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# Enhancing care of patients requiring a tracheostomy: A sustained quality improvement project

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ABSTRACT

*Introduction:* Within the UK approximately 5000 surgical and 12,000 percutaneous tracheostomies are performed annually. Whilst an essential component of patient care, the presence of a tracheostomy is not without concern. Landmark papers have demonstrated recurrent themes related to the provision of training, staff and equipment, leading to avoidable patient harm, life-altering morbidity and mortality. The development of the Global Tracheostomy Collaborative (GTC) and the Improving Tracheostomy Care (ITC) project have provided the necessary infrastructure to make improvements, with individual organizations responsible for its implementation.

*Method:* This quality improvement project, funded by the NHS Wales Critical Care and Trauma Network, developed a dedicated tracheostomy team to improve the quality of care provided to those patients requiring a tracheostomy through staff education, equipment standardisation and multidisciplinary tracheostomy ward rounds. Global Tracheostomy membership was funded through involvement in the ITC project.

*Results:* Formal tracheostomy teaching was delivered by the tracheostomy team to 165 clinicians involved in tracheostomy care. Improvements in self-assessed confidence with knowledge and were observed for all aspects of tracheostomy care. Standardisation and centralisation resulted in reduction in waste and unnecessary variation. Compliance with 'emergency tracheostomy blue box' availability with an increase from 5% to 100%.

Comparison of data from the QI period against baseline data, demonstrated improvement in rates of decannulation, and non-significant improvements in time to decannulation, critical care and hospital length of stay. Additionally, there were associated reductions in adverse events.

*Conclusion:* This QI project, supported by involvement with the GTC and ITC, resulted in reductions in adverse events, improved patient safety, non-significant reduction in time to achieve weaning milestones and a reduction in hospital length of stay.



## 1. Introduction

Within the UK approximately 5000 surgical and 12,000 percutaneous tracheostomies are performed annually [1]. The tracheostomy may be inserted as part of a surgical procedure or for those requiring prolonged periods of mechanical ventilation within critical care [2].

Whilst an essential component of patient care, the presence of a tracheostomy is not without concern [3]. The needs of patients frequently cross traditional speciality working boundaries and location and resulting complications can rapidly become fatal, especially in the critically ill [4]. Two major practice reviews highlighted many failings in the provision of care for this vulnerable group of patients [2,4]. Recurrent themes relate to the provision of training, staff, equipment and the infrastructure required to safely manage tracheostomy patients around the clock, leading to avoidable patient harm, life-altering morbidity and mortality [2,4]. Additionally, within NHS organizations there is often no formal or structured system for taking responsibility for the weaning, downsizing or de-cannulation of the tracheostomy [5]. This results in non-compliance with national guidelines, increases patient risk and prolongs length of stay [2,4].

To overcome these issues, over the past decade there have been multiple initiatives where the provision of specialist multi-disciplinary tracheostomy teams have been shown to improve patient outcomes. Additionally, organizations such as the Global Tracheostomy

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Collaborative (GTC) have been developed to partner with hospitals and healthcare providers around the world, to work together to improve the care, safety and quality of life of individuals with a tracheostomy [6,7].

Within the UK, initiatives such as the National Tracheostomy Safety Project (NTSP) and their Health Foundation-funded Improving Tracheostomy Care (ITC) program have accelerated the rate of improvement of tracheostomy care within the NHS. The ITC program funded membership of the GTC for 20 diverse UK sites and provided additional guidance, direction and a network of peer support for the clinical staff leading the project in individual sites. The program aimed to support sites rapidly implementing quality improvements that had been show to be effective in other hospitals around the world, with the tools to measure metrics offering feedback on the impact of these interventions. However, the ITC did not fund local staff time or resources to implement these processes.

Following a successful bid to the NHS Wales Critical Care and Trauma Network, we developed a bespoke 9-month Quality Improvement (QI) project based on our participation in the UK Improving Tracheostomy Care project, utilising the available GTC resources. The aim of the QI project was to improve the quality of the service provided to patients with tracheostomies within a Tertiary University Teaching Hospital.

