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Associative factors for tracheostomy in patients presenting with stridor or upper airway obstruction

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Abstract

Objective. This study aimed to identify associative factors for tracheostomy in patients presenting with airway obstruction.

Methods. Data from a tertiary hospital were reviewed to identify patients who presented with airway obstruction between 2009 and 2020. Patient demographics, causative pathology and treatments were analysed.

Results. The study identified 297 admitted patients. Of these, 66 underwent a tracheostomy and formed the 'tracheostomy' group and 231 formed the 'other intervention' group. The tracheostomy group had a higher mean age ($p = 0.003$), and higher percentages of males ($p = 0.031$) and smokers or ex-smokers ($p = 0.020$), compared to the other intervention group. The tracheostomy group also had a higher number of patients with a malignancy ($p < 0.001$) compared to the other intervention group.

Conclusion. Being older, male, a previous or current smoker, or developing airway obstruction due to a malignancy were found to be the main associative factors for requiring a tracheostomy.

Main Article

Mr P R Sharma takes responsibility for the integrity of the content of the paper

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Introduction

Background

Stridor is defined as a medium-pitched respiratory sound associated with a disrupted upper airway.[1] The causes of stridor typically involve a partial obstruction located within the extra- or intra-thoracic regions of the airway. The exact causal pathology can range from infections such as epiglottitis or supraglottitis to upper airway angio-oedema from anaphylaxis.[1–4] Acute stridor is more likely to represent an immediately life-threatening airway issue compared to a chronic presentation.[5]

The underlying pathophysiology causing stridor needs to be addressed for a definitive cure; however, there are a range of immediate management strategies that can be utilised in the acute setting to maintain the patient's oxygen saturation levels and airway. These can broadly be divided into two categories: (1) conservative treatment involving oxygen, nebulised adrenaline and intravenous steroids; and (2) invasive airway treatments involving endotracheal intubation and emergency surgical measures such as a tracheostomy to secure the airway.

Previous research has highlighted that patients with supraglottitis who present with specific symptoms such as stridor, tachypnoea or hypoxia require some form of invasive airway intervention.[6] Moreover, another article identified certain risk factors, such as being male, an older adult, having a diagnosis of diabetes mellitus or a body mass index of greater than 25 kg/m^2, that are associated with an increased likelihood of developing severe epiglottitis and subsequently an increased probability of requiring invasive airway intervention.[7] However, there is a lack of information within contemporary literature regarding which airway management method is preferred for specific groups of patients presenting with upper airway obstruction. Previous research has shown the potential benefits of tracheostomy; therefore, the early identification of patients who may benefit from tracheostomy is vital.[8–10] This is a difficult area to research as the main clinical factors for proceeding with a tracheostomy in the acute scenario concern the degree of airway obstruction alongside the clinician's judgement of potential loss of airway, with both factors being difficult to quantify and document in a medical record.

Aims

This study aimed to identify associative factors for tracheostomy in patients presenting with new-onset stridor or upper airway obstruction. Such knowledge will allow clinicians to identify those patients who may benefit from an early tracheostomy, and will assist in facilitating early discussions with patients and clinical team members regarding the need for tracheostomy.

Materials and methods

Data collection

This retrospective study was undertaken at Aberdeen Royal Infirmary, Scotland, UK. Operating theatre lists, alongside ward admission and discharge summaries, from the ENT department at Aberdeen Royal Infirmary, were utilised to identify those patients who presented with stridor or upper airway obstruction, and who were aged over 18 years, between 1 June 2009 and 1 June 2020. A previously built adult intensive therapy unit database at Aberdeen Royal Infirmary was searched to identify those patients who presented with stridor or upper airway obstruction, and who were mainly treated in the intensive therapy unit, between 1 January 2010 and 1 January 2020. Additionally, another previously built database from Ninewells Hospital in Dundee, Scotland, was searched to identify those patients who presented to their ENT department with stridor or upper airway obstruction, and who were aged over 18 years, between 30 March 2011 and 30 April 2018.

Following patient identification, the following patient information was manually transferred from the two pre-existing databases and the electronic patient record to a Microsoft Excel® (2016) spreadsheet by three of the authors (PRS, AA and SD). The patient demographics collected included: age, sex, co-morbidities such as asthma or chronic obstructive pulmonary disease (COPD), date of admission, smoking status, presence of stridor, cause of stridor or upper airway obstruction, and any surgical or medical treatments provided. The cause of stridor or upper airway obstruction was categorised into single and dual causes. Single causes were sub-categorised as: upper respiratory tract infections (URTI), malignancies, allergic reactions, benign masses, neurological disease, smoke inhalation, neck trauma, post-radiotherapy complications, post-operative complications, subglottic or tracheal stenosis, gastroesophageal reflux disease, a foreign body, and idiopathic causes. The idiopathic category includes patients who received airway management for an unknown underlying upper airway pathology. Dual causes were sub-categorised as: respiratory tract infections alongside a known malignancy affecting the upper airway, and respiratory tract infections alongside a known neurological disease.

