Promoting subglottic secretion drainage: a quality improvement project in a UK critical care unit

Nicholas Weston Smith,1 Michael Spivey2

ABSTRACT

The aim of the study was to promote the practice of subglottic secretion drainage (SSD) in a UK critical care unit. SSD is a technique employed to reduce microaspiration of oropharyngeal secretions in patients with cuffed endotracheal airways. Aspiration of oropharyngeal secretions is the accepted cause of the majority of ventilator-associated pneumonia (VAP), a complication of invasive ventilation with high associated mortality. The plan–do–study–act methodology was employed. The local critical care patient database was searched for patients requiring mechanical ventilation via a tracheostomy tube with subglottic port in the 3 months prior to intervention. Patient records were interrogated for evidence of the practice of SSD. The intervention involved the introduction of a tracheostomy care bundle to be prescribed on insertion of a tracheostomy on the critical care unit, in combination with departmental teaching. The bundle included prompts for nursing staff to practise regular SSD and to complete a tracheostomy care plan at the end of shift. A total of 24 patients were included. A review of practice was conducted every 3 months for 1 year. This showed an improvement in documented evidence of SSD from 0% of days at baseline to 85.7% of days at 1 year. Implementation of a tracheostomy order set prescribing regular SSD resulted in an improvement in the practice of SSD in patients ventilated via tracheostomy. This has implications for patient outcomes and healthcare costs, given that SSD has been shown to reduce incidence of VAP.

PROBLEM

The Royal Cornwall Hospitals (RCH) NHS Trust is the major provider of acute care in Cornwall, catering to a population of around 430,000. There were 986 critical care admissions in 2019, 35 of whom had tracheostomies at some point during their critical care stay.

Subglottic secretion drainage (SSD) is a practice designed to reduce the incidence of ventilator-associated pneumonia (VAP) through preventing microaspiration of oropharyngeal secretions. Specific oral endotracheal and tracheostomy tubes are available with subglottic ports to enable regular SSD. The RCH critical care unit uses tracheostomy tubes with subglottic ports as standard.

The focus of the project was to promote the use of SSD in those patients ventilated via a tracheostomy. We aimed to achieve a practice of SSD every 6 hours in all patients ventilated via a tracheostomy on the critical care unit within a year of commencing the project.

Previous local attempts had been made to reduce VAP incidence. Monitoring cuff pressure and maintaining head of bed elevation had become staples of local practice through their inclusion in checklists as part of daily medical reviews. However, the practice of SSD at RCH was not routine on commencing the project. Indeed, baseline data demonstrated no evidence of regular SSD in those patients ventilated via tracheostomy in the 3 months prior to commencing the project. This presented an area for quality improvement, given the evidence that regular SSD reduces rates of VAP.1

A quality improvement project using plan–do–study–act (PDSA) cycles was thought to be an appropriate method for promoting the practice. A stepwise approach would enable the team to evaluate the impact of changes. Further modifications could then be made to maximise the effect and sustainability of the intervention.

BACKGROUND

VAP is a pneumonia occurring more than 48 hours after endotracheal intubation.2 VAP is the most common form of nosocomial infection on critical care units, with a rate of 13.6 per 1000 ventilator days.3 4 It has an associated mortality between 10% and 50%, and is associated with significant morbidity, critical care length of stay, antimicrobial use and healthcare costs.1 5–7

The accepted pathophysiology of VAP is microaspiration of oropharyngeal and gastric secretions.8 The presence of an endotracheal or tracheostomy tube interferes with normal airway protection mechanisms including swallowing and coughing and may increase oropharyngeal secretions through irritation

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of the mucosa. Treatment of VAP remains a challenge, not least due to high rates of antimicrobial resistance within the critical care population, and therefore there is a focus on prevention. Several preventative strategies have been developed to reduce VAP incidence. SSD is one such strategy that works by draining pooled secretions from above the cuff of the endotracheal or tracheostomy tube, reducing the risk of microaspiration.

SSD has been the subject of significant research. In the past decade, three meta-analyses have been published in an attempt to understand the potential benefits of SSD. The first, published in 2011, described a risk ratio for VAP of 0.55 (95% CI 0.46 to 0.66, p<0.00001) with SSD, as well as reductions in critical care length of stay and duration of mechanical ventilation. The second, published in 2016, also demonstrated a significant risk ratio for VAP of 0.58 with SSD but did not establish significant reductions in critical care or hospital length of stay, duration of mechanical ventilation or mortality. More recently in 2020, a third meta-analysis again demonstrated a significant reduction in VAP with SSD, as well as a reduction in mortality.