## 2. Methodology

### 2.1. Setting

University Hospital of Wales, Cardiff is a referral centre for a wide range of tertiary clinical services, including neurosciences and cancer services. Additionally, it is a district general hospital for Cardiff and the Vale of Glamorgan. It is the major acute hospital for the Cardiff and Vale University Health Board (CVUHB). It has a 34-bed, mixed dependency critical care unit admitting 1500 patients per year, a 6-bed post anaesthetic care unit and specialist services for ear, nose & throat (ENT) and oro-maxillofacial surgery. Typically, across the specialities, 120–140 tracheostomies are performed each year. These may be for a variety of indications including prolonged mechanical ventilation or as part of head & neck surgery.

### 2.2. Patients

All patients requiring a tracheostomy between March – November 2018. These patients were compared to those requiring a tracheostomy during the same time points in 2017. Data was not analysed for patients with tracheostomy tubes in already situ at point of hospital admission.

### 2.3. Quality improvement intervention

A successful grant application was made to the Wales Critical Care Network for a 9-month pilot to improve tracheostomy care across Critical Care and Neurosciences. This funding supported the development of a tracheostomy team including physiotherapy, nursing, speech and language, and medical clinicians.

The QI project was divided into three sections:

1) Development of education, competency and patient care package
2) Standardisation and centralisation of tracheostomy equipment
3) Development of tracheostomy team to co-ordinate and implement tracheostomy weaning and decannulation plans

#### 2.3.1. Development of education, competency and patient care package

To improve the quality and safety of the service provided to patients with tracheostomies, the pilot included the formation and completion of tracheostomy study sessions, completion of nationally recognised competencies (developed by Improving Tracheostomy Care project) and clinical based support for patients and staff.

Tracheostomy training sessions were held fortnightly using the medical simulation suite at University Hospital of Wales, with sessions lasting 3.5 h and included information on reasons for tracheostomy; general care; red flags; and emergency management.

#### 2.3.2. Standardisation and centralisation of tracheostomy equipment

To reduce the variation in tracheostomy tubes being utilised by the host organisation, the selection of available tubes was reduced to two – one standard length and one variable length (both available in range of diameters). Furthermore, the procurement and storage of tracheostomy tubes and inner tubes was centralised to critical care. The aim of this process was to reduce ongoing potential variation and reduce waste caused by multiple specialities ordering equipment. To help support standardisation and centralisation, 'emergency tracheostomy blue boxes' were re-introduced and managed by the tracheostomy team. These 'emergency blue boxes' contain the essential equipment (e.g. spare inner tube, spare tracheostomy tube and one a size smaller, 10 ml syringe, stitch cutter) that may be required in the event of a tracheostomy emergency including tracheostomy tube obstruction or dislodgement. The availability of the emergency equipment at the patient's bedside was audited every week of the project.

#### 2.3.3. Development of tracheostomy team to co-ordinate and implement tracheostomy weaning and decannulation plans

The core tracheostomy team (Physiotherapy, SLT & nursing) in conjunction with ward-based staff, completed weekly tracheostomy reviews to all appropriate patients admitted to critical care and the tracheostomy cohort wards. The ward round involved a comprehensive review of patient progress, development of structured weaning plans (with associated documentation) and compliance with local guidelines/national standards. These tracheostomy ward rounds also allowed continuation of care and effective handover to staff. Prior to the quality improvement there was no formal tracheostomy ward round and reviews were completed on an ad-hoc basis by a senior physiotherapist. Local guidance documents were adhered to ensuring the safety of tracheostomy weaning, however it was completed in a less timely manner as dependant on staff availability.

During the QI period, all decisions for tracheostomy weaning (e.g cuff deflation, tracheostomy tube downsize or decannulation) were made following multi-disciplinary discussions and following local guidance [8]. Within the host organisation there was no definitive criteria for readiness to wean with decisions made on an individual patient basis. Where possible, required tracheostomy tube changes and decannulations occurred during this review session. All other interventions e.g. cuff deflation trials; capping; cough; and swallow assessments were completed a separate time.

