Tracheostomy teams reduce total tracheostomy time and increase speaking valve use: A systematic review and meta-analysis☆

Lauren Speed BSpPath*, Katherine E. Harding MPH

Eastern Health, Box Hill VIC, Australia

Keywords:
Tracheostomy; Multidisciplinary care; Intensive care units

Abstract

Purpose: Multidisciplinary tracheostomy teams have been implemented in acute hospitals over the past 10 years. This systematic review of the literature and meta-analysis aimed to assess the effect of tracheostomy teams on patient outcomes.

Materials and Methods: We conducted an electronic search of the literature in the following databases: MEDLINE, CINAHL, EMBASE, and AMED. Inclusion/exclusion criteria were applied, and included articles were assessed against quality criteria. Qualitative synthesis and meta-analysis were completed.

Results: Seven studies were included. The studies were all pre-post cohort designs of low-moderate quality. Meta-analysis showed that tracheostomy teams were associated with reductions in total tracheostomy time (4 studies; mean difference, 8 days; 95% confidence interval, 6-11; \( P < .01; I^2 = 0\% \)) and hospital length of stay (LOS) (3 studies; mean difference, −14 days; 95% confidence interval, −39 to 9; \( P = .23; I^2 = 50\% \)). Reductions in intensive care unit LOS (3 studies) and increases in speaking valve (3 studies) use were also reported with tracheostomy teams.

Conclusion: There is low-quality evidence 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. There is insufficient evidence to determine that multidisciplinary tracheostomy teams reduce hospital or intensive care unit LOS.

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1. Introduction

There is growing evidence supporting the benefits of multidisciplinary health care across a broad range of settings. Several reviews have established that multidisciplinary care improves patient outcomes including treatment and rehabilitation for chronic back pain [1], rehabilitation in post acute stroke [2], and interventions to enhance return to work in patients with cancer [3].

This trend toward multidisciplinary care has also been seen in the management of tracheostomy patients, with tracheostomy teams beginning to emerge in acute hospitals 10 years ago in the United Kingdom [4,5]. Tracheostomy care has traditionally been managed by surgical teams that performed the procedure, but this has changed with the
introduction of percutaneous tracheostomy [6]. There is also growing recognition that the needs of tracheostomy patients are complex and require the expertise of a variety of professionals for optimal management. Tracheostomy insertion has implications for communication, airway management, and nursing care [7,8], suggesting a rationale for a multidisciplinary approach involving speech pathologists, physiotherapists, and nursing staff.

Garrubba et al [9] conducted a systematic review in 2009 of multidisciplinary care for ward-based tracheostomy patients. They identified 3 studies that met the inclusion criteria and concluded that the studies demonstrated some improvements in time to decannulation, length of stay (LOS), and adverse events. However, the authors of the review noted that these results should be taken with caution because of the low quality of the evidence.

Since this time, further work has been done in multidisciplinary management of tracheostomy patients, and additional studies have been published examining the effects of multidisciplinary teams. This systematic review of the literature and meta-analysis aimed to assess the available evidence to answer the following question:

What is the effect of multidisciplinary team management compared with usual care on outcomes for patients with a tracheostomy?

2. Method

2.1. Protocol and registration

Methods were developed in advance and registered on the PROSPERO register (registration no. CRD42011001565).

2.2. Search strategy

In July 2011, an electronic search of all literature was conducted from the earliest available date in the following databases: MEDLINE, CINAHL, EMBASE, and AMED. The keywords and search terms used included tracheostomy and tracheotomy, combined with multidisciplinary, interdisciplinary, and team. Reference lists were checked, and citation tracking (using Google Scholar) was conducted for all articles that met the inclusion criteria to search for any additional articles that were not identified in the initial search.

2.3. Study selection

Titles and abstracts of articles identified in the search were independently assessed by 2 reviewers against selection criteria (Table 1). Any variations between the assessors were discussed until consensus was reached. Full-text copies of articles were obtained for those that met the selection criteria or where eligibility could not be established from the abstract. An online translator was used for non-English full-text articles to obtain sufficient information to determine eligibility, with provision for further translation if required.

