

# Outcome of permanent tracheostomy for treatment of upper airway obstruction in cats: 21 cases (1990–2007)

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**Objective**—To determine clinical outcome of permanent tracheostomy in cats with upper airway obstruction.

**Design**—Retrospective case series.

**Animals**—21 cats.

**Procedures**—Medical records were reviewed for information on history, signalment, clinical signs, results of preoperative clinicopathologic testing, cause of upper airway obstruction, surgical procedure, postoperative complications, and outcome.

**Results**—Causes of upper airway obstruction included neoplasia (squamous cell carcinoma [n = 6] or malignant lymphoma [2]), inflammatory laryngeal disease (5), laryngeal paralysis (4), trauma (3), and a laryngeal mass of unknown cause (1). Fourteen cats had dyspnea in the immediate postoperative period; dyspnea most often resulted from mucous plugs at the stoma or elsewhere in the respiratory tract. Eleven cats died, including 6 cats that died while hospitalized after surgery and 5 cats that died after discharge; 7 cats were euthanized, most often because of progression of neoplasia; and 2 were still alive at the time of the study. The remaining cat was lost to follow-up after discharge from the hospital. Overall, median survival time for the 20 cats for which information was available was 20.5 days (range, 1 day to 5 years). Cats that underwent permanent tracheostomy because of inflammatory laryngeal disease were 6.61 times as likely to die as cats that underwent permanent tracheostomy for any other reason.

**Conclusions and Clinical Relevance**—Results indicated that permanent tracheostomy was an uncommon procedure in cats with upper airway obstruction that was associated with high complication and mortality rates. (*J Am Vet Med Assoc* 2009;234:638–643)

Permanent tracheostomy is indicated when upper airway obstruction is prolonged or cannot be relieved. In cats, the most common reasons for permanent tracheostomy are laryngeal masses, ILD, laryngeal paralysis, tracheal disruption, and severe idiopathic laryngeal or pharyngeal swelling.<sup>1,2</sup> Complications associated with permanent tracheostomy in dogs and cats that have been reported include stenosis of the stoma and obstruction of the stoma with a foreign body, skin folds, or mucous secretions.<sup>1–6</sup>

In our experience, permanent tracheostomy is uncommonly performed in cats, possibly because of a

## ABBREVIATION

ILD Inflammatory laryngeal disease

belief that mucus will occlude the stoma after surgery, resulting in a poor outcome. To our knowledge, however, there have been only 4 published reports<sup>1,2,7,8</sup> on the outcome of permanent tracheostomy in cats, and 2 of these were only case reports.<sup>7,8</sup> In a study<sup>1</sup> involving 34 dogs and cats that underwent permanent tracheostomy, morbidity and mortality rates reportedly were low and overall quality of life was improved in most

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patients. However, the study included only 11 cats, and no data were given regarding outcome of this procedure in cats specifically. In a more recent study<sup>2</sup> involving 7 cats that underwent permanent tracheostomy, 3 of the cats were euthanized because of progressive anorexia or dysphagia and 3 died suddenly, presumably because of occlusion of the tracheal stoma. In the remaining cat, the tracheal stoma was surgically closed.

More information on the outcome of permanent tracheostomy in cats with upper airway obstruction would be useful when advising clients about possible treatment options. The purposes of the study reported here were to determine clinical outcome of permanent tracheostomy in cats with upper airway obstruction and identify factors associated with postoperative outcome.

## Materials and Methods

**Case selection criteria**—Medical records of cats examined at the veterinary teaching hospitals of the University of California, Davis; North Carolina State University; Iowa State University; Washington State University; University of Wisconsin, Madison; and Texas A&M University between 1990 and 2007 were reviewed. Cats were included if permanent tracheostomy had been performed to relieve upper airway obstruction, regardless of the underlying cause. Cats with concurrent diseases not related to upper airway obstruction were included in the study.

**Medical records review**—Medical records of cats included in the study were reviewed, and information was obtained on signalment (ie, age at the time of surgery, sex, breed, and body weight at the time of surgery), history, previous treatment, clinical signs, results of preoperative clinicopathologic testing, cause of upper airway obstruction, surgical procedure, postoperative treatment, postoperative complications, hospitalization time, and outcome. Laryngoscopy had been performed on all cats, and results recorded in the medical record were reviewed; radiographic reports were also reviewed when available. Long-term follow-up information was obtained through telephone interviews with owners and referring veterinarians.

