Quality Improvement Can Reduce Unintended Extubations

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TYPE OF INVESTIGATION

Quality Improvement

QUESTION

(P) For infants who require mechanical ventilation via endotracheal tube in a neonatal intensive care unit, (I) does introduction of a multi-intervention standardized quality improvement initiative (C) following an observed baseline period (O) effect a sustained reduction in unintended extubation rates?

METHODS

- **Design:** Standard quality improvement (QI) methodology was used. In the baseline period, the rate of unintended extubation (UE) was evaluated over four years, with an apparent cause analysis developed and refined during this time. This included review of contributory causes and their interplay using an Ishikawa cause-and-effect diagram in addition to a key driver diagram. Interventions were planned based on the results of these analyses. Two intervention epochs followed, with an intervening sustain period (Epoch 1: 18 months; Sustain: 3 years; Epoch 2: 32 months)
- **Allocation:** Not relevant to this study.
- **Blinding:** Not relevant to this study.
- **Follow-up period:** Not relevant to this study.
- **Setting:** A quaternary level neonatal intensive care unit (NICU). The inpatient cohort was a mix of infants who required surgical procedures, preterm infants, and infants who required extra corporeal membrane oxygenation.

- **Patients:** All inpatients receiving mechanical ventilation via an endotracheal tube.
- **Intervention:**
    - Epoch 1: 18 months
    - A number of interventions were implemented:
        - An airway alert card which included the last known position of the endotracheal tube (ETT) and date of last chest Xray (CXR).
        - Contemporary team reviews of all UE events ('real-time ACA huddles'), and establishment of an airway safety protection team
        - 5 months into Epoch 1, a UE bundle was implemented, with five components:
            1. **Daily Information Sharing**: ETT position and concerns were reported daily on morning rounds.
            2. **ETT insertion and taping consistency**: standardization of the method ETTs were secured with tape, and a standard insertion depth guide.
            3. **Positioning considerations**: Standardization of positioning for CXRs for ETT position, and mandated 2-staff member presence for major position changes.
            4. **Event recording**: education for all staff on when an UE should be reported.
            5. **A change in language**: the nomenclature for these events was changed from 'self' or 'accidental' to 'unintended' extubation.
    - Epoch 2: 32 months
    - Following the Sustain period, in Epoch 2 the following were also implemented:
        - Review, reinforcement and repeated education of Epoch 1 initiatives, with the addition of standardization of patient positioning.
        - A protocol to reduce the frequency of routine CXRs.
        - Development of the 'Zell UE Risk Tool' to identify patients at high risk of UE, with defined action points where high risk was identified.
- **Outcomes:**
    - Primary outcome: UE rate, calculated as the number of UEs per 100 patient ventilator days minus the number of tracheostomy days.
    - Secondary outcomes: number of days between events, and number of CXRs per patient day for all patients as a process measure (CXRs per patient days).
- **Analysis and Sample Size:** Change over time was analysed using statistical process control charts, with UE rate and CXR per patient days presented in *u* charts and days between events presented in a *t* chart. Analysis of demographic data was performed using standard statistical techniques.
- **Patient follow-up:** The entire inpatient cohort was included, with no mention of missing data.

MAIN RESULTS

Patient characteristics

The demographic characteristics of patients who experienced UE between Epochs were overall similar. While some variation in gestational age and birth weight distribution between epochs was identified, this did not appear to reflect a systematic change in the patient groups. More patients received sedation in the sustain and Epoch 2 phases than in Epoch 1. Reintubation rates were higher in epoch 2 than in the sustain period, but similar to baseline and epoch 1.

Outcomes

Significant and sustained reductions in UE rate per 100 ventilator days, CXR per patient days and days between events occurred following implementation of the program's QI initiatives (Table 1). Over the 10 year report, the UE rate was

reduced by 61%. A further change noted as a result of the QI program was reduced cost to the unit for CXRs, equivalent to $1.5 million (USD) per year.

Table 1: Change in UE and CXR/patient day rates between Epochs

Outcome	Baseline	Epoch 1	Epoch 2
UE rate (per 100 ventilator days)	1.75	0.99[1]	0.68[2]
Change in CXR per patient days	Not reported	Not reported	From 0.45 to 0.27
Change in days between events	Not reported	From 3 to 7	From 6 to 9

[1]This reduction occurred part way through Epoch 1, after introduction of the UE bundle.

[2]This reduction occurred part way through Epoch 2 after an initial spike in UE, addressed by introduction of the Epoch 2 initiatives.

CONCLUSION

A reduction in UE is achievable in the NICU environment following the introduction of a well-structured, multifaceted and sustained QI initiative.

COMMENTARY

Studies spanning the last thirty years have examined contributors to unintended extubation (UE) in neonatal intensive care units (NICUs).[1] Common themes emerge: low staff-to-patient ratios, less stable securement methods, procedures which cause patient movement and insufficient patient sedation.[1] Implementation of comprehensive and multifaceted quality improvement (QI) initiatives to reduce UE have more recently been demonstrated effective in multiple NICUs.[2,3] Galiote et al. report a single-centre QI project designed to reduce UE in a Level IV NICU in the USA through which a reduction in UE rate to the recommended benchmark of <1 per 100 ventilation days was achieved.[1] The QI methodology used is appropriate and the manuscript follows the reporting guidelines for QI in healthcare (http://www.equator-network.org/reporting-guidelines/squire/). Overall, the implementation project is well structured and designed.

For QI efforts to be effective in a healthcare service, it is vital to have clear leadership combined with an environment where frontline staff are empowered actively engage in the process.[4,5] There is evidence of positive cultural change in this project's NICU, with one intervention point focused on enabling nurses and respiratory therapists to speak up with their concerns. It appears that the project was appropriately multidisciplinary, with dedicated QI teams for UE prevention assembled in Epochs 1 and 2 of the intervention. It is assumed the overall QI team for UE was made up of neonatologists, nursing staff, respiratory therapists and administrators. However, given the composition of NICU clinical teams between units and neonatal networks, it would have been useful for the background and roles of each team member in this project to be described in more detail. It does not appear that there was formal parent or caregiver involvement in the study: while not commonly reported at present, collaboration with families for QI in NICUs can add great value to these endeavours.[6]

This implementation project was first prompted by an observation that UE had increased to an unacceptable level in this NICU. The process of intervention planning was well structured, and spanned across several elements of NICU care including bolstering staff presence at high UE risk timepoints, procedure standardization for endotracheal tube securement, guidance for managing patient position and episodes of high-risk movement, real-time reporting and analysis of adverse events, optimising communication, and the use of visual aids for clear identification of at-risk infants. Further information on why each particular intervention was selected over other potential interventions would be informative for NICUs planning similar projects. It is also not clear in the paper whether the team appraised reasons for the initial rise in UE in their unit that prompted the project in the first place: this may have provided valuable insight to the key UE drivers identified.

It is clear from this study and others that UE can be successfully reduced through the use of multiple, well-selected interventions that are driven by a dedicated QI team.[2,3,7] Future QI endeavours for UE in NICUs should focus on the sustainability of these initiatives, with a view to ensuring longevity of a safety culture in NICUs.

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