The selection criteria were applied to full text by each researcher independently. These results were discussed, and any disagreements between the reviewers were discussed until consensus was reached.

<table>
<thead>
<tr>
<th>Table 1 Inclusion/exclusion criteria</th>
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<tbody>
<tr>
<td><strong>Inclusion</strong></td>
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<tr>
<td>Population</td>
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<td>Intervention</td>
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<td>Outcomes</td>
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<td>Methodology</td>
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<td>Publication type</td>
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PT indicates physiotherapist/respiratory therapist; SP, speech pathologist/speech language pathologist/speech and language therapist.
2.4. Data extraction

A customized data extraction table was developed. This was pilot tested on 2 selected studies and refined accordingly. Data extraction was completed by 1 reviewer, and the second author confirmed the extracted data.

The following information was collected for each of the included studies: study objective, design and setting, inclusion criteria, exclusion criteria, recruitment procedures, subject details, intervention details, outcome measures, summary of key findings, and authors’ conclusions.

2.5. Quality assessment

Risk of bias was assessed using the checklist of Downs and Black [10] (1998) for measuring the methodological quality of randomized and nonrandomized studies. The checklist comprises 27 questions that rate the quality of the studies in 5 subsections: reporting (10 questions; maximum subsection score, 11), external validity (3 questions; maximum score, 3), internal validity bias (7 questions; maximum score, 7), internal validity (6 questions; maximum score, 6), and power (1 question; scored out of 5). Scoring for the final question, relating to power, was modified to more clearly reflect the potential of the studies to detect a change if one was present. The power of all studies to detect a change in total tracheostomy time of 3 days (deemed to be clinically significant) was independently checked using G-Power 3.1.2 (Franz Faul, University Kiel, Germany), a β of .8, α of .05, and estimating effect sizes from group means and SDs reported by the authors. Where SDs were not reported, these were approximated from similar samples from other studies to estimate effect sizes. Studies that were adequately powered were given a maximum score of 5, those that were either borderline or able to determine a statistically significant difference despite questionable sample sizes were given a score of 3, and those that were clearly underpowered scored zero for this question.

Each author completed the quality checklist independently. Results were discussed, and any differences discussed until consensus was reached.

The Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach [11] was also used to summarize the quality of the available evidence for each outcome. This approach specifies 4 levels of evidence ranging from very low to high.

2.6. Data analysis

Data were initially analyzed using a process of descriptive synthesis. All data were organized into tables for the purpose of comparing the characteristics and results of included studies.

Meta-analyses were then conducted using RevMan 5.1 software (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011) with a random effects model using the mean difference effects measure for continuous outcomes that were reported in multiple studies (the time tracheostomy was in situ, hospital LOS, and intensive care unit [ICU] LOS). The presence of heterogeneity was assessed using the I² measure.

If SDs were not reported, they were imputed from interquartile ranges or P values if these data were available [12]. When no data were available or able to be estimated, the investigators of the studies concerned were contacted to request missing data. Studies were then excluded from meta-analysis if no measure of variability was available.

3. Results

3.1. Study selection

A total of 7 studies were identified for inclusion in the review [5,13-18]. Database searching identified 404 articles after removal of duplicates. Two further articles were identified that met the inclusion criteria through citation tracking and reference list checking of included articles [5,14]. Of these, 390 were excluded because they did not meet the selection criteria from the abstract. The full text of 16 articles was reviewed. Eight of these did not meet the selection criteria [4,19-25]. One additional article [26] was excluded because it reported on the same data as another included study [14] (Fig. 1).

3.2. Quality assessment results

The included studies were generally of medium to low quality. There were no randomized control trials, and all studies scored lower on internal validity because of study design and nonrandomization of subjects to intervention groups. Of the 7 studies, 6 scored between 20 and 24 on the quality assessment out of a possible score of 32. There was 1 study that was of a lower quality with a score of 12 [5] (Table 2).

Two studies [13,16] scored lower on external validity because they examined subjects in a specialist unit. One examined patients with spinal cord injury [13], and the other, patients with severe traumatic brain injury [16]. Although generalizability of the results from these studies may be more limited, it should be considered that homogeneity in the data reduces confounding variables and therefore provides some additional confidence in the outcomes reported in these populations. None of the studies were considered to have adequate power to detect clinically significant changes in total tracheostomy time due to small sample sizes, although 3 reported statistically significant results [13,14,18].

