

## ORIGINAL ARTICLE

# Impact of team building using a novel technique (planned experimentation) to standardize endotracheal tube taping practice in the NICU

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## Abstract

**Objectives:** Convincing staff to standardize aspects of neonatal care is often difficult in the absence of strong evidence. A hospital-endorsed procedure for taping endotracheal tubes securely to a patient's face lacked such evidence and as a result, many nurses in the neonatal intensive care unit continued to tape their own way. Multiple attempts to standardize this practice were unsuccessful. This report discusses how a staff centric team building management strategy combined with a planned experimentation exercise was able to raise compliance to 100%.

**Methods:** A multidisciplinary team engaged staff in a planned experimentation exercise to rapidly study how endotracheal tubes are taped securely to an infant patient's face. The exercise helped the team build trust between management and frontline staff. The exercise was a three month factorial study designed to identify a superior taping method among those already in practice. "Time to retaping" was the primary outcome that estimated how secure an endotracheal tube was. At the beginning of the study, the team acquired full staff commitment to standardize practice to whichever method the study favored, but if neither were better, staff agreed to follow the hospital endorsed method.

**Results:** While a better method to secure endotracheal tubes was not identified, the hospital method of taping endotracheal tubes to an infant patient's face was implemented into practice successfully.

**Conclusion:** By establishing a clear commitment from staff to standardize based on results from the planned experimentation, the team was able to standardize endotracheal tube securement even while failing to define best practice.

## Key words

Safety culture, Unplanned extubation, Standardization, Quality improvement, Planned experimentation, Best practice

## 1 Introduction

### 1.1 Background

Although methods to improve compliance with practice procedures have been well described and used to make substantial improvements in certain healthcare areas, overcoming individual practice deviations that are rooted in habit and lack of

evidence for better alternatives remains a formidable problem. Standardizing practice is much more successful when a high degree of belief has already been established that a desired practice is beneficial <sup>[1]</sup>. Without this belief, providers are reluctant to change behaviors and prefer to rely on their own anecdote experiences. In addition, many health professionals consider hospital administration as ineffective. Using a more interdisciplinary model that allows frontline health professionals, such as nurses, to take active roles in practice changes and policy creation may improve acceptance and perceived efficacy <sup>[2]</sup>.

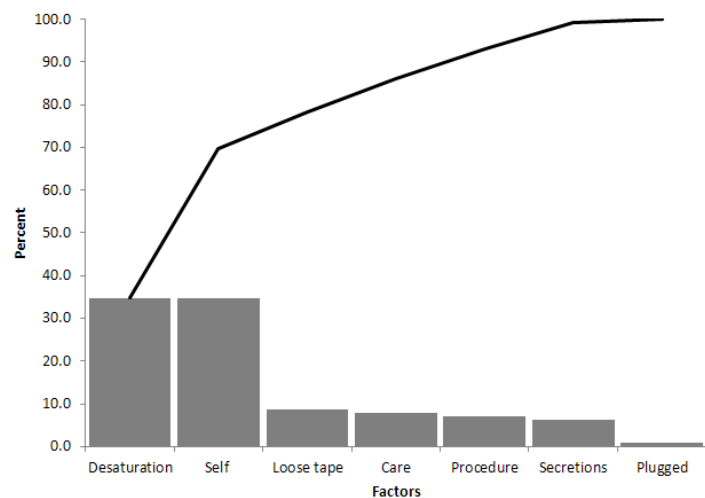
We report using a staff engaged management strategy to conduct a planned experimentation (PE) <sup>[3]</sup> exercise to compel staff to follow the hospital endorsed method of taping endotracheal tubes while previous attempts to standardize this process in the NICU have failed.