Ethical approval

Ethical approval was not required for this study; however, institutional research approval was gained from the Clinical Effectiveness Department at Aberdeen Royal Infirmary prior to data collection.

Statistical analyses

Descriptive statistics were utilised to present and summarise the patient characteristics of different groups. Statistical significance was assessed via the Pearson's chi-square test with asymptotic significance for categorical variables, and the independent-samples *t*-test was utilised for continuous variables. In analyses where the Pearson's chi-square test was inappropriate, Fisher's exact test was utilised instead. A two-sided *p*-value of less than 0.05 was regarded as statistically significant. IBM® SPSS® version 27 software was employed for all statistical analyses.

Results

Patient characteristics

Overall, 402 admissions involving patients presenting with stridor or upper airway obstruction were identified. Of these, 105 admissions were excluded from further analyses because of incomplete documentation in the electronic medical record of examination findings and/or airway interventions performed. Consequently, 297 admissions formed the study cohort. The baseline characteristics of the 297 admitted patients are displayed in Table 1.

Table 1. Baseline characteristics of all admitted patients presenting with stridor or upper airway obstruction

Characteristic	All admissions*
Age (mean (± 1 SD); years)	57 (± 18.04)
Sex (*n* (%))	
– Male	168 (57)
– Female	129 (43)
Smoking status (*n* (%))	
– Non-smoker	150 (51)
– Smoker or ex-smoker	147 (49)
COPD (*n* (%))	11 (4)
Asthma (*n* (%))	25 (8)

*Total *n* = 297. SD = standard deviation; COPD = chronic obstructive pulmonary disease

The 297 admissions were divided into two groups based on the airway intervention provided: (1) a 'tracheostomy' group, comprising admissions that resulted in a tracheostomy during the hospital stay (22 per cent); and (2) an 'other intervention' group, consisting of admissions that did not result in a tracheostomy during the hospital stay (78 per cent). The patient characteristics of these two groups are presented in Table 2.

There were statistically significant differences between the two groups in terms of age ($p = 0.003$), sex ($p = 0.031$), smoking status ($p = 0.020$) and a background diagnosis of asthma ($p = 0.022$). The tracheostomy group had a significantly higher mean age (62 ± 12.27 years), and significantly higher percentages of males (68 per cent), and smokers or ex-smokers (62 per cent), compared to the other intervention group (mean age, 55 ± 19.07 years; males, 53 per cent; smokers or ex-smokers, 46 per cent). The tracheostomy group had a significantly lower percentage of admissions with a background

Table 2. Baseline characteristics of admissions that did or did not result in tracheostomy

Characteristic	Tracheostomy group*	Other intervention group†	*P*-value
Age (mean (± 1 SD); years)	62 (± 12.27)	55 (± 19.07)	0.003‡
Sex (*n* (%))			0.031‡
– Male	45 (68)	123 (53)	
– Female	21 (32)	108 (47)	
Smoking status (*n* (%))			0.020‡
– Non-smoker	25 (38)	125 (54)	
– Smoker or ex-smoker	41 (62)	106 (46)	
COPD (*n* (%))	4 (6)	7 (3)	0.27
Asthma (*n* (%))	1 (2)	24 (10)	0.022‡

*$n = 66$; †$n = 231$. ‡Statistically significant. SD = standard deviation; COPD = chronic obstructive pulmonary disease

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of asthma (2 per cent) compared to the other intervention group (10 per cent). There was no statistically significant difference between the tracheostomy group and the other intervention group in terms of admissions with a background of COPD.

Causative pathology

Of the 297 admissions involving stridor or upper airway obstruction, 286 (96 per cent) were due to a single cause and 11 (4 per cent) were due to a dual cause. Overall, out of the single causes, 95 (33 per cent) were due to a URTI, 98 (34 per cent) were due to a malignancy and 18 (7 per cent) were due to an allergic reaction. The remaining 75 (26 per cent) within the single-cause category were due to various different causes such as: benign masses, neurological disease, smoke inhalation, trauma, post-radiotherapy complications, post-operative complications, subglottic or tracheal stenosis, gastroesophageal reflux disease, a foreign body, or an idiopathic cause. Out of the 11 dual causes, 9 (82 per cent) were due to a respiratory tract infection alongside a known malignancy affecting the upper airway, and 2 (18 per cent) were due to a respiratory tract infection alongside a known neurological disease. The specific pathologies within the subgroups of URTIs, benign masses and neurological diseases found in this study are documented in Table 3.

