Outcomes of patients with spinal cord injury before and after introduction of an interdisciplinary tracheostomy team

Tanis S Cameron, Anita McKinstry, Susan K Burt, Mark E Howard, Rinaldo Bellomo, Douglas J Brown, Jacqueline M Ross, Joanne M Sweeney and Fergal J O'Donoghue

ABSTRACT

Objectives: To assess outcomes in patients with spinal cord injury (SCI) and a tracheostomy tube (TT), before and after the introduction of a tracheostomy review and management service (TRAMS) for ward-based patients.

Design: Matched-pairs design with two cohorts, before and after the intervention.

Setting: 900-bed tertiary hospital in Melbourne, Victoria.

Participants: SCI patients with a TT that was removed: 34 patients in the post-TRAMS period (September 2003 to September 2006) were matched to 34 from the pre-TRAMS period (September 1999 to December 2001).

Intervention: TRAMS was introduced as a consultative team of specialist physicians, clinical nurse consultants, physiotherapists and speech pathologists. The team coordinated tracheostomy care, conducted twice-weekly rounds, and provided policy, education, and support.

Main outcome measures: Comparison of length of stay (LOS), duration of cannulation (DOC), improved communication through use of a one-way valve, number of adverse events and related costs.

Results: Median patient LOS decreased from 60 days (interquartile range [IQR], 38–106) to 41.5 days (IQR, 29–62) ($P = 0.03$). The pre-TRAMS median DOC decreased from 22.5 days (IQR, 17–58) to 16.5 days (IQR, 12–25) ($P = 0.08$). Speaking-valve use increased from 35% (12/34) to 82% (28/34) ($P < 0.01$). Median time to a valve trial decreased from 22 days (IQR, 13–44) to 6 days (IQR, 4–10) after TT insertion ($P < 0.01$). There were two tracheostomy-related medical emergency calls pre-TRAMS and none post-TRAMS. There were no tracheostomy-related deaths in either group. The annual cost savings from implementing TRAMS were about eight times greater than the cost of service provision.

Conclusion: Implementing a tracheostomy review and management service improved outcomes for SCI patients: they left acute care sooner, spoke sooner, and the TT was removed earlier, with associated cost savings.

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A tracheostomy tube facilitates clearance of bronchial secretions, bypass of upper airway obstruction, weaning from mechanical ventilation and earlier discharge from the intensive care unit.[1,2] Risks include loss of the artificial airway (via obstruction or dislodgement), tracheal stenosis, infection and bleeding.[2,3] Tracheostomy tubes (TTs) cause communication difficulties, patient distress and discomfort, and can delay discharge. Tracheostomy care requires specialised expertise and input from a number of disciplines,[4-6] but patients are often cared for in wards where expertise is limited.[4-6]

Patients with spinal cord injury (SCI) may require extended periods of tracheal cannulation and hospital stay because of the need for ventilation or airway clearance, or upper airway changes after surgery. In Australia, there are about 10 000 people with SCI, and about 300–400 new cases annually, with the highest incidence in the 15–24-years age group.[7] At our centre, SCI patients are the largest subgroup of patients receiving TTs. Level and completeness of injury and age are prime considerations when interpreting outcomes for patients with SCI. The American Spinal Injury Association (ASIA) has devised an international classification system for SCI severity.[8] Patients with C4 ASIA A and B (motor complete) injuries have incomplete diaphragmatic innervation and are often slow to wean from ventilation.[9,10]

Before 2002, there was no dedicated team to coordinate tracheostomy care across our centre. There were safety issues for this high-risk patient group, and staff reported they felt ill prepared to deal with their needs. Data collected on SCI patients at our centre suggested that TTs remained in situ for long periods, with associated lengthy hospital stays. In May 2002, we established the comprehensive, interdisciplinary Tracheostomy Review and Management Service (TRAMS) to improve care of patients with a TT across the centre.

