

## Original Research Article

# Implementation of a standardized neonatal skin-care bundle using the neonatal skin condition score: a quality improvement initiative in a resource-limited neonatal intensive care unit

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## ABSTRACT

**Background:** Neonatal skin, particularly in preterm and low-birth-weight (LBW) infants, is structurally immature and prone to injury, predisposing to increased transepidermal water loss, infection and prolonged hospitalization. Objective assessment of skin condition is seldom embedded in routine practice in many resource-limited neonatal intensive care units (NICUs). In our NICU, skin assessment was subjective, without a standardized scoring system, and root cause analysis identified inadequate staff training and lack of routine documentation as the main modifiable contributors. Objectives were to reduce abnormal skin findings by 50% within four weeks by embedding routine neonatal skin condition score (NSCS) assessment into practice.

**Methods:** This prospective quality improvement initiative ran for four weeks in a 35-bed tertiary NICU using two plan-do-study-act (PDSA) cycles. A standardized skin-care bundle comprising staff education, routine NSCS assessment, bedside charts and improved adhesive practices, was implemented. Proportions with dryness, erythema and breakdown were compared before and after using Fisher's exact test.

**Results:** Baseline prevalence of dryness, erythema and breakdown was 54.5%, 27.3% and 4.5%. By four weeks, dryness fell to 26.1% ( $p=0.07$ ) and erythema to 13.0% ( $p=0.28$ ), each with ~52% relative reduction, while breakdown was unchanged (4.3%;  $p=1.00$ ). Neither reached statistical significance, but both showed a downward trend, and routine NSCS assessment continued beyond the project.

**Conclusions:** A standardized skin-care bundle incorporating routine NSCS assessment was feasible and associated with clinically meaningful reductions in dryness and erythema, with sustained adoption of objective skin assessment. Larger, longer initiatives are warranted to confirm these findings.

**Keywords:** Quality improvement, Neonatal skin condition score, Neonatal skin care, PDSA, Resource-limited setting, NICU

## INTRODUCTION

### Problem description

Maintenance of skin integrity is a fundamental component of neonatal intensive care. The epidermal barrier of the newborn, particularly the preterm infant, is anatomically and functionally immature: the stratum corneum is thin and poorly cornified, cohesion between the epidermis and

dermis is reduced, and transepidermal water loss is markedly elevated, predisposing to fluid and electrolyte imbalance, thermal instability, and microbial invasion.<sup>1,2</sup> Barrier maturation after preterm birth typically requires two to four weeks and may take longer in the most immature infants, during which the skin remains a portal for infection along with percutaneous absorption of toxins.<sup>1-3</sup> Advances in neonatal care have improved the survival of extremely preterm and very-low-birth-weight

(VLBW) infants, who now undergo frequent invasive procedures, adhesive fixation of monitoring devices, and prolonged respiratory support. Prevention of iatrogenic skin injury is therefore an important quality indicator in neonatal care.

### **Available knowledge**

Evidence-based recommendations for neonatal skin care emphasize gentle handling, judicious use of adhesives, prevention of moisture-associated damage, and routine assessment of skin integrity.<sup>4</sup> The neonatal skin condition score (NSCS), developed by Lund and colleagues as part of the Association of Women's Health, Obstetric and Neonatal Nurses/National Association of Neonatal Nurses (AWHONN/NANN) evidence-based practice project, is a simple, objective bedside tool that grades three domains: dryness, erythema, and skin breakdown each from 1 (normal) to 3 (severe), giving a total score of 3 (optimal) to 9 (most impaired).<sup>5,6</sup> The score has demonstrated wide acceptable validity and inter-rater reliability across different neonatal populations and can be readily incorporated into routine nursing assessment.<sup>5,7</sup> Adhesive removal is a well-recognized cause of barrier disruption in neonatal skin, providing a rationale for protective interface practices.<sup>8</sup> Despite the availability of these tools, their implementation remains inconsistent in many low- and middle-income (LMIC) settings, where skin assessment continues to rely largely on subjective clinical judgement.

### **Rationale**

At our tertiary-care NICU, assessment of neonatal skin condition lacked standardization: practices varied among healthcare workers, documentation was inconsistent, and objective monitoring was not routinely performed. Quality improvement (QI) methodology provides a systematic framework for embedding evidence-based practice within existing systems through iterative testing, continuous measurement and multidisciplinary engagement.<sup>9-11</sup> We reasoned that integrating routine NSCS assessment into daily practice, coupled with structured education and standardized skin-care practices, would improve neonatal skin integrity while remaining feasible in a resource-constrained setting.