The role of the consultant intensivist was to provide support to the tracheostomy team and to be involved in decisions for decannulation and management plans in the event of decannulation failure e.g. escalation of care, re-insertion of tracheostomy.

The key outcomes were defined as percentage of patients successfully decannulated prior to discharge from the host organisation, critical care and hospital length of stay (at host organisation) and occurrence of adverse events (e.g. accidental decannulation, tracheostomy tube blockage or dislodgement, pressure area around tracheostomy tube, or excessive bleeding from or around tracheostomy tube). Secondary outcomes included time to cuff deflation, time to downsize of tracheostomy tube and time from tracheostomy insertion to discharge from host organisation.

To aid in these aims a driver diagram was produced (Fig. 1).

### 2.4. Data collection

The QI process was initiated in March 2018 and was evaluated until November 2018. For pre-QI comparison, retrospective data for the pre-QI project March 2017 to November 2017 (baseline data) was collected from existing host organisation databases held by the project lead and from the Global Tracheostomy Collaboratives REDCap™ database. The

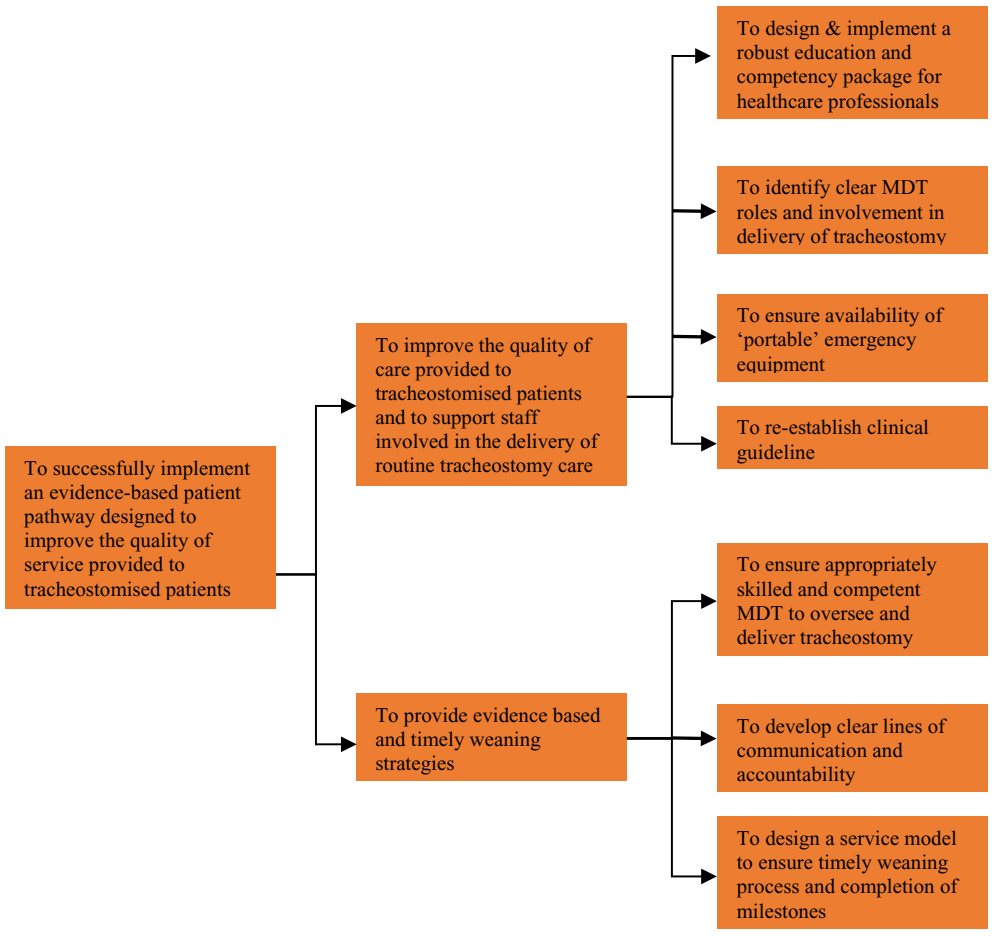


**Fig. 1.** Quality Improvement Driver Diagram.

REDCap™ was developed by an informatics team at Vanderbilt University and is brower-based. All healthcare organizations associated the global tracheostomy collaborative are able to input anonymous patient data regarding key tracheostomy outcomes e.g. adverse events, length of stay. The database also allows users to create reports based on the data inputted and compare their host organizations with other UK and international healthcare organizations.