The use of oral endotracheal and tracheostomy tubes with SSD ports has been incorporated into national guidance in the USA for those patients expected to require greater than 48 hours of mechanical ventilation—the timeframe over which a VAP develops. Locally, all tracheostomies inserted on the RCH critical care unit have a subglottic port to enable SSD as it is anticipated that the majority of this population will require greater than 48 hours of mechanical ventilation via their tracheostomy.

In addition to SSD, other evidence-based measures for reducing the incidence of VAP include:

- Maintaining endotracheal cuff pressures.
- Head of bed elevation to 30°–45°.
- Minimising sedation and muscle relaxant.
- Minimising duration of mechanical ventilation.
- Selective oral and gastric decontamination.

Many centres have successfully implemented care bundles combining a selection of these strategies, demonstrating a subsequent reduction in their incidence of VAP. Locally, it was decided to first focus on promoting regular SSD before considering its inclusion within a VAP prevention bundle.

MEASUREMENT

Population

The RCH critical care unit uses the Philips Medical Systems CareVue clinical information system. This system allows for electronic documentation and prescription, and enabled identification of all patients that received mechanical ventilation via a tracheostomy at RCH by the local data collector. The following exclusion criteria were applied as these patients would not routinely have a tracheostomy with SSD port inserted:

- Those patients admitted to the critical care unit with a tracheostomy following head and neck surgery.
- Those patients repatriated to the critical care unit from other centres.

Outcome

The aim of the project was to promote regular SSD. The major outcome measured would therefore be the number of days on which regular SSD every 6 hours occurred as a proportion of the number of days ventilated via a tracheostomy. Once patients were identified, the following data were collected through a review of the electronic patient notes within CareVue by the authors:

- The number of days ventilated via the tracheostomy (ventilator days).
- The number of ventilator days on which regular SSD was documented.

If there was documentation of SSD at a minimum of every 6 hours within a 24-hour period, then this was included as evidence of regular SSD. If this requirement was not met within a 24-hour period, then regular SSD was deemed not to have occurred on this day. The number of ventilator days on which SSD occurred as a percentage of total ventilator days would provide the outcome measure of SSD compliance.

Baseline measurement

The baseline measurement identified nine patients during the 3-month period of November 2018 to January 2019. Interrogating the electronic patient notes within CareVue revealed that these nine patients combined for 111 ventilator days.

Ongoing measurement

It was decided that the team would repeat the cycle of data collection every 3 months. This would enable sufficient time for interventions to be introduced and modified between cycles while providing a manageable study population for each cycle. At each stage, suitable patients were identified, and exclusion criteria were applied as stated earlier. The electronic notes were then reviewed by authors for evidence of regular SSD.

DESIGN

A key component of the design was to incorporate the intervention into the CareVue information technology system. All documentation and prescribing on the RCH critical care unit are done on CareVue, and any change had to fit with current CareVue practices. It was expected that by using existing IT systems to implement change, the outcomes would be more likely to become accepted practice, and therefore any improvements more likely to be sustainable.

The initial intervention was the development of a prescription for SSD every 6 hours within CareVue. The functionality of CareVue means that when an item is prescribed, nursing staff are reminded to carry out the prescription at the allocated time. Once the prescription
is carried out, nursing staff document that it has been done via checking a box. By making use of the prescribing functionality of CareVue, the team would be adapting an existing process proven to be reliable for the prescription of medications, to meet the aim of ensuring regular SSD.

The prescription was incorporated into a new ‘care bundle’ to further promote tracheostomy nursing care. This care bundle, once prescribed, would include the prescription for SSD every 6 hours, a reminder for nursing staff to complete a tracheostomy care plan every 12 hours within their shift (an existing CareVue document), and a reminder for clinicians to consider a change of tracheostomy at 90 days.

The quality improvement team included a trainee doctor, a staff nurse and an intensive care consultant. Inclusion of a staff nurse was important in promoting the project among nursing staff, the group that would be taking on the extra work of increased SSD. The project required working closely with local IT staff to design and implement effective changes within the CareVue system. Working as a multidisciplinary team would help to provide a good understanding of the processes involved in both prescribing and carrying out prescriptions on the critical care unit.

Patients and the public were not involved in the design, conduct or reporting of the quality improvement project.