**Surgical procedure**—The same general procedure for permanent tracheostomy was used in all cats. In brief, the cat was positioned in dorsal recumbency, and a ventral midline incision was made through skin and subcutaneous tissue overlying the first 5 to 6 cervical tracheal rings. The sternohyoid muscles were separated and sutured to each other dorsal to the trachea with horizontal mattress sutures. A tracheal stoma was created by removing a rectangular segment of the ventral aspect of the trachea extending 3 to 6 tracheal rings, being careful to spare the underlying mucosa. The tracheal mucosa was incised on the midline and sutured to adjacent skin in a simple interrupted or continuous suture pattern with absorbable or nonabsorbable suture material. Excess peristomal skin was removed as indicated. Subcutaneous tissue and skin proximal and distal to the stoma were closed in a routine manner.

**Statistical analysis**—Causes of upper airway obstruction were categorized as neoplasia, ILD, laryngeal

paralysis, and trauma. The ILD category included all laryngeal diseases with an inflammatory component (eg, granulomatous laryngitis or lymphocytic-plasmacytic laryngeal inflammation) for which an underlying cause could not be identified. The Cox proportional hazard regression method was used to determine whether cause of upper airway obstruction, age, body weight, sex, or the presence of mucous plugs at the tracheal stoma during recovery from anesthesia was associated with hospitalization time or outcome. Results are presented as hazard rate ratios and 95% confidence intervals. Analyses were performed with standard software.<sup>a</sup> Values of  $P < 0.05$  were considered significant.

## Results

Twenty-one cats met the criteria for inclusion in the study. There were 2 Siamese cats, 1 Maine Coon cat, and 18 mixed-breed cats. Fourteen were male (12 castrated), and 7 were female (all spayed). Information on age and body weight at the time of surgery was available for 20 cats. Mean  $\pm$  SD age at the time of surgery was  $9.8 \pm 4.9$  years; mean weight at the time of surgery was  $4.2 \pm 1.2$  kg ( $9.2 \pm 2.6$  lb).

Owners of all 21 cats reported that the cats had difficulty breathing prior to admission to the veterinary hospital, and all cats had signs of dyspnea at the time of initial examination. Additional initial complaints included stridor ( $n = 11$ ), dysphonia (10), coughing (6), weight loss (3), vomiting or retching (2), and dysphagia (1). Duration of clinical signs ranged from 0 to 224 days (median, 42 days). Twenty of the 21 cats had previously been treated medically, with the most common treatments including antimicrobials ( $n = 19$ ), corticosteroids (11), bronchodilators (3), a diuretic (1), an antihistamine (1), aspirin (1), an antacid (1), propranolol (1), an antifungal medication (1), and an opioid (1).

For 16 cats, radiographic reports were available for review. Eleven of the 16 cats did not have any clinically important radiographic abnormalities, 3 had cardiomegaly without any evidence of heart failure, 1 had pulmonary edema, and 1 had pulmonary edema with bronchopneumonia.

Results of preoperative laryngoscopy were available for all 21 cats. Abnormalities included a laryngeal or pharyngeal mass ( $n = 14$ ), laryngeal paralysis (4), diffuse laryngeal or pharyngeal swelling (2), and laryngeal deformation (1). Results of palpation of the neck were abnormal in 9 cats. Seven cats had evidence of a palpable mass or thickening during palpation of the neck. In the other 2 cats, palpation of the neck resulted in coughing or worsening of the dyspnea.

Causes of upper airway obstruction included neoplasia (squamous cell carcinoma [ $n = 6$ ] or malignant lymphoma [2]), ILD (5), laryngeal paralysis (4), trauma (3), and a laryngeal mass of unknown cause (1). In 2 of the 4 cats, laryngeal paralysis was a result of damage to the recurrent laryngeal nerves during surgical removal of a mass at the thoracic inlet. One cat with ILD had undergone endotracheal intubation for dental extractions shortly prior to the initiation of respiratory abnormalities.