The causative pathologies within the tracheostomy group and the other intervention group are displayed in Table 4. There was a statistically significant association between having a URTI ($p < 0.001$), malignancy ($p < 0.001$), or a respiratory tract infection together with a neurological disease ($p = 0.049$) and receiving a tracheostomy. Within the single-cause category, the tracheostomy group had a significantly lower percentage of URTI patients (11 per cent) compared to the other intervention group (38 per cent); however, there was a significantly higher percentage of patients with a malignancy within the tracheostomy group (63 per cent) compared to the other intervention group (24 per cent). Within the dual-cause category, the tracheostomy group had a significantly higher percentage of patients with a respiratory tract infection together with a neurological disease (3 per cent) compared to the other intervention group (0 per cent). There was no other statistically significant difference between the tracheostomy group and the other intervention group in terms of causative pathologies.

Table 3. Specific pathologies within URTI, benign mass and neurological disease subgroups in this study

URTI
– Supraglottitis
– Epiglottitis
– Laryngitis
– Tracheitis
– Glossitis
– Tonsillitis (including peritonsillar abscess)
Benign masses
– Cystic thyroid mass
– Laryngocele
– Inflammatory airway mass
– Vocal fold polyps
Neurological diseases
– Multiple system atrophy
– Guillain-Barré syndrome
– Motor neurone disease
– Spinocerebellar ataxia
– Parkinson's disease

URTI = upper respiratory tract infection

Discussion

Summary

Tracheostomy is a life-saving airway procedure utilised for various different upper airway pathologies; however, it is generally reserved for the most critically unwell patients.[11] In summary, the results obtained from this study indicate that patients are more likely to receive a tracheostomy for new-onset stridor or upper airway obstruction if they are of an older age, male, and smoker or ex-smoker. Having a previous diagnosis of COPD or asthma did not result in an increased likelihood of receiving a tracheostomy. In terms of causative pathology, these results suggest that patients are more likely to receive a tracheostomy if the upper airway obstruction is associated with an underlying malignancy diagnosis or if they develop a respiratory tract infection alongside a neurological disease. No increase in the likelihood of receiving a tracheostomy was noted for any other conditions studied.

Patient characteristics

In terms of patient characteristics, these findings differ from some of the current literature but support other studies.[7,12,13] Felton *et al.* evaluated the type of airway management received by adults with acute epiglottitis and the factors associated with requiring advanced airway management.[12] They found that patient demographic factors such as age and sex were not associated with requiring an advanced airway. In that study, an advanced airway was defined as including non-surgical intubation, cricothyroidotomy and surgical tracheostomy. Suzuki *et al.*[7] carried out a study with a similar design to that of Felton *et al.*,[12] and reported older age and male sex to be factors significantly associated with severe epiglottitis, consistent with the present study's findings. Severe epiglottitis in Suzuki and colleagues' study was defined as that requiring airway intervention or resulting in early death within 2 days of admission. The inconsistency in results may be explained by the difference in sample sizes between these studies. Felton *et al.*[12] had a significantly smaller sample size, of 70 patients, compared to the sample sizes of Suzuki *et al.*,[7] of 6072 patients, and the present study, of 297 patients. Therefore, it can be reasonably inferred that older age and male sex are likely to be important associative factors for requiring tracheostomy.

Huttner *et al.* found that the presence of COPD is a predisposing factor for receiving a tracheostomy in patients with an intracerebral haemorrhage.[13] This contradictory result may be due to the difference in study design, as Huttner *et al.* only focused on the need for tracheostomy in patients who had an intracerebral haemorrhage as opposed to stridor or upper airway obstruction. However, it is important to note that the number of patients with COPD is very low within the present study and therefore it is difficult to deduce a plausible conclusion.

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Table 4. Causative pathologies of admissions that did or did not result in a tracheostomy

Causative pathology	All admissions (*n*)*	Tracheostomy group (*n* (%))†	Other intervention group (*n* (%))‡	*P*-value
Single causes				
– URTI	95	7 (11)	88 (38)	<0.001**
– Malignancy	98	42 (63)	56 (24)	<0.001**
– Allergic reaction	18	2 (3)	16 (7)	0.38
– Benign masses	4	0 (0)	4 (2)	0.58
– Neurological disease	8	3 (5)	5 (2)	0.38
– Smoke inhalation	7	0 (0)	7 (3)	0.36
– Trauma	8	1 (1)	7 (3)	0.69
– Post-radiotherapy complication	8	2 (3)	6 (3)	1.00
– Post-operative complication	5	0 (0)	5 (2)	0.59
– Subglottic or tracheal stenosis	10	2 (3)	8 (3)	1.00
– Gastroesophageal reflux disease	4	0 (0)	4 (2)	0.58
– Foreign body	1	0 (0)	1 (0)	1.00
– Idiopathic cause	20	2 (3)	18 (8)	0.27
Dual causes				
– Infection + malignancy	9	3 (5)	6 (3)	0.42
– Infection + neurological disease	2	2 (3)	0 (0)	0.049**