**STRATEGY**

**PDSA cycle 1**

The care bundle was implemented in February 2019 following a baseline measurement that demonstrated no evidence of regular SSD. The intervention resulted in a moderate improvement in SSD compliance. Results following the first cycle were presented at a departmental governance meeting, and this was an opportunity to promote the project, as well as the benefits of SSD.

While results following the first cycle were encouraging, the intervention had not achieved the stated aim of regular SSD for all patients ventilated via a tracheostomy. Further changes would therefore be needed. It was noted that when the care bundle had been prescribed, compliance with SSD targets was good; however, the bundle had only been prescribed in two of four patients. It became clear that the initial intervention relied heavily on the assumption that medical staff knew about the existence of, and would remember to prescribe, the bundle for appropriate patients.

**PDSA cycle 2**

The next stage was to focus attention on ensuring that the care bundle was being prescribed. The existing tracheostomy insertion documentation on CareVue was modified to include a tick-box reminder to prescribe the tracheostomy care bundle. This would prompt the clinician responsible for inserting the tracheostomy to prescribe the care bundle immediately after insertion. It was anticipated that this prompt would ensure that the care bundle was prescribed for every patient who had a tracheostomy inserted on the unit. The next round of data collection demonstrated a further improvement over the subsequent 3 months. Again, results were presented at the departmental governance meeting, providing a further opportunity to remind clinicians to prescribe the care bundle.

**PDSA cycle 3**

A further 3 months of data collection demonstrated a consistent increase in the occurrence of regular SSD. Interestingly, further analysis of the data demonstrated that over the previous two rounds of data collection, when the care bundle had been prescribed, compliance with regular SSD remained high.

**RESULTS**

Over the course of 1 year, 24 patients were included in the data for a total of 353 ventilator days. Rates of SSD compliance as the number of days on which regular SSD occurred as a proportion of the total number ventilator days increased throughout the study period (table 1).

| Table 1 | Number of days ventilated via tracheostomy, number of days ventilated with regular SSD and percentage of days ventilated with regular SSD within each 3-month cycle |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baseline | PDSA cycle 1 | PDSA cycle 2 | PDSA cycle 3 |
| Number of patients | 9 | 4 | 8 | 3 |
| Ventilator days | 111 | 65 | 142 | 35 |
| Number of ventilator days with regular SSD | 0 | 20 | 120 | 30 |
| SSD compliance (%) | 0 | 30.8 | 84.5 | 85.7 |

PDSA, plan–do–study–act; SSD, subglottic secretion drainage.
CareVue contains all documentation of nursing and medical care on the unit. Owing to consistently excellent documentation by nursing staff, there were minimal missing data. When SSD was not done, the reason for this was described within CareVue. If the reason was thought to be adequate (eg, absence from the unit), then this data point was included as an episode of SSD occurring. If there was no reason, or an inadequate reason documented, then this was included in the results as regular SSD not occurring.

LESSONS AND LIMITATIONS

Lessons were learnt throughout the process and the project had its strengths and limitations. Using the functionality of an IT system to implement quality improvement interventions, while incorporating the expertise of a multidisciplinary team meant that the changes introduced combined well with current practice. However, smaller than expected patient numbers and an uncertainty over whether the measured change reflects an improvement in documentation or a real change in practice are significant drawbacks.

The major strength of this project was the ability to work within an integrated IT system. Using an existing system meant no extra training was required for staff carrying out the intervention or collecting the data. There were no additional forms or stickers, reducing the burden of the intervention for nursing staff. Being able to use the functionality of CareVue to introduce a prescription for SSD helped to ensure good compliance with the intervention from nursing staff.

A further strength of the project was the multidisciplinary nature of the team, as well the availability and expertise of local IT staff. The member of staff responsible for making changes within CareVue was himself a staff nurse and knew the system’s strengths and limitations. Having medical and nursing staff involved in designing the intervention meant that there was a good understanding behind the processes involved with prescribing, carrying out prescriptions and documenting care on the unit. This resulted in an intervention that was reliable and sustainable.

Collecting a second round of data after 3 months and analysing the results helped the team to modify the intervention as the project was progressing. It was noted at this stage that the care bundle when prescribed was leading to excellent documentation of SSD; however, it had not been prescribed in half of the patients, leading to only 30.8% compliance with regular SSD. Redesigning the process to promote care bundle prescription was a key step in maximising the effect of the intervention at an early stage. Waiting a year to reaudit would have resulted in time wasted.

An added benefit of an online system was the ease with which records can be interrogated, allowing for quick and complete data collection. Easy data collection makes quality improvement more accessible, and projects are more likely to be completed when full data are readily available.

