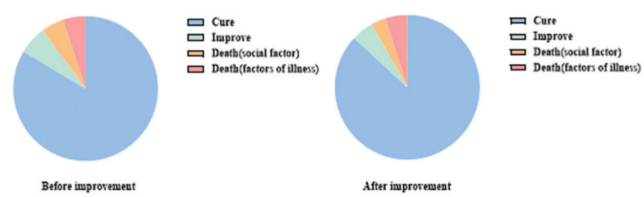
After the improvement of intervention measures, neonates' overall improvement and cure rate reached 91.8%, compared with 89.9% before the improvement. The death rate due to social factors decreased from 5.1% to 3.3%, and the death rate due to disease decreased from 5.1% to 4.9%, showing an improvement in survival rate but with no statistical significance (Figure 4). It was suggested that applying CQI methods may improve the survival rate of EPIs.

Figure 3. Changes in the incidence of different complications before and after improving intervention measures in the delivery room.



$^{a}P < .05$

Figure 4. Comparison of overall survival rate of newborn infants.



DISCUSSION

In previous clinical practice, we found that antenatal consultations with obstetricians focused more on maternal risk. In contrast, antenatal consultations with neonatologists focused more on the prognosis of the newborn after delivery.[27] With a neonatologist involved in the antenatal consultation, parents can more comprehensively assess their newborn's long-term prognosis and financial burden, so that they can more objectively and carefully consider whether to offer help.[28]

CQI is a new quality management theory that is developed based on total quality management and pays more attention to process management and link quality control.[29] With the development of medical and health undertakings, clinical medical and health safety management has put forward new requirements, the significance of CQI management is to let front-line staff participate in quality improvement measures to improve the overall quality of work due that front-line staff have a rich clinical experience.[30]

In this study, we comprehensively assessed the impact of the CQI approach on the survival of EPIs in six areas: antenatal consultation, resuscitation team, temperature maintenance, early application of PS, invasive mechanical ventilation and breastfeeding, and evaluated the role and significance of the CQI approach by counting changes in common complications and neonatal scores.

Improving the survival rate of EPIs requires a dedicated team and a comprehensive approach to care. Current supporting strategies for EPIs include delayed cord ligation, early postnatal continuous positive airway pressure ventilation, and coordination with delayed cord ligation, which require a multitasking approach.[31] Delayed umbilical cord ligation refers to the execution of umbilical cord ligation after the newborn's respiratory system is stable and established, the placenta blood transfusion to the newborn stops, or at least 30 s after delivery.[32] The lungs of EPIs expand, and the absorbed oxygen reaches the whole body through the pulmonary blood vessels, thus increasing their blood volume. Delayed umbilical cord ligation can obtain the physiological blood delivered by the placenta, thereby achieving the transfer of placental blood to the body, promoting the increase of circulating capacity, brain oxygen content and hemoglobin, and improving the concentration of red blood cells in premature low birth weight infants with sufficient iron content. The probability of anemia in the later stage is greatly reduced.[33] Besides, EPIs due to immature lung development, resulting in the lack of active substances on the lung surface, easy to appear alveolar collapse, resulting in progressive atelectasis, resulting in respiratory distress.[34] Continuous positive airway pressure provides positive pressure for children's inhalation and exhalation to maintain continuous positive airway pressure, ensure that children's inhalation can obtain higher air supply pressure and flow, reduce inspiratory work, prevent alveolar collapse and improve respiratory function.[35] Therefore, a relatively permanent resuscitation team is needed to ensure a successful transition to neonatal respiratory circulation through regular training and rehearsals to enhance proficiency and cooperation.

Maintenance of body temperature is key to a good prognosis for EPIs.[36] Hypothermia can lead to increased metabolic demands, acid-base balance disturbance, respiratory failure, hypoglycaemia and even death, and is an independent risk factor for death and serious complications in preterm babies.[37] The lower the gestational age of the preterm infant, the higher the environmental temperature requirements, and higher ambient temperatures will increase the risk of infection.

In this study, we found that the body temperature of EPIs was significantly increased by applying measures such as transferring heating boxes, controlling the ambient temperature, and preheating the objects exposed to the newborn, which was consistent with a study proposed by Kathleen Godfrey et al.[38]

Most EPIs require respiratory support to complete the transition after birth.[39] Due to incomplete lung development, EPIs have a high likelihood of lung-related complications. The use of an invasive ventilator can lead to pressure damage and volume damage to the lungs.[40] In our study, we found that the early application of PS could significantly reduce the duration of invasive mechanical ventilation, thereby improving the prognosis for lung-related conditions, which was in line with a study of Christoph Härtel et al.[41] Moreover, the application of CQI methods could reduce the incidence of complications in EPIs, which was in accordance with previous study.[42]

Our study has some limitations. First, the sample size is small, which might affect the generalizability and interpretation of our results. Second, this study did not carry out long-term follow-up, so the long-term effect of CQI approach on managing EPIs remains unclear. Therefore, further large-scale the long-term studies should be carried out in further studies to explore the long-term growth and development effects of CQI approach on managing EPIs.

In conclusion, our study demonstrates that applying the CQI approach significantly increases the body temperature and improves the incidence of complications EPIs, and is conductive to the survival of EPIs. Our study provides a reliable reference for treating EPIs and has obvious clinical significance.

CONFLICTING OF INTERESTS

The authors declare no conflicts of interest.

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AUTHOR CONTRIBUTIONS

Yang Chen and Tingting Cheng contributed equally to this study.

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