Title

*Improving care for our most vulnerable patients*

Timeslot

Thursday 27th March, 3:30pm presentation 3

Presenting author

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Abstract

Title: Improving care for our most vulnerable patients: A Human Factors approach to reducing unplanned extubations in the NICU.

Background: Pre-term and low birthweight infants require effective ventilation for survival, which depends on precise positioning and ongoing management of endotracheal tubes (ETTs). However. optimal positioning of the ETT has been increasingly challenging for low birthweight infants. The challenge is predominantly due to the decreasing size of those infants and the fact that the usual techniques for calculating ETT depth translate poorly to them (Bartle et al., 2019; Bellini, 2019; Cerone & Pinheiro, 2022; Leung, 2018). Studies suggest that 15-30% of ETTs are malpositioned, either too shallow or too deep tubes can lead to serious complications, such as unplanned extubations or chronic lung issues (Ebenebe et al., 2020). Addressing these issues require understanding the challenges clinicians face during ETT placement and management. A Human Factors approach offers a valuable framework to analyse complex clinical scenarios, identify problems, and improve patient outcomes (Halamek et al., 2019; Yamada et al., 2019). Bringing a Human Factors lens to unplanned extubations will enable a comprehensive understanding of the factors influencing clinician's decision-making when caring for intubated infants.

Aims: This study aimed to reduce unplanned extubations and improve outcomes for neonatal patients by investigating the factors leading to ETT malpositioning. The study was a collaboration between the Neonatal Intensive Care Unit (NICU) of a Brisbane hospital and a team of Human Factors professionals. The Human Factors team led the project and took a contemporary approach to examine ETT positioning.

Methods: The study employed a cross-sectional design consisting of two components: an online survey and a simulation of retaping for a preterm infant manikin. The survey, based on the Theory of Planned Behaviour, was distributed to staff at the NICU (N=300). Neonatal nurses (N=24) participated in simulations comprised teams of two, comprising one neonatal clinician and a research confederate.

Results: Survey responses (n =71) comprised a median of 7.5 years of clinical experience (IQR 3-15.25), with 48% of staff regularly taping ETTs for low birth-weight infants. Tube malpositioning was only 8%, with little variation between taping techniques. Observations identified several barriers to precise ETT positioning, including tape residue occluding tube depth markers, tube markings spaced too far apart to allow precise 2.5mm adjustments. Additional factors that may influence the accuracy of ETT positioning include the level of explicit communication during retaping, variability in holding the ventilation device, and different approaches to securing the tube.

Discussion: A Human Factors approach investigated the challenge of precisely positioning ETTs from a whole-of-system perspective: the team, the procedure, the equipment, and the clinical environment. One key finding was that it was not a gap in knowledge, skills, or abilities of the clinicians. Instead, there were gaps in the design of the equipment (e.g. ETT markings and tape) which impact task performance. Despite these micro-level issues, the rate of tube malpositioning was low during the simulation. This suggests that unplanned extubations are likely due to other factors at the macro-level, such as workplace cultural norms. Future research should focus on in-situ observations within the NICU to explore environmental factors and investigate how neonatal clinicians monitor and manage ETTs during routine care. Whereas traditional safety interventions often prioritise a training solution, our novel approach in this study demonstrates the need to investigate different elements within the system, not just the individual clinician performance.

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# Improving care for our most vulnerable patients: Reducing unplanned extubation in neonates

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## Intubating preterm infants

- Thread a tiny endotracheal (ET) tube through the infant's vocal cords.
- Carefully place the tip of the tube at the midway between the thoracic inlet and the carina.
- Tape the tube as securely as we can, so that it doesn't move.

## Challenges

- About 15-30% of ET tube are positioned incorrectly
- **ET tube positioned too high** → Increased risk of dislodgement → Potential airway loss
- **ET tube positioned too low** → Risk of tracheal injury → Possible long-term lung and breathing complications

## Retaping

- Clinicians confirm the depth of an ET tube via a chest X-ray image, adjust the tube if needed, and retape the tube securely.

## Study design

- Observation-based exploratory study in simulation lab.
- 24 neonatal nurses paired up to retape an intubated infant manikin.
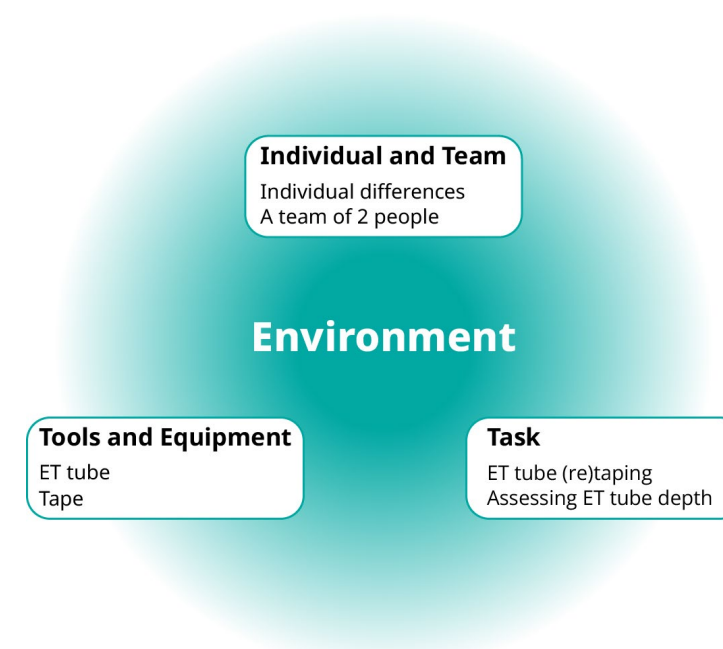
**Our observations:**

- Tube placement – accuracy
- Taping technique – variations
- Teamwork – dynamics

## Human Factors model



**Individual and Team**
Individual differences
A team of 2 people

**Environment**

**Tools and Equipment**
ET tube
Tape

**Task**
ET tube (re)taping
Assessing ET tube depth

## Key observations

**Individuals and Teams**
- "Fat fingers".
- Explicit vs. implicit communication.

**Tools and Equipment**
- Markers on the tube space too apart.
- Tape residual occludes the depth markers.

**Task**
- Different methods of holding the ventilation device.

## Next step

- In-situ observations to examine the influence of environmental factors, routine care, and monitoring and management of the tube.

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