Both the existing host organisation database and the REDCap™ database were in use for both the QI and pre-QI period and hence the process of data collection remained constant throughout. Adverse events data was collected via review of medical notes, discussion with nursing, medical and allied health professional staff (physiotherapy, speech and language therapy) and review of clinical incidences. This process was completed as standard and as part of the tracheostomy team review and therefore did not require any additional research approvals.

### *2.5. Statistics*

Data were analysed using SPSS v25 statistical software (SPSS, Chicago, Ill). All statistical tests were 2-sided, and significance was determined at the 0.05 probability level. Simple descriptive data are presented using median and inter-quartile range. Fishers exact test was utilised for analysis of nominal data.

### *2.6. Ethical considerations*

This project constituted an improvement in the standard care delivery with no randomisation and thus met the definition of a service evaluation under the NHS Health research authority guidelines [9]. As such ethical approval was not required, and because all outcome measures are collected as part of routine care, the need for consent was waived.

## 3. Results

### *3.1. Development of education, competency and patient care package*

Formal tracheostomy teaching was delivered by the tracheostomy team to 165 clinicians involved in tracheostomy care. Of these, 75.8% were nurses, 7.3% physiotherapists, 8.5% speech and language therapists, 7.3% medical and 1.2% other health care professionals.

Improvements in self-assessed confidence with knowledge and skills (assessed on a 1–5 scale, with 1 being not confident and 5 being very confident) were observed for all aspects of tracheostomy care (see Fig. 2), with greatest increases observed for 'methods of insertion' and 'communication and swallow'.

### *3.2. Standardisation and centralisation of tracheostomy equipment*

Standardisation and centralisation resulted in reduction in waste from over 50 tracheostomy tubes per year (at a cost of approximately £GBP2,800) to zero in 2018. During the QI project, the compliance with 'emergency tracheostomy blue box' availability increased from 5% to 100%.

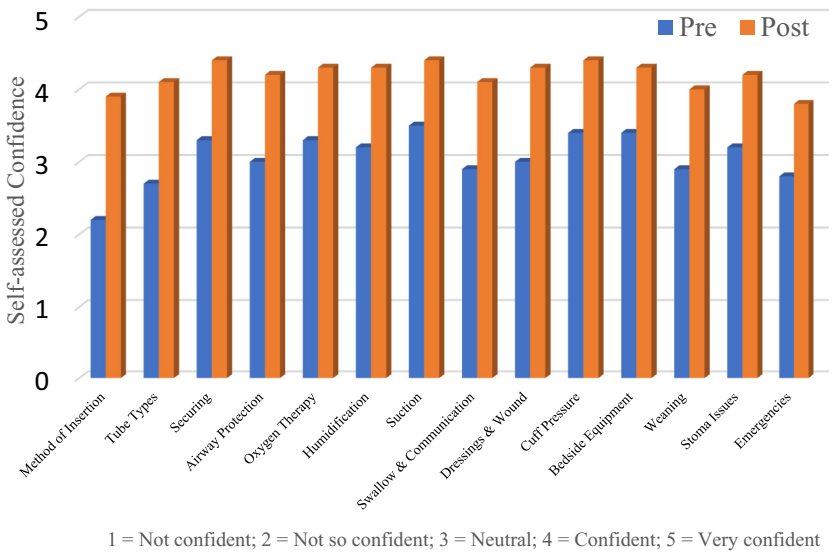


**Fig. 2.** Self-assessed clinician confidence pre- and post- tracheostomy teaching.

### *3.3. Development of tracheostomy team to co-ordinate and implement tracheostomy weaning and decannulation plans*

#### *3.3.1. Demographics*

All patients requiring a tracheostomy during the QI period were included for analysis (n = 76). This data was compared to baseline data from the same time period in 2017 (n = 81). The data is provided in Table 1. Demographic data for age, BMI and number of co-morbidities remained similar for both the pre-QI and QI period (see Table 1). Within the host organisation there is no protocol or standard operating procedure regarding the timing of insertion of tracheostomy, with the decision to undertake a tracheostomy being made on a case by case basis. This process did not change during the quality improvement project, however it is noted that the time to insertion was lower during the QI period (15 days to 12 days).