### **Specific aim**

To reduce the proportion of neonates with abnormal skin findings by 50% within four weeks through the implementation of a standardized neonatal skin-care bundle incorporating routine NSCS assessment in a tertiary-care neonatal intensive care unit.

## **METHODS**

### **Study design**

This QI initiative used the model for improvement with sequential plan-do-study-act (PDSA) cycles to evaluate

the feasibility and effect of implementing a standardized neonatal skin-care bundle incorporating routine NSCS assessment.<sup>9,10</sup> The project ran prospectively over four weeks, from 31 May to 30 June 2019.

### **Setting**

This QI initiative was conducted in a tertiary care teaching hospital in Northeast India. The hospital has a 35-bedded inborn level 3B NICU. The unit admits preterm and term neonates requiring intensive care, including respiratory support, parenteral nutrition, and invasive monitoring. Before this project, skin assessment was based largely on subjective clinical judgement without a standardized scoring system, and documentation varied among providers, resulting in inconsistent recognition and management of early skin injury.

### **Baseline assessment**

A preliminary audit over three consecutive days using the NSCS demonstrated frequent skin abnormalities among admitted neonates: the baseline prevalence of dryness, erythema, and skin breakdown was 54.5%, 27.3%, and 4.5%, respectively. Informal discussion with nursing staff confirmed uncertainty regarding objective skin assessment and wide variation in day-to-day practice.

### **Quality improvement team**

A multidisciplinary QI team was constituted comprising two pediatric postgraduate trainees (PGT) posted in the NICU, a senior staff nurse designated as nursing coordinator, NICU staff nurses, and a faculty supervisor (the NICU in-charge). The faculty supervisor provided oversight, while residents/trainees coordinated data collection, staff education, auditing, and feedback.

### **Root-cause analysis**

Before designing the intervention, the team performed a structured root-cause analysis using an Ishikawa (fishbone) diagram (Figure 1). Four major domains contributing to suboptimal neonatal skin condition were identified. People-related factors included limited staff training, staffing constraints, and limited medical supervision. Process-related factors comprised inconsistent probe-site rotation, excessive or prolonged adhesive exposure, and inconsistent diaper care and hygiene practices. Material-related factors included limited availability of Tegaderm and skin barriers. Policy- and system-related factors included the absence of routine NSCS assessment and the lack of a standardized neonatal skincare protocol. These findings guided development of the intervention bundle.

### **Interventions**

Guided by the root-cause analysis, a standardized neonatal skin-care bundle with five components was developed.

### *Staff education*

A structured session on neonatal skin physiology, common causes of injury, principles of skin care, accurate use of the NSCS, and prevention of adhesive-related injury, moderated by the NICU faculty supervisor.

### *Routine NSCS assessment*

It was introduced as a standardized bedside tool, performed three to four times weekly during morning rounds.

### *Standardized documentation*

A dedicated NSCS proforma (Figure 3) completed by the bedside nurse and independently verified by the pediatric resident to reduce observer variability.

### *Visual reinforcement*

Colored NSCS reference charts displayed within the NICU to facilitate rapid bedside scoring.

### *Improved adhesive practices*

Protective transparent dressings (Tegaderm) were applied before fixation of respiratory interfaces where feasible; where hospital supplies were unavailable, caregivers were advised to procure them if affordable.

### *PDSA cycles*

Cycle 1 (weeks 1 to 2) focused on integrating the NSCS into routine practice through staff education, introduction of NSCS documentation, and display of bedside scoring charts and daily audits during rounds, aiming for familiarization and consistent adoption. Cycle 2 (weeks 3 to 4), informed by review of the first cycle, additionally targeted adhesive-related injury through protective Tegaderm use before respiratory-device fixation, reinforcement of education, continued auditing, and regular feedback.

### *Measures and data collection*

The process measure was the integration of routine NSCS assessment and standardized documentation into daily practice. The outcome measure was the proportion of neonates with abnormal skin findings, that is, dryness, erythema, and skin breakdown on the NSCS. Continued use of the NSCS after completion of the formal project was recorded as a measure of sustainability; formal balancing measures were not systematically collected.

Baseline data were collected over three consecutive days; subsequent assessments were performed three to four times weekly, and aggregate proportions were calculated after each PDSA cycle and compared with baseline.