Here we report the impact of TRAMS on SCI patients. We hypothesised that this structured, coordinated approach would lead to measurable improvements in care. Past evidence supporting this hypothesis is scant, comprising a few studies in heterogeneous patient populations other than SCI.[4,6,11,12]

Methods

This study was conducted at the acute campus of Austin Health, a 900-bed tertiary hospital operating across acute, subacute and rehabilitation campuses. The Victorian Spinal Cord Service (VSCS) at Austin Health is a statewide service that provides acute management and rehabilitation for patients with traumatic SCI from Victoria, Tasmania and southern New South Wales.

We used a matched-pairs design of two cohorts of SCI patients (before and after the introduction of TRAMS). We excluded SCI patients with no neurological deficit, those who required permanent tracheostomy, and those who died of non-TT related causes. Patients treated after the introduction of TRAMS were individually matched to patients treated before its introduction, first by the level of SCI, then injury severity, and finally age. Injury severity was defined by ASIA score. The level and severity of injury were assessed by the VSCS. Patients were matched within one level for spinal cord injury and one grade for ASIA score. Age was matched within 10 years.

The TRAMS model

TRAMS was introduced as a consultative team of respiratory and ICU doctors, clinical nurse consultants, physiotherapists and speech pathologists. This interdisciplinary team coordinated all practices surrounding tracheostomy management across three campuses and into the community. It also provided support and education to patients, caregivers and staff.

Box 1 lists the services and education provided by TRAMS. The team conducted twice-weekly rounds of all ward-based patients with a TT (excluding ear, nose and throat patients). Patients were seen between rounds as required. The TRAMS team monitored upper airway, respiratory function and general medical conditions, and consulted on readiness for TT removal. Before recommending decannulation of the TT, the team conducted a risk–benefit analysis, assessing respiratory and medical status, airway patency, airway clearance and airway protection, along with other factors, such as need for further surgery or cognitive decline.

Team members worked part-time with TRAMS and also elsewhere in the centre within their own disciplines. TRAMS now has a full-time clinical nurse consultant, a role that was part-time at the time of the study.

The TRAMS service delivery model was shared with numerous other facilities, one of which has reported on its experience.[6]

Data collection

We collected data for pre- and post-TRAMS periods. Pre-TRAMS data were collected retrospectively by file audit of the 27 months before the implementation of TRAMS (1 September 1999 – 31 December 2001), and post-TRAMS data were collected prospectively over 37 months of TRAMS practice (1 September 2003 – 30 September 2006). A 20-month interval was left between the two cohorts to minimise possible contamination effects during the period in which new practices were introduced.

Information was collected on demographics; level of spinal injury (ASIA level); date and type of TT insertion; mechanical ventilation and ICU hours; length of acute hospital stay (LOS); duration of cannulation (DOC); frequency and timing of use of a one-way speaking valve (Passy–Muir, PMV007, Irvine, Calif, USA); and adverse events, including medical emergency calls (specifically "code blue" calls) and tracheostomy-related deaths.

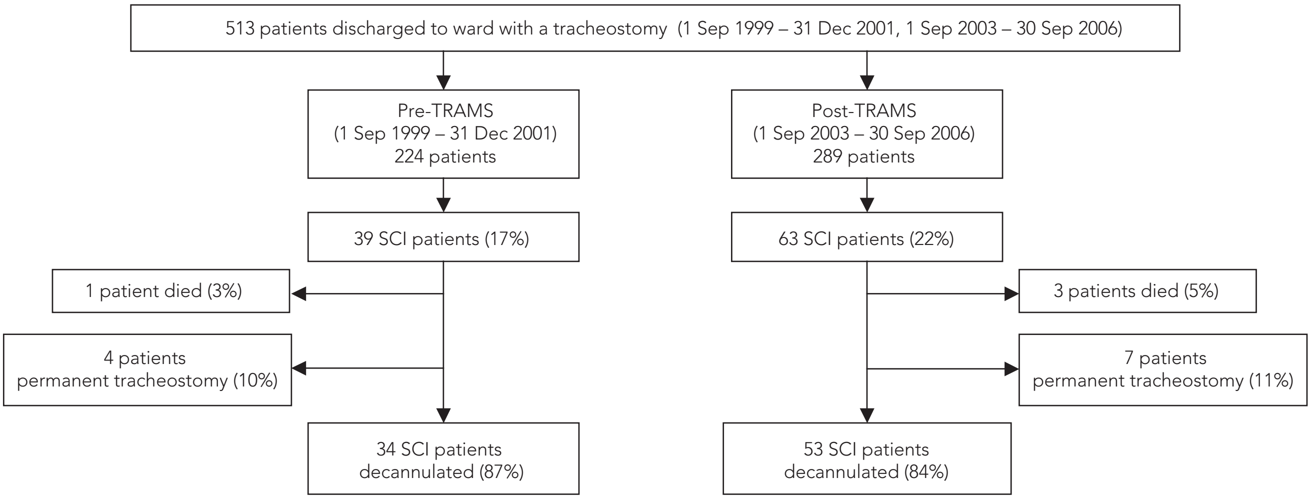
Box 1. Services provided by the Tracheostomy Review and Management Service (TRAMS)