#### *3.3.2. Weaning milestones*

When comparing key metrics between baseline and QI period, median time from tracheostomy insertion to cuff down was reduced from 9 days compared to during QI at 7 days (P = .138). Median time from tracheostomy insertion to decannulation also reduced from 18 days to 13 days (P = .099). Further descriptive data shown in Table 2.

**Table 1**
Demographics.

| | Pre-QI | QI |
|---|---|---|
| Admission to tracheostomy (days) | 15.0 (12.5–17.0) | 12.0 (9.0–15.0) |
| Insertion type (Percutaneous: Surgical) | 34:44 | 36:39 |
| Age | 58 (56–63) | 59 (58–63) |
| Body mass index | 25.9 (24.4–26.1) | 26.0 (24.5–27.1) |
| Number of Co-morbidities | 1 (1–2) | 1 (1–1) |
| Admission speciality | | |
| Cardiology | 3 | 7 |
| ENT | 5 | 0 |
| General medicine | 19 | 9 |
| General surgery | 5 | 3 |
| Neurology | 2 | 4 |
| Neurosurgery | 33 | 32 |
| OMFS | 10 | 14 |
| Stroke | 0 | 2 |
| Thoracic surgery | 0 | 1 |
| Trauma and orthopaedics | 1 | 4 |
| Vascular surgery | 3 | 0 |

Data expressed as median (95% CI) or frequency.

The percentage of those achieving each weaning milestone was also calculated and shown in Table 2. Of note, those achieving tracheostomy decannulation was 63.0% pre-QI and 76.3% during the QI process (P = .084). Sub-analysis of specific factors such as percutaneous insertion compared to surgical insertion, indications for insertion or speciality of cohort ward were not completed. Due to the QI nature of the project it was deemed necessary to include all patients for analysis.

#### *3.3.3. Communication and swallow*

Prior to the QI project, Passy Muir speaking valves (PMVs) use was minimal. PMV's were not routinely used to facilitate verbal communication for patients receiving ventilation and therefore had no voice. During the QI project, 100% of appropriate patients were using the in-line PMVs to facilitate voice and therefore using verbal communication whilst ventilated. The median time from speech and language therapy referral to voicing trial was 0 days e.g. patients were trialled with speaking valve on initial contact from Speech and language therapist/tracheostomy team.

Pre QI-project, eating and drinking practice for patients who had a tracheostomy with or without mechanical ventilation was variable and Speech and Language Therapy (SLT) assessment for all patients prior to commencing oral intake was not occurring. During QI project, all patients were assessed by a SLT prior to commencing oral intake and 100% of those appropriate were safely eating/drinking whilst ventilated. The median time to swallow assessment by SLT was 8 days from initial contact reflecting clinical interventions such as optimising secretion management, establishing PMV regime prior to assessment.

#### *3.3.4. Adverse events*

There was a significant reduction in the incidence of adverse events during the QI period (P = .003). For those patients requiring a tracheostomy prior to the QI project, 21.1% had at least one tracheostomy related complication, compared to 7.6% during the QI intervention.

#### *3.3.5. Critical care and hospital length of stay*

Data for critical care and hospital length of stay for patients requiring a tracheostomy is summarised in Table 3. There was a clinically significant, but not statistically significant, reduction in total hospital length of stay (9.5 day reduction; P = .065).