The project was not without its limitations. It is difficult to determine whether the improvement in regularity of SSD was really a change in practice or simply the result of the intervention.

| Table 2 | Compliance with regular SSD with regard to whether the care bundle had been prescribed |
|----------------|---------------------------------------------------------------|
|                | PDSA cycle 1 | PDSA cycle 2 | PDSA cycle 3 |
| Care bundle prescribed | y | n | y | n | y | n |
| SSD compliance (%) | 100 | 0 | 97.6 | 0 | 100 | 0 |

n, no; PDSA, plan–do–study–act; SSD, subglottic secretion drainage; y, yes.
of more complete documentation. At baseline, document-
tation of SSD was very sporadic and there were no days
on which any patient had four episodes or SSD every 6
hours documented. However, at this time, there was no
dedicated location within CareVue to document SSD if it
was carried out. The intervention provided a reminder to
carry out SSD but also a place in which staff could docu-
ment that it was being done. Whether the results simply
reflect better documentation or indeed better practice is
unclear. A way around this issue would have been to survey
nursing staff at baseline to get a measure of whether they
were doing regular SSD in appropriate patients or not.

Over the course of the last 6 months of data collec-
tion, two patients were not prescribed the care bundle.
Both were patients who had their tracheostomy with
SSD port inserted in theatre on behalf of the critical
care unit, bypassing the tick-box reminder included in
the tracheostomy insertion checklist. The tracheostomy
care bundle was not prescribed and neither patient had
any documented evidence of SSD as a result. This was an
unanticipated failure of the design of the intervention,
resulting in a cohort of patients bypassing the reminders
put in place. This should form a focus for further quality
improvement work.

Finally, patient numbers were lower than expected. The
initial baseline period of 3 months of data collection iden-
tified nine patients for a combined 111 days. Subsequently,
the above was determined that 3 monthly intervals should provide
reasonable patient numbers. Unfortunately, the subse-
quent 3 months included only four patients (63 ventilator
days), and the final 3 months of data collection included
three patients (35 ventilator days). If a single patient in
these cohorts was not prescribed the care bundle, then
it led to major changes to the results. Conversely, having
small patient numbers did allow us to analyse each
patient’s records in detail. This helped us to determine
the reasons why the bundle had not been prescribed or
why SSD had not happened when prescribed.

CONCLUSION

Our aim was to achieve regular SSD every 6 hours in all
patients ventilated via a tracheostomy with dedicated
subglottic port inserted at RCH. After 1 year, we have
demonstrated an improvement in the documentation
of SSD every 6 hours from 0% to 85.7% of days. While
this falls below our 100% target, it clearly represents an
improvement. The reasons for falling below our target
were not catching those patients that had a tracheostomy
with SSD port inserted in theatre within the intervention,
and this cohort should be the focus of further quality
improvement.

The cost of a VAP in a UK critical care unit has been
calculated in the region of £9000, while studies in the USA
have calculated costs between $10000 and $40000.13–15
Cost analyses have shown that implementing regular SSD
is a cost effective strategy, in spite of the additional cost of
the subglottic port endotracheal tube.16–18 Meta-analysis
has given a number needed to treat of 11 for SSD.9 Our
project did not involve any additional material costs given
tracheostomies with subglottic ports were already being
used at the RCH critical care unit. Assuming similar
patient numbers to the study year (n=24), if our project
creates a sustained improvement in SSD with 85% compli-
ance over the coming year, we would expect to prevent
around two cases of VAP and its associated economic
burden.

The link between regular SSD and reduced rates of
VAP is well documented. Given that the methodology
described by this project has been shown to promote
regular SSD, it would be interesting to note whether it has
impacted on local rates of VAP. In order to evaluate this,
the project would be required, the intervention arm of
which could employ the processes described within this
report. While the project focused on those patients with
tracheostomies, there is scope for expansion to include
patients ventilated on critical care via oral endotracheal
tubes. Although not used at RCH currently, oral endo-
tracheal tubes are available with subglottic ports for use
when prolonged mechanical ventilation is anticipated. It
would be interesting to note how centres that employ the
use of oral endotracheal tubes with subglottic ports have
gone about creating a culture of regular SSD. Indeed,
units employing these endotracheal tubes may find this
methodology of promoting SSD helpful.

Finally, all quality improvement work should be sustain-
able. While junior doctors rotate, nursing staff are often
employed on a longer-term basis. The project will be
ongoing and led by nursing staff with the aim of creating
a sustained improvement in patient care and outcomes.
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