- Twice-weekly ward rounds by the TRAMS team for all ward-based patients with a tracheostomy tube (except ear, nose and throat in-patients).
- Patient consultations on other days as needed.
- Patient support, and education for ward staff.
- Regular assessment of patient readiness for decannulation.
- Support of patients with long-term tracheostomies in the community, with equipment, consumables, tube changes and education.
- Tracheostomy resource and equipment library.
- Implementation and review of interdisciplinary tracheostomy policy and procedures:[16]
  - Overarching tracheostomy policy
  - Procedures, including emergency procedures and decannulation.
- Critical incident review.
- Delivery of interdisciplinary tracheostomy education via:
  - TRAMS website (http://www.tracheostomyteam.org)
  - TRAMS intranet site for all staff to access policies and educational resources
  - Interdisciplinary educational resources, including a patient education brochure *About your tracheostomy;* tracheostomy e-learning packages;[17] and an interdisciplinary tracheostomy policy and procedures.[18]
  - TRAMS Tracheostomy Training Program day workshops.
  - Competency training programs.

Data analysis

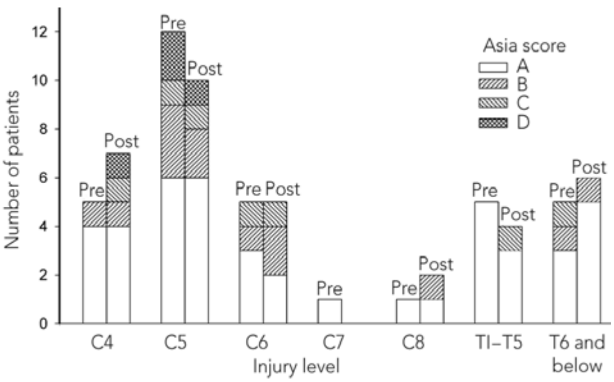
We calculated approximate costs and savings related to implementing the TRAMS team. The approximate cost of a bed-day for our patient cohort was determined. Acute hospitalisation costs were calculated using individual patient costs for patients with a tracheostomy in the spinal unit over the 12-month period July 2005 to June 2006. These costs were determined from the in-house clinical costing system, and included nursing and medical costs,

Figure 1. Flow chart of patients in the study



SCI = spinal cord injury. TRAMS = Tracheostomy Review and Management Service.

Figure 2. Levels of spinal cord injury* of patients in the pre- and post-TRAMS cohorts



* Level and severity of injury were graded according to the American Spinal Injury Association (ASIA) classification system.

plus associated costs such as allied health, pathology, pharmacy and imaging. Savings were calculated from the equation:

(Mean reduction in LOS × bed-day cost × number of patients) – (cost of implementing the service × proportion of TRAMS service spent on SCI patients).

Normality was assessed for all analyses, and appropriate non-parametric methods were applied as necessary, using a matched–pairs analysis. The relationships between introduction of the TRAMS program and LOS, DOC and time to use of a one-way valve were assessed using the Wilcoxon sign-rank test. The relationship between introduction of TRAMS and frequency of use of a one-way valve was assessed using the χ^2 test. A Kaplan–Meier survival analysis and log-rank test for equality of survival functions were used to assess one-way valve use. All data analysis was performed using Intercooled Stata version 9.0 for Windows (Statacorp, College Station, Tex, 2005). Statistical significance levels were set at $P < 0.05$.