**Table 2**
Tracheostomy weaning milestones.

| | 2017 (n = 81) | 2018 (n = 76) | |
|---|---|---|---|
| Cuff deflation completed (n, %) | 62 (76.5%) | 65 (85.5%) | P = .162 |
| Time to cuff deflation (days) | 9.0 (CI 6.5–13.0) | 7.0 (CI 6.0–9.0) | P = .138 (Z = −1.485) |
| Downsize completed (n, %) | 23 (28.4%) | 15 (19.7%) | P = .264 |
| Time to downsize (days) | 17.0 (CI 12.0–23.0) | 36.0 (CI 15.0–46.0) | P = .058 (Z = −1.899) |
| Decannulation completed (n, %) | 51 (63.0%) | 58 (76.3%) | P = .084 |
| Time to decannulation (days) | 18.0 (CI 13.0–21.0) | 13.0 (CI 9.0–16.0) | P = .099 (Z = −1.651) |

Data expressed as median (95% CI) unless otherwise stated.

## 4. Discussion

There is growing international evidence that specialist tracheostomy teams improve patient outcomes and enhance the weaning process [10,11]. However, despite this increasing evidence base, there is little evidence of appropriately resourced and funded tracheostomy teams within the UK, and where such teams exist, the focus is on tracheostomy ward rounds rather than providing both staff training and clinical contact [5,12].

Within this funded QI programme formal teaching was provided to 140 clinical staff, with the majority being staff nurses. The major focus of the teaching was emergency management processes for patients with tracheostomies and the requirement for appropriate emergency tracheostomy equipment to be available at the patient bedside. Analysis of pre- and post-training self-assessment showed non-significant increases in all aspects of tracheostomy care, with the greatest increases occurring in 'knowledge of tracheostomy insertion methods' and 'tracheostomy tube types'. Formal teaching was supported by tracheostomy competency documents developed by the Improving Tracheostomy Care collaborative and the National Tracheostomy Safety Project.

Weekly tracheostomy review by specialist therapy and nursing staff, in conjunction with staff training, resulted in improvements adverse event occurrence, tracheostomy weaning and patient length of stay. It is noted that there was a reduction in the time from admission to tracheostomy insertion. There was no change in policy regarding the timing of tracheostomy insertion within the host organisation and therefore possible reasons for this reduction in time are unclear. Similarly it is unclear if this reduction in time from admission to tracheostomy insertion had any effect on the results of the QI project.

In comparison to data from the previous year, patients included in the QI project had a reduction in adverse events (21.1% having at least one adverse event pre-QI compared to 7.6% in during the project). Similarly, there was a trend towards increased achievement of tracheostomy weaning milestones, most notably a 13.3% increase in decannulation rate (63.0% pre-QI compared to 76.3% during). Both times to cuff deflation and decannulation were reduced (9 days in 2018 versus 7 days in 2018; 18 days versus 13 days respectively). There was an increase in the time to tracheostomy tube downsize (17 days and 36 days for 2017 and 2018 respectively) but this was associated with a large reduction in the patients receiving a downsize as part of their tracheostomy wean (28.4% of patients pre-QI versus 19.7% during) suggesting a drive towards decannulation from the original tracheostomy tube rather than additional steps in the process. The result of the reduction in adverse events and improved tracheostomy wean resulted in non-significant reductions in critical care length of stay (LoS) (20.5 days [CI 17.0–25.0] pre QI and 19.0 days [CI 15.5–21.5] during QI) and a non-statically significant reduction in total hospital length of stay (52.5 days [CI 42.0–59.5] and 43 days [CI 29.0–54.9] for pre and during QI respectively). Despite being not statistically significant, both above reductions should be considered as clinically significant. The lack of statistical significant is likely the result of the sample size and the heterogeneity of the population included (e.g. range of presenting pathologies). As previously stated, no sub-analyses of data for indications for insertion, process of insertion or cohort ward were completed. It is likely that the QI project had greater influence on specific groups e.g. patients admitted with neurological or neurosurgical diagnosis as these had the longest weaning times and length of stay times. Future audits and evaluations will address these issues to allow more targeted input by the tracheostomy team.

However, when considering an average number of patients requiring tracheostomies per year (130 on average), these lengths of stay reductions were equivalent to releasing 195 critical care bed days and 1040 ward bed days.