**Surgical procedure**—All cats survived the surgical procedure. In 4 cats (3 with squamous cell carcinoma

and 1 with a laryngeal mass of unknown cause), total laryngectomy was performed at the same time permanent tracheostomy was performed.

**Postoperative care**—All cats were maintained in an intensive care unit with 24-hour observation while hospitalized after surgery. Fifteen cats received nebulization therapy after surgery, with frequency of nebulization ranging from every 2 to every 8 hours. Nebulization frequency varied with duration of hospitalization, with nebulization being less frequent as duration of hospitalization increased. Medical records for the remaining 6 cats did not contain any information on nebulization. Four of these cats survived to discharge and 2 died (1 because of a mucous plug obstruction and 1 because of pulmonary edema and bronchopneumonia).

Information on in-hospital orders for observation and cleaning of the tracheal stoma was available in medical records of 18 cats. Specific information on observation and cleaning of the tracheal stoma was not available for the remaining 3 cats, all of which survived to discharge, although cleaning was likely performed because 2 of the 3 cats were being treated with antimicrobials topically around the stoma. All 21 cats were treated medically after undergoing permanent tracheostomy, with the most common treatments including antimicrobials ( $n = 18$ ), corticosteroids (9), opioids (5), bronchodilators (4), *N*-acetyl cysteine (4), diuretics (2), meloxicam (1), and acepromazine maleate (1).

**Postoperative complications and outcome**—Fourteen of the 21 cats developed complications in the immediate postoperative period. The most common complication was dyspnea ( $n = 14$ ), which most often resulted from mucous plugs at the stoma or elsewhere in the respiratory system. Six of the 21 cats died while hospitalized, and in 5 of these 6 cats, the cause of death was attributed to asphyxiation, with mucous plugs observed in the bronchi and at the site of the tracheal stoma at necropsy in 3 cats and mucous plugs observed at the site of the tracheal stoma in the other 2. In the remaining cat, death was attributed to pulmonary edema and pneumonia. Other postoperative complications that were recorded included infection of skin around the tracheal stoma ( $n = 1$ ), vomiting (1), and anorexia (1).

Fifteen cats were discharged from the hospital; time from surgery to discharge ranged from the night of surgery to 13 days (median, 5 days). Regression analysis indicated that whether mucous plugs were detected at the tracheal stoma during recovery from anesthesia was not significantly ( $P = 0.077$ ) associated with hospitalization time (hazard rate ratio, 0.36; 95% confidence interval, 0.11 to 1.11).

Information on discharge instructions provided to owners was available for 13 of the 15 cats that were discharged from the hospital. There was substantial variation in recommendations given to owners regarding care and observation of the tracheal stoma. Owners of 8 cats were instructed to humidify the stomal site 1 to 4 times a day, with recommended methods of humidification including placing the cat in the bathroom while showering and using a standard room humidifier. Cleaning of the tracheal stoma was specifically recommended to owners of 10 cats, with cleaning frequen-

cy ranging from as needed to every 3 hours. Clipping hair around the stoma was recommended to owners of 7 cats. Owners of 3 cats were instructed to use saline solution to moisten the stomal site 2 to 3 times a day. Owners of 11 cats were instructed to administer antimicrobials systemically ( $n = 5$ ), topically (4), or both systemically and topically (2). Owners of 3 cats were instructed to administer prednisone, and the owner of 1 cat was instructed to administer meloxicam.

Seven of the 15 cats that were discharged were subsequently euthanized, with the most common reason for euthanasia being progression of neoplasia ( $n = 4$ ). One cat was euthanized 3 days after surgery because of extreme fractiousness, which prevented appropriate medical care and resulted in severe dyspnea. Another cat was euthanized 14 days after surgery because the owner was concerned that appropriate veterinary care would be unavailable after an anticipated move. The remaining cat was euthanized 395 days after surgery because of malignant lymphoma and renal failure. This cat had undergone permanent tracheostomy because of ILD, and at the time of euthanasia, the tracheal stoma was completely closed and the cat was breathing through its mouth.