## 1.2 Management purpose

### 1.2.1 Reduce unplanned extubations in the NICU

In our 75 bed NICU, as many as 20-30 infants can be found intubated with an endotracheal tube (ETT) for extended periods of time. Maintaining these ETTs in the correct location inside the infant's trachea is problematic due to several issues such as desire to avoid sedation for prolonged periods, short tracheas and inadequate securement devices/techniques. An unplanned extubation (UE) happens when the ETT is dislodged from the trachea at an unanticipated time. Studies suggest infants requiring reintubation have increased oxygen requirements, significantly longer length of hospital stay and perhaps, significant systemic and cerebral hemodynamic changes with ETT intubation and repositioning <sup>[5-7]</sup>. While 10 UE per 1,000 ventilated days fall within general national averages for pediatrics, we acknowledge that this rate is unacceptably high for infants <sup>[5, 8-10]</sup>. A Pareto analysis of factors associated with unplanned extubations over 12 months identified loose tape as an important preventable reason for UEs (see Figure 1). Desaturation, although a frequent associated factor, was a physiological response to UE, rather than a preventable cause. After much discussion and discourse with frontline staff, self-extubations were related frequently to suboptimal tube securement. Recognizing that variation in the way endotracheal tubes are secured onto a patient's face could contribute to UEs, our UE prevention team wished to standardize the taping process.

**Figure 1.** Factors associated with Unplanned Extubations During August 2007 to 2008 - Baseline Period (N = 127). "Desaturation" is a symptom associated with an unplanned extubation that had already happened. "Self, loose tapes, care, procedure, secretions" are conditions associated with unplanned extubations and "plugged tube" was an infrequent factor that necessitated the replacement of a tube.

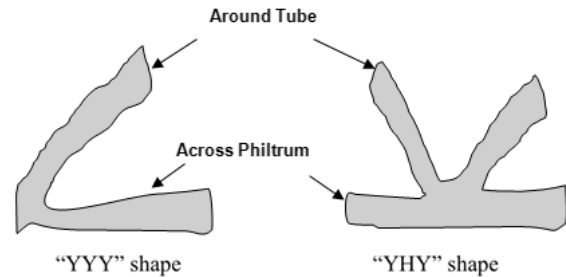


### 1.2.2 Improve staff compliance with standard practice

Bedside staff was reluctant to follow a hospital-endorsed technique for taping ETTs securely onto a patient's face (called "YYY") because there is no evidence supporting the "YYY" method as best practice for neonates. Hence, nurses preferred to use a taping method many of them were taught, called "YHY"; although ironically, there is also no evidence that this is the superior method. Figure 2 illustrates the difference between the two taping configuration. Up to 76% of patients'

endotracheal tubes were secured with “YHY” and repeated attempts to standardize towards “YYY” have failed. Another important practice, some nurses variably used a “barrier moustache” that meant a strip of hydrocolloid barrier placed on the skin between the upper lip and the nose. While the intention of this practice was to protect the neonate’s sensitive skin from irrigating tape adhesives, impact on tube securement was unknown and therefore, worth investigating as a second factor in our study.

**Figure 2.** The ETT is secured by cutting three pieces of tape, either in a “Y” or an “H” shape, and using them sequentially overlying one another to secure the ETT onto the baby. In each case, the bottom (base) portion is taped across the philtrum above the baby’s upper lip and the top portion is wrapped around the endotracheal tube.



Planned experimentation is a factorial analysis technique used to simultaneously study the impact of 2 or more variables on an outcome. With proper implementation, PE can save an organization time, cost and measure the factors’ impact on outcomes.

### 1.3 Project aim

The intended improvement of this study was to standardize the way staff taped ETTs in neonates. While previous attempts have failed, our approach represents a unique attempt to standardize staff practice by engaging them in a PE exercise that addressed their legitimate concerns: does using “YYY”, “YHY”, and/or hydrocolloid moustache make ETTs more secure?

## 2 Methods

### 2.1 Planning the intervention

The intervention consisted of two components: (1) multidisciplinary teaming building and (2) use PE as the team exercise to drive eventual standardization of how endotracheal tubes are taped securely to an infant’s face.