### *Statistical analysis*

Because the data are aggregate proportions from a small QI initiative rather than repeated measures on individually tracked infants, outcomes are reported primarily as proportions and absolute and relative changes over time. The proportions of neonates with each skin abnormality at baseline and at the end of the intervention (independent samples) were compared using two-tailed Fisher's exact test, which is appropriate for the small cell counts observed; a  $p$  value  $<0.05$  was considered statistically significant. The initiative was designed to detect practice-level improvement and was not powered for formal hypothesis testing.

### *Ethical considerations*

This was a departmental quality improvement initiative undertaken to improve routine clinical care using evidence-based, internationally accepted practices, without introducing experimental interventions and without denying any infant an established benefit. In line with institutional and national practice for such initiatives at the time, formal Institutional Ethics Committee review was not sought. No individually identifiable patient data are presented, and patient confidentiality was maintained throughout data collection and reporting. The initiative is reported in accordance with the SQUIRE 2.0 guidelines.<sup>12,13</sup>

## **RESULTS**

### *Process measure*

Routine NSCS assessment was established and sustained as part of daily NICU practice. Following the initial staff education, neonates were scored three to four times weekly during morning rounds throughout both PDSA cycles, with each score documented on the standardized proforma by the bedside nurse and independently verified by the pediatric resident. This represented a shift from ad hoc, subjective skin assessment to a structured, objective, and routinely documented process integrated into the existing workflow.

### *Outcome measure*

At baseline, 22 neonates were evaluated. Dryness was the most frequent abnormality (12/22; 54.5%), followed by erythema (6/22; 27.3%) and breakdown (1/22; 4.5%). After the first cycle, 23 neonates were assessed: dryness fell to 47.8% (11/23) and erythema to 17.4% (4/23), with no documented breakdown (0/23). At the end of the second cycle, 23 neonates were evaluated: dryness decreased further to 26.1% (6/23) and erythema to 13.0% (3/23), while breakdown was documented in 1/23 (4.3%).

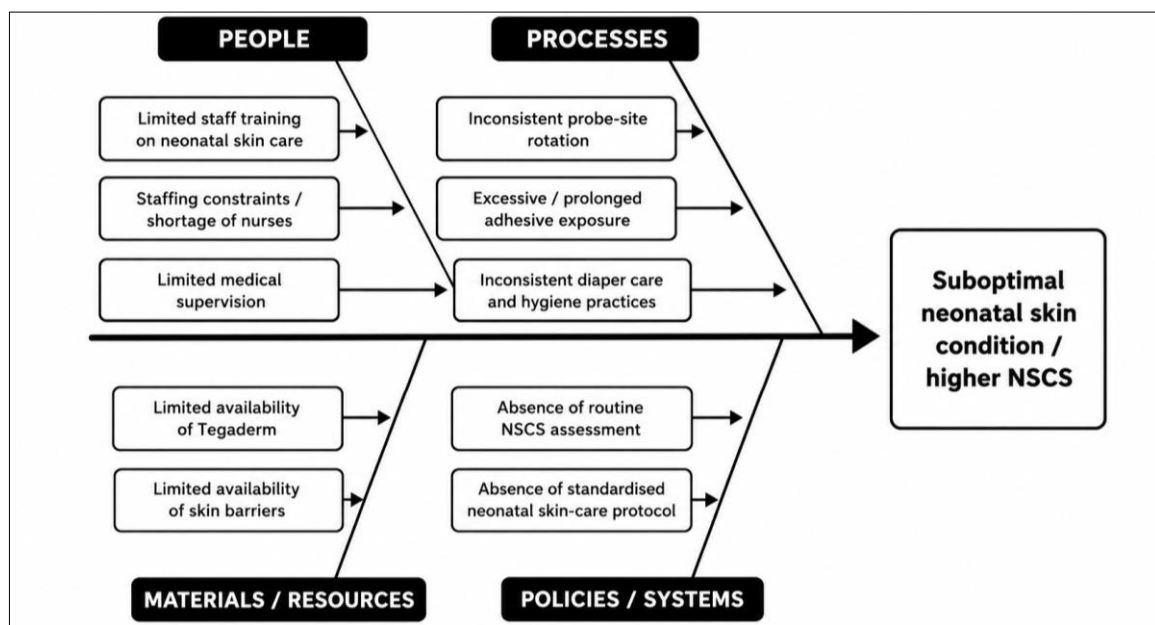
Over four weeks, dryness fell by 28.5 percentage points (an approximately 52% relative reduction; Fisher's exact  $p=0.07$ ) and erythema by 14.3 percentage points (an

approximately 52% relative reduction;  $p=0.28$ ). Neither reached conventional statistical significance in this small sample, but both showed a consistent downward trend across sequential cycles (Figure 2). Breakdown was uncommon throughout and did not change ( $p=1.00$ ). The pre-specified 50% relative-reduction target was met for dryness and approximated for erythema. Changes across cycles are summarized in Table 1 and Figure 2.