Because all of the studies in this review are observational, the evidence is considered to be low using the GRADE approach [11].
3.3. Study characteristics

3.3.1. Settings/population

The included studies involved a total of 769 participants (Table 3). There were 466 who received treatment once a tracheostomy team had been implemented and 305 who were treated before commencement of a tracheostomy team. Sample sizes range between 27 and 79 for the comparison groups and 34 and 119 for the intervention groups. All studies included adults who had a tracheostomy in situ and were conducted in a teaching or tertiary acute hospital setting. Indications for tracheostomy were described in 4 studies [5,15,17,18] and the most common indications included prolonged ventilation/weaning, postoperative airway management, and upper airway compromise. Four studies investigated tracheostomy teams that reviewed patients once they had been discharged from the ICU and transferred to a general ward [13-15,18]. Two studies described teams that managed patients on both general wards and in the ICU [5,17], and 1 study [16] did not specify if the tracheostomy team reviewed patients on the ward, ICU, or both. Tracheostomy insertion consisted of a mix of percutaneous and surgical in all studies.

3.3.2. Study design

All included articles described observational cohort studies with a pre-post design.

Table 2 Quality assessment results

<table>
<thead>
<tr>
<th>Study details</th>
<th>Reporting (maximum = 11)</th>
<th>External validity (maximum = 3)</th>
<th>Internal validity Bias (maximum = 7)</th>
<th>Confounding (maximum = 6)</th>
<th>Power (maximum = 5)</th>
<th>Total (maximum = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetto et al [14] (2011)</td>
<td>8</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>de Mestral et al [15] (2011)</td>
<td>11</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>LeBlanc et al [16] (2010)</td>
<td>10</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Parker et al [17] (2010)</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Tobin and Santamaria [18] (2008)</td>
<td>8</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>23</td>
</tr>
</tbody>
</table>
Data were collected before the implementation of a tracheostomy team retrospectively and postimplementation prospectively in 5 studies [5,13,15,17,18]. One study collected all data prospectively [14], and 1 study collected all data retrospectively [16]. One study used a matched pairs design within the 2 cohorts [13]. The period of data collection varied and ranged from 6 months to 4 years before a tracheostomy team and from 6 months to 3 years once a team had been implemented.

3.3.3. Intervention
All tracheostomy teams included allied health and nursing staff, and all but 1 [5] included medical input. The included medical specialty varied across these 6 studies and included respiratory [13,14]; intensivists [13,14,18]; surgeons [15,16]; ear, nose, and throat specialists [14]; and non-specified [17]. The frequency of the intervention the team provided varied between studies ranging from daily to weekly ward rounds. Four of the studies [5,13,15,17] described consultative teams where recommendations were made by the tracheostomy team to the treating medical team. It was not clear from the other studies [14,16,18] if they treated patients independently or made recommendations to the treating team.

Other roles described in the studies included education programs [5,13,14,17,18], guidelines for standard care [13,14,17,18], and development of policies [13,14,17,18].

3.3.4. Outcomes
The most common outcome measure was the total time the tracheostomy was in situ, and this was reported by 6 of the 7 studies [5,13-17]. Of the 7 studies [13,16-18], 4 measured hospital LOS. Two studies measured the time to decannulation postdischarge from ICU [14,18], and 3 measured ICU LOS [13,14,18]. Five of the studies noted complication or adverse events [5,13-15,21], and 3 studies also reported on use of a speaking valve [13,15,16].

3.4. Results outcomes

3.4.1. Time tracheostomy in situ
Sufficient data were available from 4 of the 6 studies [13-16] reporting total tracheostomy time to perform a meta-analysis. Two studies were excluded because SDs were not available or able to be estimated [5,17]. In the pooled data (Fig. 2), tracheostomy teams were associated with a reduction in the total tracheostomy time (mean difference, 8 days; 95% confidence interval [CI], –6 to –11; P < .01). There was no evidence of heterogeneity ($I^2 = 0\%$).