Five of the 15 cats that were discharged subsequently died. One cat had been readmitted to the hospital 2 months after the initial surgery because of severe stricture of the stoma but died as a result of obstruction of the stoma with secretions before the stoma could be revised. The other 4 cats were suspected to have died as a result of occlusion of the airway by mucous plugs, but cause of death was not confirmed in these cats. One of these 4 cats had been hospitalized for 5 days after undergoing permanent tracheostomy and had developed a mucous plug obstruction at the tracheal stoma during this time that required assistance from the hospital staff to relieve the obstruction. The cat was found dead by the owner the morning after discharge. The second was a 2-month-old kitten that had undergone permanent tracheostomy because of deformation of the larynx secondary to trauma. The cat had initially recovered well, and the owner had insisted on taking the cat home the night of the procedure. The cat was found dead by the owner the next morning. The third was a 12-year-old Maine Coon that had undergone permanent tracheostomy because of laryngeal lymphoma. During a recheck examination 3 weeks after surgery, the stoma site reportedly had healed well, but the owner found the cat dead 7 weeks after surgery. The fourth was an 8-year-old mixed-breed cat that had undergone permanent tracheostomy because of laryngeal collapse and paralysis. The cat reportedly recovered from surgery without incident but was found dead 8 weeks after surgery.

Two of the 15 cats that were discharged from the hospital were still alive at the time of the present study. Follow-up times for these 2 cats were 3 months and 5 years. The cat that was still alive 3 months after surgery had undergone permanent tracheostomy because of inflammation of the oral cavity secondary to a fight with another cat. The cat had recovered well, and swelling of the oral cavity decreased during the first 2 weeks after surgery. The tracheal stoma was surgically closed 50 days after surgery. The cat that was still alive 5 years

Table 1—Results of Cox regression analysis of factors potentially associated with outcome (survived vs died) in 21 cats undergoing permanent tracheostomy because of upper airway obstruction.

Variable	Hazard rate ratio	95% CI	P value
Weight (kg)	0.57*	0.27–1.18	0.13
Age (y)	0.93*	0.79–1.10	0.42
Reason for tracheostomy			
ILD	6.61†	1.50–29.17	0.013
Neoplasia	0.28†	0.057–1.40	0.12
Laryngeal paralysis	0.75†	0.15–3.76	0.73
Documented mucous plugs at any time after recovery	3.21†	0.64–16.03	0.15
Concurrent laryngectomy	1.71†	0.41–7.17	0.46

\*The hazard rate ratio represents the increase in the likelihood of death associated with a 1-kg (2.2-lb) increase in body weight or a 1-year increase in age. †A hazard rate ratio > 1 indicates a higher likelihood of death among cats with the variable of interest, compared with cats without the variable of interest.  
CI = Confidence interval.

after surgery had undergone permanent tracheostomy because of laryngeal paralysis and was reportedly doing well at the time of final follow-up. The remaining cat that was discharged from the hospital was lost to follow-up.

Overall, median survival time for the 20 cats for which information was available was 20.5 days (range, 1 day to 5 years). Eleven of the 20 (55%) cats died, including 6 cats that died while hospitalized after surgery and 5 cats that died after discharge; 7 (35%) were euthanatized; and only 2 (10%) were still alive. Median survival time for the 7 cats that were euthanatized after discharge from the hospital was 35 days (range, 3 to 420 days).

Of the factors examined, only undergoing permanent tracheostomy because of ILD was significantly associated with outcome (Table 1), with cats that underwent permanent tracheostomy because of ILD 6.61 times as likely to die as cats that underwent permanent tracheostomy for any other reason. Detection of mucous plugs at the tracheal stoma during recovery from anesthesia was not significantly associated with outcome.

## Discussion

Results of the present study indicated that permanent tracheostomy is an uncommon procedure in cats with upper airway obstruction (our review of medical records for 6 veterinary medical teaching hospitals for the 18-year period from 1990 through 2007 yielded only 21 cases) that is associated with high complication and mortality rates. Cats undergoing permanent tracheostomy because of ILD had a higher likelihood of dying, compared with cats that underwent the procedure for any other reason. Other variables we examined, including age, body weight, whether mucous plugs were detected at the tracheal stoma during recovery from anesthesia, and concurrent laryngectomy, were not significantly associated with outcome. Given our findings, we suggest that alternatives to permanent tracheostomy, such as temporary tracheostomy or arytenoid lateralization, be considered when appropriate and that owners be thoroughly counseled as to the risks associated with permanent tracheostomy.