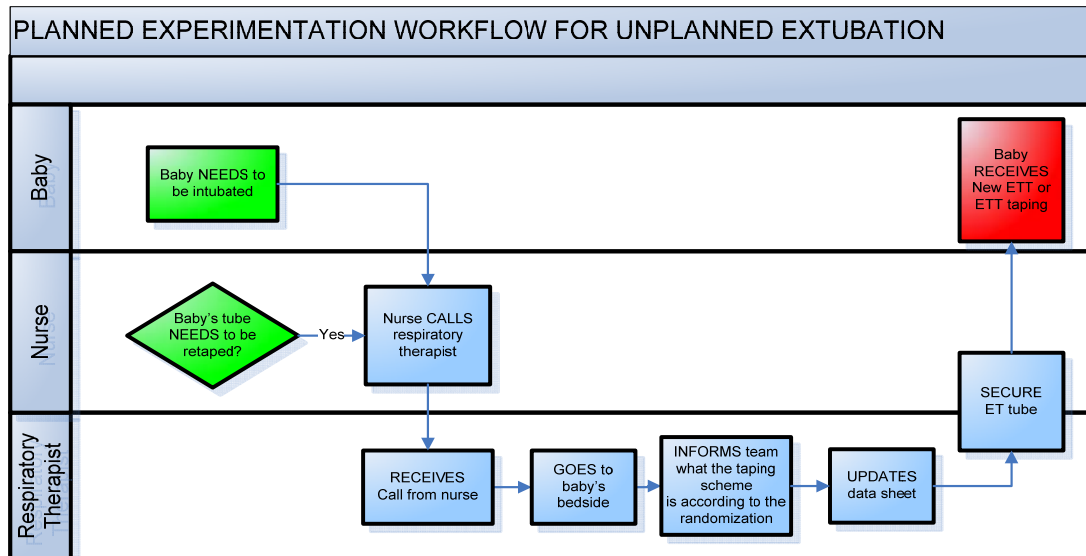
### 2.2 Team building

A multidisciplinary improvement team representing day and night nurse shifts, physicians, and respiratory therapists met biweekly to monitor the study’s progress and to provide the means of communication between staff and the improvement leadership. Meeting ground rules were established that included: (1) everyone’s ideas were valuable and encouraged to share them in a safe meeting environment, and (2) any ideas can be explored by conducting small, unobtrusive, PDSA (plan, do, study, act) cycles. Essentially, such operational rules aim to build confidence and trust amongst team members.

### 2.3 Using PE exercise to standardize practice

At the start of the study, the team facilitated widespread agreement on standardizing practice to whichever method the study favored, but if neither were better, staff committed to do “YYY” in order to reduce practice variation. The team developed a workflow to clearly defined roles and responsibilities of the three main participants (bedside nurse, respiratory therapist and patient) in securing endotracheal tubes (see Figure 3). Testing 2 factors, taping configuration (YYY vs. YHY) and use of hydrocolloid moustache (Yes vs. No), yield 4 possible factor combinations. The planned experimentation portion of the study required that each of these combinations be randomly determined each time the ETT needed to be retaped. To avoid disrupting care and adding non-value work to bedside staff, a randomized sequence of the methods was predetermined at the beginning of each patient’s enrollment and displayed clearly at the bedside. With each

retaping event, the nurse would follow the next taping sequence specified on the list. Periodic walk rounds once a week monitored adherence with study procedures. The study was conducted in full accordance of all institutional Research Policies and Procedures and all applicable Federal and state laws and regulations including 45 CFR 46, 21 CFR Parts 50, 54, 56, 312, 314 and 812 and the Good Clinical Practice: Consolidated Guideline approved by the International Conference on Harmonization (ICH).



**Figure 3.** Swim-lane diagram illustrates the decision and workflow process for retaping endotracheal tubes in the study. Nurses determine when an endotracheal tube needed to be re-secured, while the respiratory therapist assisted the taping process and documented.

### 2.4 PE study design

To simultaneously test each of the two taping methods, tape configuration (YYY vs. YHY) and hydrocolloid moustache (use vs. not use), and their combinatorial affects on ETT retaping time, we designed a 2 × 2 factorial matrix that yield 4 possible combinations to test. Infants intubated for the first time or intubated infants whose ETT needed retaping were enrolled. Infants with tracheostomies, other tube securing devices, or who were nasally intubated were excluded. The baseline retaping rate in our unit was approximately 30/week, or an average of 5.6 hours between retaping events. Power calculation based on initial estimates of frequency of retaping anticipated a 3-week study period; however, due to a greater than expected number of excluded retaping times, the study took three months to complete. The study team met monthly to assess the study status.