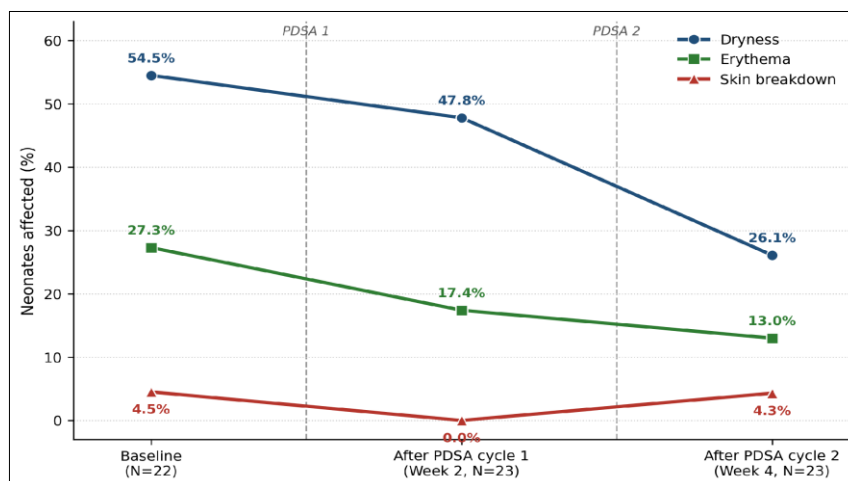
#### Sustainability (post-PDSA period)

Beyond the formal four-week measurement period, routine NSCS assessment continued in the NICU after completion of the quality improvement initiative. The scoring system remained integrated into daily clinical practice as part of routine skin assessment during morning rounds,

suggesting that the intervention was acceptable to healthcare staff and feasible within the existing workflow. Continued use of the NSCS reflected successful adoption of a standardized, objective approach to neonatal skin assessment without requiring additional infrastructure or personnel. However, no formal post-intervention audit or longitudinal outcome assessment was undertaken after completion of the project. Therefore, sustainability in this study refers to the continued implementation of routine NSCS assessment as part of standard clinical practice rather than demonstration of sustained improvement in neonatal skin outcomes. Future quality improvement initiatives should incorporate periodic audits and longer follow-up to evaluate whether continued implementation translates into sustained improvements in neonatal skin integrity.



**Figure 1:** Ishikawa (fishbone) diagram of the factors contributing to suboptimal neonatal skin condition, grouped by people, processes, materials/resources, and policies/systems.



**Figure 2:** Run chart of the proportion of neonates with dryness, erythema and skin breakdown at baseline and after each PDSA cycle. Dashed lines mark the introduction of two PDSA cycles.

**Table 1: Proportion of neonates with skin abnormalities on the NSCS at baseline and after sequential PDSA cycles.**

| Skin finding          | Baseline (n=22), N (%) | After PDSA 1 (n=23), N (%) | After PDSA 2 (n=23), N (%) | P value* |
|-----------------------|------------------------|----------------------------|----------------------------|----------|
| <b>Dryness</b>        | 12 (54.5)              | 11 (47.8)                  | 6 (26.1)                   | 0.07     |
| <b>Erythema</b>       | 6 (27.3)               | 4 (17.4)                   | 3 (13.0)                   | 0.28     |
| <b>Skin breakdown</b> | 1 (4.5)                | 0 (0)                      | 1 (4.3)                    | 1.00     |

\*Fisher's exact test (two-tailed), baseline versus end of intervention (after PDSA cycle 2). PDSA 1=after 2 weeks; PDSA 2=after 4 weeks

Name: \_\_\_\_\_ D.O.B.: \_\_\_\_\_  
Gestational Age: \_\_\_\_\_ D.O.A.: \_\_\_\_\_  
Birth weight: \_\_\_\_\_

### Neonatal Skin Condition Score (NSCS)

| Date       | Dryness                  |                          |                          | Erythema                 |                          |                          | Breakdown                |                          |                          | Total Score |        |
|------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------|--------|
|            | 1                        | 2                        | 3                        | 1                        | 2                        | 3                        | 1                        | 2                        | 3                        | By Nurse    | By PGT |
| 31/05/2019 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |             |        |
| 01/06/2019 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |             |        |
| 02/06/2019 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |             |        |
| 03/06/2019 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |             |        |