Fourteen of the 21 cats in the present study had at least 1 episode of dyspnea after surgery, with dyspnea most often resulting from mucous plugs at the stoma or elsewhere in the respiratory system. Overall, 11 of the 21 cats died, and in 6 of the 7 cats in which a cause could be documented, death appeared to be a result of asphyxiation associated with mucous plugs. The 4 cats in which a cause of death could not be documented all died at home, but we strongly suspected that death was a result of asphyxiation in these cats also. Two of these 4 cats died the night they were discharged from the hospital, and the other 2 died 7 and 8 weeks after surgery. Owners of the latter 2 cats reported that the cats had apparently been doing well at home before they died. In cats, the high risk that mucous plugs will result in occlusion of the respiratory tract following permanent tracheostomy may be attributable to the small size of the tracheal stoma and the reported propensity of cats to develop thick airway secretions.<sup>4</sup>

An important finding in the present study was the wide variation in postoperative care. Although certain tasks such as humidification and stomal site cleaning were commonly performed while cats remained in the hospital, the frequency, duration, and manner with which these tasks were performed varied. Similarly, guidelines for the care of human patients that have undergone tracheostomy have been inconsistent,<sup>9–11</sup> and although the potential benefits of humidification and airway suctioning have been frequent topics of research and discussion,<sup>9–13</sup> there appears to be little consensus on their use in human patients. Reducing mucous production and preventing airway obstruction are important goals in the postoperative treatment of patients that have undergone tracheostomy, and the number of cats in the present study found to have mucous plugs at the stomal site or elsewhere in the respiratory system emphasizes the importance of addressing these concerns.

Airway suctioning is currently considered an important treatment for most human patients that have undergone tracheostomy.<sup>9,13</sup> However, the optimal frequency and best method of suctioning have been the topic of continued debate. Current data seem to suggest that suctioning should be done only on an as-needed basis and should be as limited in extent as possible to reduce the risks of complications such as hypoxia, hypotension, atelectasis, infection, and mucosal damage.<sup>9,13</sup> For those veterinary hospitals where tracheostomy is performed, we recommend that intensive care staff be trained to recognize those patients that are in need of this treatment and that a protocol be developed to limit suctioning to the superficial airways, to use only clean catheters, and to use negative pressures no greater than 120 mm Hg.<sup>13,14</sup>

Postoperative treatment in cats that have undergone permanent tracheostomy should be aimed not only at removing mucous obstructions but also at reducing the tenacity of mucous secretions. Permanent tracheostomy alters the anatomy of the upper airway, with dysfunction of and damage to the mucociliary elevator being the most important consequence.<sup>9,13,14</sup> In human patients, humidification is routinely used as a method to reduce tenacity of mucous secretions, with the method and frequency of humidification tailored to individual patient need. In a

study<sup>15</sup> of alterations of the tracheal mucosa in dogs that underwent tracheostomy, it was found that the tracheal mucosa had adapted in most dogs by 8 weeks after surgery and had returned to a relatively normal histologic appearance by 16 weeks after surgery. Thus, it appears that humidification is required most frequently during the first 3 months after surgery and less frequently thereafter. When crusting and thick secretions are evident during the immediate postoperative period, nebulization may be required as frequently as every 2 to 4 hours.<sup>9</sup> Maintaining patient hydration is also important in maintaining normal mucociliary transport and consistency of mucous secretions.