### 2.5 Measures

Initial compliance with taping method (YYY vs. YHY) was assessed via an online staff survey (N = 65). Assessment of staff compliance with YYY method was done as a single day, point prevalence audit of all intubated neonates in the unit at nine months and 38 months after the intervention ended. The primary outcome for the planned experimentation exercise was minutes between taping events (called “retaping time”). UE’s relatively fewer occurrence would have required a longer study time to detect improvements. We chose retaping time as an UE surrogate under the assumption that longer retaping times were associated with better-secured ETTs and therefore less UEs. When an infant’s ETT was retaped in the operating room or electively reinserted, the time period before and after the event was excluded. The background variables of this design were degree of activity and nasal-oropharyngeal secretion; a 4-grade scoring system for each variable were created and used by nurses to assess at each retaping event (see Table 1).

**Table 1.** Scoring system for activity and secretion level

Score	Activity	Secretion
0	None	None
1	Minimal movement to stimulation	No suctioning required
2	Active hand movement	Suctioning of mouth
3	Active movement of baby's hands, head and torso	Oropharyngeal suctioning

## 2.6 Analysis

Graphical analysis, descriptive statistics, factorial analysis, correlation analysis, and multiple regression analysis were done. The two factors, tape configuration and hydrocolloid moustache usage, and their interactions were analyzed on their effects on retaping time. Secretion and activity level were included in the regression analysis as covariates. Additional subgroup analysis was done for a “high risk” group of patients whose ETT needed to be retaped more than three times or had secretion scores of 2 or 3.

NICU staff training. The improvement team led a unit wide education program using mannequin demonstrations to reinforce taping skills. Staff peers administered one-on-one bedside education, encouraging opportunity for immediate feedback and questions. In addition, bedside computer screensavers were used to remind staff of the education they received.

## 3 Results

Over 3.5 months, 154 retaping events were recorded from 38 eligible patients, of which 109 events came from 12 patients having more than three retaping events.

### 3.1 Tape configuration

There was no significant retaping time difference between the YYY and YHY technique (see Table 2,  $p = .24$ ). When the comparison was done for “high risk group” patients, again no difference was found (see Table 2,  $p = .16$  and  $p = .24$ , respectively).

**Table 2.** Effect of two factors, their interaction and background variables on retaping time (elapsed minutes between retaping events). Higher secretion level is associated with lower retaping time.

Factors	<i>P</i> value
Tape configuration	.24
Patient with > 3 retaping events	.16
Patient requiring suctioning	.24
Hydrocolloid moustache	.66
Patients with > 3 retaping events	.31
Patients requiring suctioning	.27
Interaction between 1 and 2	.69
Patient with > 3 retaping events	.78
Patient requiring suctioning	.63
Background variables	
Secretion (score = 2, 3)	< .007
Actiity (score = 3)	.77

### 3.2 Hydrocolloid moustache

There was also no impact of using the hydrocolloid moustache on retaping time ( $p = .66$ ). No difference was found when the analysis was repeated on the high-risk patient group (see Table 2,  $p = .31$  and  $p = .27$ ).

### 3.3 Interactions

Results suggest the interaction effects between tape configuration and hydrocolloid moustache use did not impact retaping time ( $p = .69$ ). No effect was seen for patients where retaping was done  $> 3$  times (see Table 2,  $p = .78$ ) and where secretion was high (score 2 or 3) ( $p = .63$ ).