The study received approval from the Austin Health Human Research Ethics Committee.

Results

During the study periods, 513 patients had a TT: 224 in the pre-TRAMS group and 289 in the post-TRAMS group (Figure 1). Of these 513 patients, 102 had an SCI (the largest single group): 39 in the pre-TRAMS group and 63 in the post-TRAMS group. In the pre-TRAMS SCI group, one patient died (non-tracheostomy-related death), and four had a permanent tracheostomy. In the post-TRAMS SCI group, three died (non-tracheostomy-related death), and seven had permanent tracheostomies. These patients were excluded from the study, leaving 34 decannulated SCI patients in the pre-TRAMS group and 53 in the post-TRAMS group.

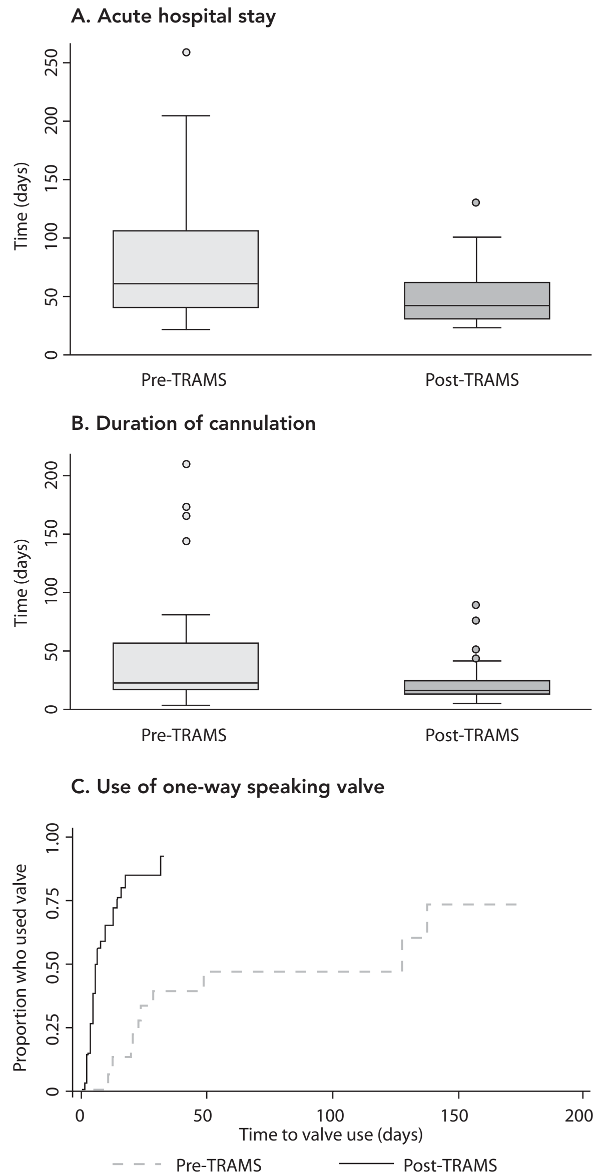
The 34 patients in the post-TRAMS group were matched to patients in the pre-TRAMS group by level of SCI, followed by ASIA score (Figure 2) and then age. There were no statistically significant differences between the groups in sex (pre-TRAMS, 70% male; post-TRAMS, 82% male), age (pre-TRAMS, 35.5 years; interquartile range [IQR], 23.8–51.8; post-TRAMS, 44 years; IQR, 30.8–51.0) ($z = 1.319$, $P = 0.19$) or type of tracheostomy insertion (pre-TRAMS, 70% surgical; post-TRAMS, 73% surgical). There were also no statistically significant differences between the groups in the number of hours of mechanical ventilation (pre-TRAMS, 221.5 h; IQR, 54.8–371.3; post-TRAMS, 200 h; IQR, 103.0–321.8) ($z = 0.368$, $P = 0.71$) or ICU hours (pre-TRAMS, 352.5 h; IQR, 132.5–436.0; post-TRAMS, 260.5 h; IQR, 168–533) ($z = 0.521$, $P = 0.60$).

