Esophageal feeding tube placement and the associated complications in 248 cats

Citation for published version:
Breheny, C, Boag, A, Anderson, D, Cantatore, M, Chandler, M, Holm, SE, Le Gal, A, Nuttall, T & Gunn-Moore, D 2019, 'Esophageal feeding tube placement and the associated complications in 248 cats', *Journal of Veterinary Internal Medicine*, vol. 33, pp. 1306-1314. https://doi.org/10.1111/jvim.15496

Digital Object Identifier (DOI):
10.1111/jvim.15496

Published In:
Journal of Veterinary Internal Medicine

Received: 8 November 2018 | Accepted: 29 March 2019

DOI: 10.1111/jvim.15496

Journal of Veterinary Internal Medicine Open Access

ACVIM American College of Veterinary Internal Medicine

STANDARD ARTICLE

Esophageal feeding tube placement and the associated complications in 248 cats

Craig R. Breheny[1] | Alisdair Boag[1] | Alice Le Gal[1] | Sven-Erik Hõim[2] | Matteo Cantatore[2] | Davina Anderson[2] | Tim Nuttall[3] | Marjoie L. Chandler[4] | Danièlle A. Gunn-Moore[1]

[1]Department of Internal Medicine, Royal (Dick) School of Veterinary Studies, Ringgold Standard Institution—Internal Medicine, University of Edinburgh, Easter Bush, United Kingdom

[2]Surgery Department, Anderson Moores, Winchester, United Kingdom

[3]Department of Dermatology, Royal (Dick) School of Veterinary Studies, Ringgold Standard Institution—Internal Medicine, University of Edinburgh, Easter Bush, United Kingdom

[4]Nutrition Department, Vets Now—Nutrition, 11 Mavisbank Place, Lasswade, United Kingdom

Correspondence
Craig R. Breheny, Royal Dick School of Veterinary Studies, Ringgold Standard Institution—Internal Medicine, Hospital for Small Animals, University of Edinburgh, Easter Bush EH25 9RG, United Kingdom.
Email: cbreheny@exseed.ed.ac.uk

Abstract

Background: Esophageal feeding tubes are commonly used to provide enteral nutrition to cats, but their use is associated with adverse effects.

Objectives: To evaluate the complications associated with e-tube placement in cats and to identify factors predisposing to these complications.

Animals: Cats that had an esophageal feeding tube placed (n = 248).

Methods: This was a retrospective case review in which clinical records were interrogated across 2 referral centers to identify records of cats that had esophageal tubes placed. Clinical data were collected for signalment, clinical indication, method of placement, time of removal, and any complications. Logistic regression was then employed to assess the odds of an increase in complications, including infection and death.

Results: For those cats that survived to discharge, tubes were in place for a median of 11 days, ranging from 1 to 93 days. Complications occurred in 35.8% of the cats, with the most common being tube dislodgement (14.5%), followed by stoma site infections (12.1%). Cats receiving glucocorticoids or oncolytic agents (OR = 3.91; 95% CI, 1.14-13.44) and with discharge at the stoma site (OR = 159.8; CI, 18.9-1351) were at an increased odds of developing a stoma site infection, whereas those with a lower weight (OR = 1.33; 95% CI, 1.02-1.75) or (pancreatic [OR = 4.33; 95% CI, 1.02-18.47], neoplastic [OR = 15.44; 95% CI, 3.67-65.07], respiratory [OR = 19.66; 95% CI, 2.81-137.48], urogenital [OR = 5.78; 95% CI, 1.15-28.99], and infectious diseases [OR = 11.57; 95% CI, 2.27-58.94]) had an increased odds of death. The duration of time in place and the cat being discharged with the tube in place were not associated with an increased risk of infection or death.

Abbreviations: BCS, body condition score; CI, confidence interval; cm, centimeter; DSH, domestic shorthair; *E. coli*, *Escherichia coli*; E tube, esophagostomy tube; Fr, French gauge; kg, kilogram; O tube, oesophagostomy tube; OR, odds ratio.

Conclusions and clinical importance: Owners should be made aware of the potential risks involved and their predisposing factors.