Of the 6 studies, 5 reported a reduction in the total tracheostomy time [5,13-16], although the reduction was found to be statistically significant in only 1 of these [14]. This same study also found a significant reduction in mean decannulation time after discharge from the ICU.

3.4.2. Length of stay
Meta-analysis was conducted by combining results of 3 of the 4 studies reporting hospital LOS [13,16,18]. One study was excluded because SDs were not available or able to be estimated [17]. Only the first of 3 years of postintervention data reported by Tobin and Santamaria [18] were included in the meta-analysis to increase heterogeneity with the other studies in this group. Tracheostomy teams were associated with a reduction in the hospital LOS (Fig. 3); however, this was not statistically significant (mean difference, 14 days; 95% CI, –9 to –39; P = .23), and there was moderate heterogeneity ($I^2 = 50\%$). One of the studies reported a significant reduction in LOS after the introduction of the multidisciplinary team [16]. The remaining 3 reported no significant difference between the 2 groups.

Three studies reported on LOS in the ICU, and all reported an observed reduction in the intervention group, but none reported statistically significant results [13,14,18]. Meta-analysis was not conducted for ICU LOS because a measure of variability was available for only 2 reported studies [13,18].

3.4.3. Speaking valve use
Three studies reported on speaking valve use, all reporting substantial increases (significant at $P < .01$) in 1-way valve use [13,15,16] after the introduction of the multidisciplinary team (Fig. 4). Meta-analysis was not conducted for speaking valve use because a measure of variability was not available for this outcome.

One study also reported a statistically significant reduction ($P < .01$) in days to initial valve use [13].

3.4.4. Adverse events
Four studies reported on adverse events. These included clinical incidents [14], code blues [13], and tracheostomy tube–related complications [5,15] (eg, accidental decannulation, tube blockages, burst cuff, bleeding, or wound infections).

Only 1 of these [15] tested the differences statistically, showing a significant decrease in the number of tube blockages ($P = .02$) and calls for respiratory distress ($P = .04$) but no differences in other tube complications (displacement, accidental decannulation, and cuff rupture).

3.4.5. Qualitative data
Two studies reported on qualitative data collected from staff involved in patient care. Improved awareness and knowledge of staff [17] and positive feedback on teaching programs [14] were noted.

3.4.6. Cost savings
Two studies [13,14] reported on cost savings, Annual calculated savings of AUD $402465 [13] and the significant implications for cost savings related to ICU LOS [14] were noted.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Study setting</th>
<th>Sample</th>
<th>Period of data collection</th>
<th>Participant details</th>
<th>Team characteristics</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameron et al [13]</td>
<td>Tertiary acute hospital—ward-based patients</td>
<td>N = 34 Median age, 35.5 y (IQR, 23.8-51.8)</td>
<td>Pre: 27 mo, Post: 37 mo</td>
<td>70% surgical insertion Spinal cord injury</td>
<td>Respiratory and ICU physicians, CNC, PT, and SP. Twice weekly ward rounds, patient consultations as needed, patient support, and education for ward staff</td>
<td>Reduction in LOS (median, 60-41.5 days) Significant increase (P &lt; .01) in speaking valve use (35%-82%), Low adverse events (2-0)</td>
</tr>
<tr>
<td>Cetto et al [14]</td>
<td>Teaching hospital—ward-based patients</td>
<td>N = 71 Mean age, 62.5 y</td>
<td>Pre: 19 mo, Post: 19 mo</td>
<td>43 percutaneous, 36 surgical insertions; mean APACHE II score, 52.13</td>
<td>PT, ENT, SP, outreach, and resuscitation practitioner; ICU physician; respiratory physician; and a dietitian Daily ward round</td>
<td>Significant reduction (P &lt; .0001) in time to decannulation (mean, 21-11 days) and total tracheostomy time (mean, 34-25 days) Reduction in mean time in ICU days (19.16-14.14 d) Reduction in severe clinical incidents (58-9)</td>
</tr>
<tr>
<td>de Mestral et al [15]</td>
<td>Tertiary care hospital trauma center—ward-based patients</td>
<td>N = 32 Mean age, 46.3 y (SD, 21.2)</td>
<td>Pre: 1 y, Post: 1 y</td>
<td>APACHE II, TBI, 25.1; surgery ward, 78.19%</td>
<td>Surgeon, surgical resident, PT, SP, and CNC twice weekly ward rounds</td>
<td>Decrease in the no. of days to decannulation (mean, 50.4-28.4 d) Significant increase (P &lt; .001) in speaking valve use (19.4%-67.4%) Significant decrease in no. of patients with tube blockage (P = .016) and no. of calls to ward for respiratory distress (P = .039).</td>
</tr>
<tr>
<td>LeBlanc et al [16]</td>
<td>Tertiary acute hospital—trauma center</td>
<td>N = 27 Mean age, 36.5 y; SD, 16.42</td>
<td>Pre: 3 y, Post: 21 mo</td>
<td>Admission GCS, 4.93; APACHE II, 24.75</td>
<td>Trauma surgeons and residents, PT, SP, and CNC Twice weekly rounds, individualized planning for all patients</td>
<td>Decrease in time to decannulation (mean, 41.9-35.4 d) Significant reduction in LOS (mean, 107.81-69.94 d) Significant increase (P = .004) in speaking valve use (33%-71%)</td>
</tr>
</tbody>
</table>
4. Discussion