Median length of acute hospital stay was reduced from 60 days pre-TRAMS (IQR, 37.8–106.5 days) to 41.5 days post-TRAMS (IQR, 28.75–61.75 days) ($z = –2.137$, $P = 0.03$) (Figure 3A.) The pre-TRAMS median duration of cannulation was 22.5 days (IQR, 17–58) compared with 16.5 days (IQR, 12–25) ($z = –1.761$, $P = 0.03$) post-TRAMS (Figure 3B).

Use of a one-way valve increased from 35% (12/34) to 82% (28/34) ($P < 0.01$). One-way valves were used earlier post-TRAMS, with the median time to valve use reduced from 22 days (IQR, 13–44 days) to 6 days (IQR, 4–10 days) post-TT insertion ($z = –2.580$; $P < 0.01$). Before the introduction of TRAMS, half the patients had used a one-way valve within 130 days, post-TRAMS half had used a one-way valve within 10 days (Figure 3C).

There were two tracheostomy-related code blue calls for patients in the pre-TRAMS group and none in the post-TRAMS group. There were no tracheostomy-related deaths in either group. The approximate cost savings from implementing TRAMS for SCI patients was A$1 240 933 over 37 months, or A$402 465 annually.

Figure 3. Major outcome measures pre- and post-implementation of TRAMS



A. and B. *Box plots show median (central line), 25th and 75th percentiles (box limits), lowermost and uppermost values within 1.5× interquartile range of the box limits (whiskers), and outliers (○).*
C. *Kaplan–Meier survival analysis and log-rank test.*

Discussion

Following the introduction of a coordinated, interdisciplinary team approach to tracheostomy care, there was a reduction in time to decannulation and acute hospital length of stay, and earlier, more frequent use of one-way speaking valves in SCI patients, the largest subgroup of TT patients at our centre. Implementing the TRAMS team for SCI patients also resulted in significant cost savings.

The goals of tracheostomy management in the ward are to maintain airway patency, to optimise the quality and safety of care, and to remove the tube as soon as safely possible. Ideally, the TT is removed before transfer to a less acute setting, where rehabilitation and recovery can continue. In this study, we demonstrated a median reduction in acute LOS of 18.5 days in SCI patients with a TT after the introduction of the TRAMS team. LOS is influenced by a number of factors, but the post-TRAMS reduction is encouraging, and is likely related to the fact that TTs were removed earlier. We adhered to a structured decannulation and documentation process. There was a median reduction of 6 days in DOC in the post-TRAMS group, equivalent to a 27% reduction in comparison with the pre-TRAMS group. A reduction in DOC has the potential to enable earlier return to normal speech and swallowing, as well as reducing the risk of both local and respiratory tract infection and tracheal complications.[2,3] In addition, patients and caregivers view removal of the TT as a very positive step. The reduction in DOC post-TRAMS reflects the same trends as reported in other studies of non-SCI patients.[4,6,11,12]

An important change in patient care after implementation of TRAMS was the significant improvement in patients' ability to communicate. The presence of an inflated cuff on a tracheostomy tube leads to either complete loss or significant impairment of speech, causing patients to experience feelings of isolation, vulnerability and frustration. Bergbom-Engberg[13] reported that the inability to communicate resulted in patients feeling agony or panic. Furthermore, safety of care and quality of life can be compromised when a patient is unable to communicate.[11] Cuff deflation and placement of a one-way valve on the TT enable the patient to voice, cough, and swallow more easily.[7,14-17] Our findings show a significant increase in both the number of patients who used a one-way speaking valve ($P < 0.001$) and a significant reduction in days to initial valve use ($P < 0.001$). By introducing a one-way valve in more patients and at an earlier time, we enabled more patients to communicate with relatives and staff during a period of great vulnerability. At our centre, the use of the valve is also an important step in moving the patient towards decannulation. Extensive interdisciplinary education on the use of one-way speaking valves was one of a number of practice changes instituted post-TRAMS.[18,19]

Measurement of adverse events is inherently challenging in a two-cohort before-and-after study, as adverse events are likely to be under-reported in the retrospective group. However, code blue calls and deaths remained low post-TRAMS, even though TTs were removed earlier than in the pre-TRAMS group.