### 3.4 Background variables

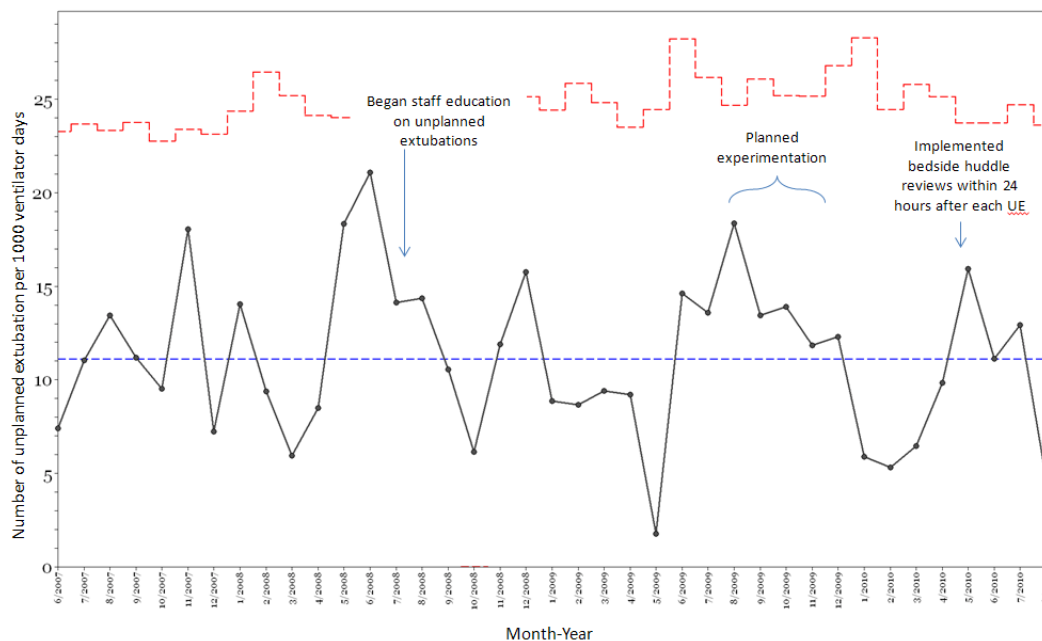
Our results indicate patients who required suctioning (secretion scores of 2 and 3) had shorter retaping time (see Table 2,  $p < .007$ ). However, distribution of retaping time for the low and high secretion groups had a large overlap. Surprisingly, activity level did not show a consistent impact.

### 3.5 Standardization

Our improvement team used the PE results to convince NICU nurses that the YHY method was no better than the YYY method, and therefore, they should endorse the hospital procedure standard which recommended the YYY method. A point prevalence audit nine months after the study showed 100% of intubated patients' ETT secured using YY ( $n = 21$ ). This improvement was sustained in another audit at 38 months post-intervention (100% YYY,  $n = 25$ ).

### 3.6 Unplanned extubations

Reductions in the UE rate during the study were transient and rose shortly after the study despite having standardized the ETT retaping process (see Figure 4).



**Figure 4.** U-chart of NICU unplanned extubation rate from 6/2007 to 8/2010. Three major interventions are annotated: 1) staff education, 2) planned experimentation, and 3) bedside huddles.

### 3.7 Problems encountered

The need to clarify operational definitions was often underestimated, especially for terms that were familiar to members of the improvement team but not frontline providers. For instance, we needed to clarify “retaping time” as the time lapse between two consecutive retaping events and not how long the retaping process took. The team also realized that a better definition of “unplanned extubation” is needed – one that distinguished those that happen during bedside care (*i.e.* patient transfers) which may be more preventable.

### 3.8 Lessons learned

The multidisciplinary team played a critical role in communicating and clarifying any concerns and questions staff had. Staff was surprised to learn about the wide degree of practice variation in using YYY, YHY, and hydrocolloid moustache. By the end of the study, the need for two providers to retape all endotracheal tubes became more important to many staff.

## 4 Discussion

Using ETT securement as an example, we report a strategy that successfully standardized a care practice despite previous failed attempts. We believe success was attributable to: (1) a multidisciplinary team building process that engaged staff from the beginning of the practice change process, and (2) using planned experimentation to find evidence (or lack thereof) that would cause skeptical influencers among staff to support change.