*$n = 297$; †$n = 66$; ‡$n = 231$. **Statistically significant. URTI = upper respiratory tract infection

A comparison of the effect of smoking on upper airway obstruction and tracheostomy between this study and current literature is difficult given the lack of research within this field. However, it is known that active and passive smoking are contributing factors to the development of upper airway diseases, including laryngeal cancer.[14] As upper airway obstruction related to an underlying malignancy diagnosis was found to be associated with receiving a tracheostomy, it is not unexpected that being a current or an ex-smoker was also found to be associated with receiving a tracheostomy in the present study.

Causative pathology

In terms of causative pathologies leading to tracheostomy, the findings from the present study are largely supported by the current literature.[11,15] Balfour-Lynn *et al.* have written extensively on the identification and management of URTIs such as epiglottitis, tracheitis and peritonsillar abscesses in the paediatric setting.[15] The authors expressed that a tracheostomy is rarely required for URTIs in the paediatric population. This mirrors the results of the present study, as there was a significantly lower percentage of patients with a URTI in the tracheostomy group as compared to the non-tracheostomy (other intervention) group. However, it is important to note that Balfour-Lynn *et al.*[15] focused on the paediatric population, whereas the present study excluded those aged under 18 years. Certain URTIs, such as epiglottitis, are known to be separate entities in adults when compared to children, and therefore it may not be possible to extrapolate and compare management techniques for children with URTIs with those for adults.[6] Overall, there is a lack of literature investigating the use of tracheostomy in adults with URTIs, and therefore comparison of results with other studies has proven difficult. This is an area that requires additional research to help further determine the exact indications of a tracheostomy in adults with URTIs.[10]

With regard to malignancies, Gilyoma *et al.* have reported results comparable to the present study.[11] Their second most common indication for receiving a tracheostomy was for malignancies causing upper airway obstruction, whereas this was the most common indication in the present study. Their most common indication was trauma-related, and this was likely associated with their patient demographic, as their cohort's mean age was only 38 years. Overall, this suggests that a major associative factor for requiring a tracheostomy may be upper airway obstruction secondary to a malignancy. Interestingly, there was no significant difference observed between receiving a tracheostomy or another treatment within the respiratory infection and malignancy dual-cause category in the present study. This may be explained by the very low number of cases recorded. This is an area that requires further investigation in the future.

In contrast, developing a respiratory infection alongside a neurological disease was found to be significantly associated with receiving a tracheostomy. Various neurological disorders, for example Parkinson's and motor neurone disease, are known to cause upper airway abnormalities;[16,17] however, a neurological disease by itself was not found to be significantly associated with receiving a tracheostomy in the present study. It may be that a respiratory tract infection superimposed on a dysfunctional airway due to a neurological disorder has a high chance of causing severe upper airway obstruction, necessitating a tracheostomy. However, because of a lack of investigation into the impact of respiratory tract infections on patients with pre-existing neurological disorders, it is difficult to make comparisons and draw valid conclusions. Moreover, the present study only had two such cases; therefore, further research is required before more generalisable conclusions can be inferred.

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Limitations

An important limitation of the present study is the small sample size of some of the subgroups included in analyses; for example, the numbers of patients with asthma or COPD, and certain upper airway pathologies such as benign masses or trauma. As previously stated, this leads to difficulties in drawing valid and generalisable conclusions.

- A tracheostomy can be a life-saving intervention for a patient with airway compromise
- Tracheostomy for airway compromise is significantly more likely if patients are older, male, have a history of smoking, or developed airway obstruction secondary to malignancy
- This information can facilitate early discussions with patients and multidisciplinary team members regarding the potential of early tracheostomy as a treatment option

Another limitation of this study involves the process of patient identification. Only those patients with stridor or upper airway obstruction who were referred to the ENT department or were treated in the intensive therapy unit were included within the present study. This effectively excludes those patients who may have been treated in another department without involvement from the ENT department or the intensive therapy unit. This may have introduced bias within the present study, as the ENT department and the intensive therapy unit generally only treat the most critically unwell patients who present with stridor or upper airway obstruction.

Conclusion

The present study aimed to identify factors associated with receiving a tracheostomy in patients who present with new-onset stridor or upper airway obstruction. Based on this study's results, it can be concluded that being older, male, a smoker or an ex-smoker, or having stridor or an upper airway obstruction linked to an underlying diagnosis of a malignancy are the main associative factors for requiring a tracheostomy. Further research is required to clarify the frequency and requirement of a tracheostomy in patients presenting with dual causes, such as a respiratory tract infection alongside a neurological disorder or a malignancy affecting the upper airway.

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