**• Dryness:**  
1 = Normal, No signs of Dry skin  
2 = Dry Skin with visible scaling  
3 = Very Dry Skin with cracking and/or fissures present

**• Erythema:**  
1 = No evidence of Erythema  
2 = Visible Erythema (<50% body surface)  
3 = Visible Erythema (>50% body surface)

**• Breakdown:**  
1 = Non evident  
2 = Small and/or localized areas  
3 = Extensive

Perfect score = 3, Worst score = 9

**Figure 3: Standardized neonatal skin condition score proforma introduced during the quality improvement initiative for routine bedside assessment and documentation.**

## DISCUSSION

This initiative showed that a simple, structured neonatal skin-care bundle incorporating routine NSCS assessment was feasible in a resource-limited tertiary NICU and was associated with a clinically meaningful improvement in the two most common manifestations of impaired skin integrity. Over four weeks, dryness fell from 54.5% to 26.1% and erythema from 27.3% to 13.0%, each an approximately 52% relative reduction, although neither reached conventional statistical significance in this small sample. Breakdown was uncommon at baseline and remained unchanged. Improvement was achieved with limited additional infrastructure, and NSCS assessment continued after the formal project, suggesting successful integration into routine workflow.

The progressive reduction in dryness across sequential cycles is instructive. Dryness was the most prevalent abnormality at baseline and offered the greatest scope for measurable change. A small reduction after the first cycle followed by a larger reduction after the second illustrates a core QI principle: education alone may be insufficient, whereas repeated measurement, reinforcement, feedback, and modification of care processes across cycles can yield greater improvement.<sup>10</sup> Erythema showed a parallel downward trend; although the small number of events limits statistical inference, the consistency of direction supports a genuine improvement signal. The absence of change in breakdown is best explained by a floor effect, that is, only one neonate was affected at baseline, and it should not be read as failure of the intervention.

The NSCS was originally developed and validated within the AWHONN/NANN neonatal skin-care project, where it proved reliable across raters and settings.<sup>5-7</sup> Our findings extend this work by showing that the tool can be embedded into everyday practice in a resource-limited NICU using a QI approach. Involving bedside nurses as primary assessors, with resident cross-checking, promoted shared responsibility for skin integrity; visual reference charts reduced reliance on memory; and the iterative PDSA approach allowed the intervention to evolve, with the second cycle addressing adhesive-related injury consistent with evidence that adhesive removal disrupts the neonatal barrier.<sup>8</sup> That low-cost, evidence-based skin-care measures can benefit neonates in resource-constrained settings is well supported.<sup>14,15</sup>

## Strengths

The project addressed a clinically relevant but frequently under-recognized component of neonatal care using an objective tool. The intervention was developed from local root-cause analysis and tailored to the needs of our NICU rather than being adopted as a generic intervention. Nursing staff played a central role in implementation, while iterative PDSA cycles enabled continuous refinement based on local experience. The bundle was inexpensive and feasible despite resource constraints, and routine NSCS assessment was sustained beyond the formal project period.

## Limitations

Several limitations should be acknowledged. This was a small, single-center initiative conducted over only four weeks, limiting generalizability and statistical power;

consequently, the reductions observed did not reach conventional statistical significance despite their magnitude. The neonates assessed at baseline and follow-up were not the same individuals; therefore, differences in patient characteristics, such as gestational age, birth weight, illness severity, and duration of stay, may have influenced the observed prevalence. The changing NICU population represents an important limitation. Although routine NSCS assessment continued after completion of the project, skin outcomes were not monitored beyond the intervention period. Therefore, the long-term sustainability of the observed clinical improvements could not be evaluated.

## CONCLUSION

A standardized neonatal skin-care bundle incorporating routine NSCS assessment, staff education, structured documentation, bedside visual reinforcement, and improved adhesive practices was feasible in a resource-limited tertiary care NICU and was associated with a clinically meaningful reduction in dryness and erythema, without major additional infrastructure. Continued use of the NSCS after the project suggests that a simple objective tool can facilitate sustainable practice change. Larger and longer initiatives incorporating patient-level longitudinal data, formal processes and balancing measures, and statistical process control are warranted to confirm, quantify, and sustain these improvements across neonatal units.

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