Engaging staff in the practice change process thru team building. A staff centric management strategy is critical for success. The ensuing conversations amongst team members produced rich content and ideas, many of which came directly from new staff. It has become increasingly clear that practice change requires genuine, rather than obligatory, buy in from those doing them. Our experience suggest that one underlying challenge for achieving sustainable change is to convince conscientious healthcare providers that practicing a certain way will be best for their patients. Therefore the search for “best practices” should involve staff who will be the ones doing them. Critical to this engagement is effective peer to peer coaching and leadership support, especially when educating staff on new procedures and processes. Literature suggests these methods (*e.g.* coaching, reminders, revision of professional roles) are effective in achieving guideline compliance<sup>[11]</sup>, provided they are applied within a learning, supportive environment.

Using planned experimentation to get staff buy in. The planned experimentation exercise empowered staff with the ability to affect change, rather than just follow “orders” from leadership. The result was tremendous staff commitment to not only complete the study, but also keep their promise to standardize taping practice. Having representation from various clinician levels, nurses and respiratory therapists, day and night staff enhanced communication and ensured message consistency. In the end, a multidiscipline group of staff at the sharp end of care was able to agree to standardize a practice that had failed several attempts at standardization for many years. Ironically, our finding of non-superiority made it easier for staff to “let go of old habits” and try new ways. As others have described<sup>[12]</sup> we found engaging “early adopters” and “early majority” helped “laggards” and “late majority” individuals accept changes.

### 4.1 Factorial analysis

Planned experimentation allowed simultaneous testing of multiple factors and their interactions, saving time and effort. Our staff, for the first time, gained experience for this analytical strategy and will be applying it to other quality improvement efforts involving multiple factors and where serial experimentation is difficult.

### 4.2 Integrating into everyday workflow

The team was careful to minimize protocol related bedside activities that added no value to patient care. Therefore, pre-randomizing the taping method sequences saved staff time, reduced stress, and facilitated participation.

### 4.3 Limitations

#### 4.3.1 Outcome measures

Using retaping time as the outcome metric only addressed UEs associated with loose tape or retaping procedures. The inverse relationship between retaping time and UEs’ is an assumption difficult to prove. Although it was not the intent of this study to prove this relationship, we wished to provide some insight into possible hypotheses. Although this study was

not powered to identify subpopulation risk factors for UE, the results did suggest that conditions such as secretions deserve further studied. Minimizing secretions and the impact such accomplishments would have on UEs remains unclear.

#### **4.3.2 Concurrent interventions**

Other improvement interventions related to ETT management were happening during this study and could have influenced outcome. For example, a separate initiative to educate staff about proper patient positioning during x-rays could have made nurses more careful when handling intubated infants. The team permitted such parallel efforts, anticipating that the combined impact could benefit patients sooner. Unfortunately, the problem of teasing out factor associations and interactions remains.

#### **4.3.3 Impact on unplanned extubations**

While this project had heightened staff awareness of UEs, it did not appear to reduce UEs. Transient dips in the UE rate in the midst of various interventions suggest a complex problem with no single solution. Standardizing how ETTs are taped to the face is not enough. Perhaps the solution lies not in as much as how an ETT is secured, but rather how the securement is monitored and maintained over time under risky circumstances (*i.e.* high secretion).

## **5 Conclusion**

### **5.1 Quality improvement and team management**

Planned experimentation is a powerful tool for engaging frontline providers in search for best practices and, even when a best practice is not found, it can be a successful driver for standardizing care processes. For success in healthcare, implementation of planned experimentation requires a staff centric management strategy that engage frontline healthcare providers to determine what test factors are important and decide how they will respond to potential results. The role of leaders is to facilitate the process and hold staff accountable to these two tasks.

### **5.2 Clinical practice**

Preventing UEs' in neonates is a multifaceted problem that requires a multifaceted solution. Having standardized taping method thru this study, we can now study other factors that impact UEs. Currently, we hypothesize that bedside care factors to maintenance vigilance are likely to play a critical role.

## **Acknowledgement**

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## **Conflict of interests**

The authors declare that they have no conflict of interests.

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