The completion of this quality improvement project has reduced unnecessary waste of tracheostomy tubes. During 2017 approximately 80–100 tracheostomy tubes were disposed of as they were either beyond expiry dates, not appropriate for use (e.g. single lumen tubes), or not used within host organisation. The cost of these tubes was approximately £2800. During the QI project there was no recorded waste. In addition, staff reported significant benefit in the reduction in variation with clinicians reporting increased awareness of the types of tubes in use and where to get replacements if necessary.

There is a clear cost involved in supporting a tracheostomy team. For the current QI project, funding supported 0.3 whole time equivalent (WTE) physiotherapy, 0.3 WTE speech and language, 0.5 WTE staff nurse and one consultant Intensivist session per month. The annual cost for this was approximately £GBP59,000. However, using the relatively conservative cost model from the NHS Institute for Innovation and Improvement cost model (ward bed day £GBP225, critical care bed day £GBP1,321) [14] the observed bed day reduction provides estimated savings of £491,595. This combined with reductions in waste account for an annual cost reduction of £GBP435,395.

These results compare to existing literature which that multidisciplinary tracheostomy care contributes to a reduction in total tracheostomy time and increase speaking valve use for patients leading to improved quality of life [10]. A 2013 systematic review and meta-analysis demonstrated tracheostomy teams were associated with a reduction in the total tracheostomy time (mean difference of 8 days; 95% confidence interval [CI] 6 to 11 days; p ≤.01) [10]. The authors

**Table 3**
Critical care and hospital length of stay for patients requiring a tracheostomy.

| | 2017 (n = 81) | 2018 (n = 76) | |
|---|---|---|---|
| Critical care (days) | 20.5 (CI 17.0–25.0) | 19.0 (CI 15.5–21.5) | P = .655 (Z = −0.447) |
| Tracheostomy insertion to hospital discharge (days) | 35.0 (CI 25.1–46.0) | 26.0 (CI 16.0–44.0) | P = .232 (Z = −1.194) |
| Hospital admission to hospital discharge (days) | 52.5 (CI 42.0–59.5) | 43 (CI 29.0–54.9) | P = .065 (Z = −1.844) |

Data expressed as median (95% CI).

also concluded that there is insufficient evidence to determine that multidisciplinary tracheostomy teams reduce hospital or intensive care unit LoS [10]. Meta-analysis of the 3 available studies showed a mean difference of −14 days (p = .230). This compares to our QI project, which reported a median difference of −9.5 days (p = .065).

McGrath and colleagues [9] have also demonstrated the impact of tracheostomy QI projects. The authors evaluated the QI impact of the GTC in 4-UK based sites. In their project there was a significant trend month-by-month towards reducing LoS, with median hospital LoS reduced by 6 days over the 12 months of the project (CI 9.96–3.96 days) [8]. In one of the included sites ICU LoS reduced significantly over the duration of the project with a median slope of −0.11 (−0.25 to 0), equating to a reduction in median ICU LoS of 1.3 days over the project. The authors recognised that one of the sites (with the greatest number of patients requiring a tracheotomy) demonstrated the most significant improvements. However, like in our project, this was the site receiving the most investment including the establishment of a specialist multidisciplinary tracheostomy team.

We recognize that utilisation of QI and baseline data, as well as the lack of blinding of the study team to the outcomes is major weaknesses of our study. The results may be subject to temporal changes and measurement bias [13]. However, there were no other major QI projects or service developments introduced during the study period. Involvement with the ITC continued throughout both the pre- and during QI time periods and therefore is unlikely to have influenced the findings.

## 5. Conclusion

This QI project, supported by involvement with the Global Tracheostomy Collaborative and the NTSP's Improving Tracheostomy Care project, resulted in reductions in adverse events, improved patient safety, non-significant reduction in hospital length of stay and in time to achieve weaning milestones. Crude analysis based on length of stay reductions alone showed significant cost savings to the organisation, more than covering the costs of provision of the team. The results of this project have been used to gain substantive funding for a multidisciplinary tracheostomy team.

## Declaration of Competing Interest

The authors declare no declarations of interest.

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