Some evidence has suggested that a team-based approach to tracheostomy management improves outcomes for specific patient groups. In 2006, Frank et al[12] reported a study before and after introduction of a multidisciplinary team in a rehabilitation centre specialising in treatment of patients with paraplegia and severe brain damage. The team implemented a swallowing therapy and decannulation program for patients with severe neurogenic dysphagia, including those who were in a persistent vegetative state. They demonstrated significant reductions in cannulation time but did not report on patients with SCI as the primary diagnosis. Hunt and McGowan[11] described their approach to tracheostomy management by a specialist team comprising a physiotherapist, speech pathologist, nurse and anaesthetist. They evaluated their service over a 3-year period after implementation of the team, but did not report pre-intervention data, making it difficult to determine the impact. They reported weaning times over the 3 years of the service with a decreasing trend for surgical patients, but more variable weaning times for medical patients.

Norwood et al[4] investigated the effects of introducing a specialist tracheostomy outreach service comprising a physiotherapist and an ICU outreach nurse in an acute-care teaching hospital. They reported results before and after implementation of the team within the ICU and ward settings, and documented a significant decrease in the number of patients discharged to the ward with a TT, and a reduction in the number of complications for ward-based patients. Although the study reported outcomes pre- and post-service implementation for all patients with a TT, it did not provide primary diagnostic information. Patients appeared to be heterogeneous, and it is unclear whether they included SCI patients.

More recently, Tobin and Santamaria[6] reported on their intensivist-led tracheostomy team in the ward setting. They found a significant trend to reduced decannulation times and also a significant reduction in hospital LOS and hospital stay after ICU discharge. They found improved decannulation rates across the period of the study, with the effect of the team intervention improving over time. SCI patients were not identified as part of their patient cohort.

In our study, the pre-TRAMS and post-TRAMS cohorts were managed at the same centre, under the same primary SCI team. The study had some limitations as the groups were not randomised, there was no blinding, and the pre-intervention data were collected retrospectively. Randomisation was not considered logistically possible as TRAMS was implemented to treat all patients, as well as to educate staff on evidence-based practices; the new model and pre-existing practices could not operate simultaneously within the spinal unit. Matching the participants by the major confounding variables for the study outcomes (level and severity of SCI and age) should have minimised bias.

The median age in the post-TRAMS cohort was slightly higher, although not significantly so. If this had any effect, it would be expected to increase LOS in this group. The types of tracheostomy insertions (surgical versus percutaneous) and length of ICU stay were similar in the two groups, again suggesting they were well matched. There were no other significant changes in the management of these patients in our centre during the intervention period.

Several crucial questions remain, including what effect TRAMS has on other subgroups of patients, and which specific practice changes implemented by the TRAMS team were responsible for improving quality and safety of care? Another important area to study is the effect of the TRAMS model on patients who require long-term tracheostomy and placement in the community.

Conclusions

Implementing a tracheostomy review and management service (TRAMS) was associated with improved patient outcomes for SCI patients with a tracheostomy. Tracheostomy tubes were removed earlier, with a significant reduction in acute hospital length of stay and substantial cost savings. More patients were able to speak significantly sooner than before the introduction of TRAMS. The incidence of adverse events remained low despite earlier removal of tracheostomy tubes.

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Author details

Tanis S Cameron, Manager, Tracheostomy Review and Management Service (TRAMS), Senior Clinician, Speech–Language Pathologist
Anita McKinstry, Speech Pathologist
Susan K Burt, Speech Pathologist
Mark E Howard, Director, Victorian Respiratory Support Service, and Senior Respiratory Physician, Institute for Breathing and Sleep, Bowen Centre
Rinaldo Bellomo, Director of Intensive Care Research and Intensive Care Specialist
Douglas J Brown, Director, Victorian Spinal Cord Service
Jacqueline M Ross, Senior Clinician, Physiotherapist, Victorian Spinal Cord Service
Joanne M Sweeney, Director, Speech Pathology
Fergal J O'Donoghue, Senior Respiratory Physician and TRAMS Clinical Director, Institute for Breathing and Sleep, Bowen Centre
Austin Hospital, Melbourne, VIC.
Correspondence: tanis.cameron@austin.org.au

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