This review examined the evidence from 7 studies measuring the impact of multidisciplinary tracheostomy teams in acute hospital settings. Most studies reported observed benefits after the introduction of the tracheostomy team, including reductions in total tracheostomy time (5/6 studies), overall LOS (2/4 studies), increased use of speaking valves (3/3 studies), reduced LOS in ICU (3/3 studies), and reduced adverse events (4/5 studies). However, individually, the studies had relatively small sample sizes, and many had insufficient power to find statistically significant effects. A key benefit of this review was the use of meta-analytical techniques, statistically combining the results from individual underpowered studies to increase the power of the analysis. The review supports and builds upon the findings of a previous systematic review published by Garrubba et al [9] and provides additional evidence of the potential benefits of multidisciplinary tracheostomy teams with the inclusion of 4 additional studies and meta-analysis.

Meta-analysis suggests that multidisciplinary tracheostomy teams are associated with a mean reduction in total tracheostomy time of 8 days (95% CI, 6-11 days). Earlier decannulation has important clinical benefits for communication and swallowing and restoring normal respiratory physiology including cough function [27]. There is also less time for adverse events and reduced potential for infection. This reduction in time to decannulation is likely due to collaboration, holistic care, and a range of specialties contributing to the treatment plan. These findings concur with findings in multidisciplinary care in acute stroke units [28].

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study setting</th>
<th>Sample</th>
<th>Period of data collection</th>
<th>Participant details</th>
<th>Team characteristics</th>
<th>Outcomes</th>
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</thead>
<tbody>
<tr>
<td>Norwood et al [5]</td>
<td>Acute teaching hospital—both ICU and ward-based patients</td>
<td>N = 51</td>
<td>1 y</td>
<td>88% percutaneous insertion</td>
<td>PT and ICU outreach sister daily review</td>
<td>Reduction in time to decannulation (mean, 18.95-18.5 d)</td>
</tr>
<tr>
<td>Parker et al [17,21]</td>
<td>Large regional tertiary referral hospital—ward-based and those from ICU referred by ICU medical staff</td>
<td>N = 41</td>
<td>6 mo</td>
<td>22 surgical insertions, 19 percutaneous insertions</td>
<td>CNC, PT, SP, dietician, social worker, and medical officer ICU and respiratory consultation service as required Weekly ward rounds. Advice to treating team.</td>
<td>Reduction in LOS (mean, 34-30 d) Improved awareness and knowledge of staff postimplementation Increase in days of tracheostomy in situ (13-20 d). Reduction in adverse events (32%-24%)</td>
</tr>
<tr>
<td>Tobin [6,18]</td>
<td>Tertiary referral hospital</td>
<td>N = 41</td>
<td>1 y</td>
<td>24% surgical, 76% percutaneous insertion</td>
<td>Intensivist, ICU liaison nurse, PT, SP, and dietitian Twice weekly ward rounds. Review and individualized tracheostomy weaning program</td>
<td>Hospital LOS (mean, 42-45 d in y 1; decreased to 40 in y 2 and 34.5 in y 3). Increase in ICU LOS (10-11 in y 1). Reduction in decannulation time from ICU discharge (mean, 14-9 d)</td>
</tr>
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</table>