Five of the 10 cats in the present study that were known or suspected to have died as a result of obstructive mucous plugs died  $\geq 7$  days after surgery, indicating that the risk of mucous plug obstruction is still present after discharge from the hospital and suggesting that current recommendations for home care have been inadequate. Hedlund et al<sup>1</sup> have suggested that owners initially inspect the stoma every 4 to 6 hours and remove accumulations of secretions as needed but that after the first month, as the tracheal mucosa begins to adapt, inspection frequency can be reduced to once or twice a day. Given findings for cats in the present study, we likewise recommend that owners inspect and clean the stoma and provide humidification at least every 4 to 6 hours for at least the first month after surgery, with frequency of stomal care adjusted thereafter on an individual basis as determined by the attending clinician. Although this time commitment will likely put a strain on the owner, family commitment is a prime factor in the success of tracheostomy in people.<sup>13</sup>

In the present study, granulomatous laryngitis and lymphocytic-plasmacytic laryngeal inflammation were grouped together as ILD. Underlying causes of these disease processes in cats have been identified,<sup>7,8,16</sup> and it is likely that multiple factors contribute to these conditions. In addition, ILD has previously been attributed to endotracheal intubation in cats,<sup>8</sup> and 1 cat in the present study had undergone endotracheal intubation for dental extraction shortly before signs of respiratory tract disease had first been noticed. A previous report<sup>16</sup> described 5 cats with laryngeal masses in which lymphoid hyperplasia was initially diagnosed that were subsequently found to have laryngeal neoplasia. Thus, it is possible that some cats in the present study classified as having ILD actually had neoplasia, with inflammatory changes representing a secondary response. For this reason, we recommend caution in drawing conclusions from this group of cats. Importantly, despite an early report<sup>17</sup> of an excellent prognosis for cats with granulomatous laryngitis,<sup>18</sup> subsequent reports<sup>7,8,16</sup> of cats with ILD have indicated that the prognosis is much more variable and often poor. Of the 5 cats with ILD in the present study, 4 died. It is possible that because of the underlying inflammation, cats with ILD were more likely to form mucous plugs that occluded the tracheal stoma. Given the high hazard rate ratio associated with ILD in the present study, we recommend that before a permanent tracheostomy is done in cats with this condition, medical treatment aimed at reducing the inflammation be provided first, with a temporary tracheostomy being performed if necessary.

Four of the cats in the present study underwent permanent tracheostomy for treatment of laryngeal paralysis. Surgical options for treatment of laryngeal paralysis in cats include unilateral and bilateral arytenoid lateralization, ventriculocordectomy, partial left arytenoidectomy, and castellated laryngofissure.<sup>18</sup> Although limited information is available on the outcome of surgical treatment of laryngeal paralysis in cats, arytenoid lateralization has reportedly been successful in ameliorating signs of laryngeal paralysis and has been associated with few life-threatening complications.<sup>18,19</sup> Considering the complication and mortality rates for cats in the present study, it seems prudent to exhaust alternative treatment options, such as arytenoid lateralization, in cats with laryngeal paralysis before attempting permanent tracheostomy.

Stricture of the tracheal stoma is a well-established complication of permanent tracheostomy.<sup>1,3-5</sup> Reported causes of stricture formation are poor mucosa to skin apposition, aggressive tissue handling, small initial stoma site, and surgical site infection. In the present study, 2 of the 7 cats that survived  $\geq 60$  days had severe or complete stricture of the stoma, and in 1 of these cats, obstruction of the strictured stoma by a mucous plug resulted in death of the cat. It is reasonable to assume that the inherent small size of the trachea in cats results in a high risk of stricture formation.

Limitations of the present study include those shortcomings inherent to most retrospective case series. Procedures were performed by multiple clinicians at various institutions, biopsy specimens were interpreted by multiple pathologists, postoperative care varied, and the quality of records was not consistent. Further, there was a relatively small number of cases identified during the study period, and the follow-up period was not standardized.

In conclusion, permanent tracheostomy appears to be an uncommon procedure in cats with upper airway obstruction that is associated with high complication and mortality rates. Intensive postoperative management is needed to prevent asphyxiation associated with mucous plugs, and cats undergoing this procedure for treatment of upper airway obstruction secondary to ILD may be at greater risk for death. Alternative treatment options such as temporary tracheostomy and arytenoid lateralization should be considered when appropriate, and owners should be thoroughly counseled as to the risks associated with permanent tracheostomy and the required postoperative management.

a. Egret Statistical Software, version 2.0, Cytel Software Corp, Cambridge, Mass.

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