IQR indicates interquartile range; APACHE, Acute Physiological and Chronic Health Evaluation; GCS, Glasgow Coma Scale; ENT, ear, nose, and throat specialist; CNC, clinical nurse consultant/clinical nurse specialist; TBI, traumatic brain injury.
There is a constant drive to reduce health care costs by reducing the amount of time that patients spend in hospital. Interventions that can reduce LOS are, therefore, of considerable importance to health administrators. There is currently insufficient evidence to conclude that tracheostomy teams decrease hospital LOS, although statistically significant reductions have been reported in 2 studies. The meta-analysis conducted in this review suggested a reduction in LOS with tracheostomy teams, but this was not statistically significant. This analysis was limited by the data reported including the need to impute SDs from interquartile ranges in 1 study [13], which may have led to an underestimated effect size.

There is insufficient evidence that multidisciplinary tracheostomy care leads to a reduction in ICU LOS. The 3 studies [13,14,18] that measured this outcome implemented teams in a general ward setting and observed nonsignificant reductions in ICU LOS with the use of tracheostomy teams. It is possible that the presence of a specialized tracheostomy team in the ward setting results in greater confidence and support for general ward care and earlier transfer from the ICU. Given the high costs associated with each additional stay spent in ICU [29], any reduction in ICU LOS can have significant cost benefits for health care services, and further study in this area may be beneficial.

Although LOS and time to decannulation were the most common outcome measures reported in the studies identified in this review, there are other outcomes in tracheostomy care that may be of important clinical significance. A substantial increase in speaking valve use was reported in the 3 studies evaluating this outcome, with the proportion of patients using speaking valves increasing from one third or less in the preintervention phase to two thirds or more after introduction of the team. One study [13] also showed that speaking valves were used earlier once a tracheostomy team was implemented. These results are clinically significant as they allow patients to communicate verbally, improving quality of life and cough function and reduce tracheal secretions [7,30]. Similarly, the impact of multidisciplinary teams on adverse events received minimal attention. Tube-related complications may occur infrequently but can have a dramatic impact when they do. Several studies in this review suggest that multidisciplinary teams may reduce adverse events, but insufficient power and lack of statistical testing mean that there is currently a lack of evidence to draw conclusions about these outcomes.

The studies included in this review showed some variation in the makeup of the multidisciplinary tracheostomy team, but there is insufficient evidence to conclude whether any combination of health professionals was associated with improved outcomes. Of the 7 included studies, 6 had teams that consisted of 1 or more medical specialists from varied fields (respiratory, intensivists, surgeons, and ear, nose, and throat specialist), nursing, physiotherapy, and speech pathology, and the studies report similar trends that favor implementation of a tracheostomy team. However, it is possible that medical input and leadership is important in the makeup of the team because the only study that had no medical input [5] reported no change or an increase in the total tracheostomy time. Tobin [6] (2009) suggested the important team members in a tracheostomy team to be a physician experienced with tracheostomy, critical care nurse, physiotherapist, and speech pathologist. Tobin also noted that the role of the physician was important in providing the team, particularly allied health, with the authority to manage the patient’s care. The functions provided by the teams also varied, including various combinations of treatment, consultation, education, and policy interventions. There is currently insufficient evidence to determine which of these functions are most effective in achieving improved outcomes and represents an area for further research.

![Fig. 2](Fig. 2 Forest plot for total tracheostomy time.)

![Fig. 3](Fig. 3 Forest plot for LOS.)
time and increased speaking valve use. Although reductions in hospital and ICU LOS have been reported in some studies, findings have been inconsistent, and there is currently insufficient evidence to determine that multidisciplinary tracheostomy teams improve these outcomes.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcrc.2012.05.005.

References