KEYWORDS
esophagostomy, E-tube, O-tube

1 | INTRODUCTION

Anorexia is a common clinical manifestation of illness that can compromise clinical outcome and it is often observed as a nonspecific sign of illness in cats.[1] Early and appropriate nutritional support is crucial for recovery from illness in both human and veterinary medicine.[2] This support addresses the nutrient requirements to assist in recovery, including but not limited to cellular metabolism, tissue healing, and immunocompetence.[1,3,4]

Feeding tubes bypass diseased or traumatized tissues, as well as removing reliance upon a cat's appetite to meet nutritional demands. They can also be used to administer medications, provide a natural route for water delivery in cats that might be susceptible to volume overload, or both. Continued enteral nutrition maintains enterocyte health, promotes local immunoglobulin production, ensures effective gastrointestinal integrity to minimize bacterial translocation, and promotes hepatic and renal blood flow in rodent models.[5–7] Early enteral nutrition has been shown to reduce hospitalization times in dogs with septic peritonitis.[8] Additionally, enteral nutrition is usually more cost effective than parenteral options.[3]

Esophageal feeding tubes have numerous benefits in comparison to other methods of delivering enteral nutrition. They are relatively easy to place and do not require any specialized equipment.[9] The gauge of the tubes is usually adequate to allow a variety of food types to be administered, and can also facilitate the administration of medication. Esophagostomy tubes (e-tubes) are thought to be generally well tolerated and there is no lower limit as to how long they must stay in place, in contrast to the minimal time in place necessary for gastrostomy or jejunostomy tubes. Cats can be discharged home with e-tubes in place, allowing for a shorter duration of hospitalization than otherwise possible.[8] However, their placement is not an entirely benign process, with tube dislodgement, stoma site infection, and trauma of cervical neurovascular structures being possible consequences.[10,11] There is also the necessity for general anesthesia to facilitate tube placement, which might not be possible in critically ill cats.

There is a paucity of information in both the human and veterinary literature regarding e-tube placement, with only 1 previous study describing complications in 46 cats.[11] The number of cases in that study was relatively small and they did not investigate stoma site infections in detail. As more veterinarians use this technique, it is important that veterinarians and owners are aware of the care needed in managing these cats in the home as well as the clinic environment, the likely duration an e-tube will be in place, and of potential complications, including their relative frequency of occurrence.

The aim of this study was to identify the nature and prevalence of complications following e-tube placement, and whether any cat factors influence this. Our hypothesis was that those cats that were immunosuppressed, and had tubes in place the longest would be most susceptible to infection.

2 | MATERIALS AND METHODS

This study was conducted at 2 referral centers in the United Kingdom, Centers A and B. Clinical records from May 1, 2005, until May 1, 2017, were reviewed in order to identify cats in which an e-tube had been placed. The following terms were used to search electronic clinical records: "O tube," "O-tube," "E tube," "E-tube," "Oesophageal feeding tube," "Esophageal feeding tube," "Oesophagostomy tube," "Esophagostomy tube," and "feeding tube." Alongside this, clinical billing records were reviewed for either the e-tube feeding charge, or the e-tube placement charge.

The criteria for case selection were that placement of an e-tube had been recorded; the date that this occurred; that complications were noted; and that the date of removal was recorded. Cases were excluded if the date of removal (intentionally or otherwise) was not recorded. Clinical records were reviewed from the first consultation at the referral institution until the e-tube was removed, including those in which it was removed following death.

The following details were identified in the cats' clinical records for each tube placed: case signalment; body weight; body condition score (BCS); diagnosis, if achieved; date the e-tube had been placed; make (ie, manufacturer) and gauge of tube; whether antimicrobials were being administered at the time of tube placement, if so, which antimicrobial drug(s) were administered; presence and nature of complications; whether discharge was present at the stoma site and the date the discharge was identified (the gross character of the discharge was inconsistently available so was not recorded); whether an infection was identified at the stoma site and the date the infection was noted; culture and in vitro antimicrobial sensitivity profile; whether the cat had a systemic infection present; whether the cat was receiving either glucocorticoids or oncolytic agents (the dosing and timings these were started was inconsistently available so not recorded); whether the cat was discharged from the hospital with the tube in place; the date the tube was removed and whether removed intentionally or by the cat; and whether the cat was euthanized with the tube in place or not. The following data were then calculated: time from presentation to the referral center to tube placement (days); number of days from tube placement to discharge being noted around the stoma site (where applicable); number of days from tube placement to stoma site infection (where applicable); and the number of days that the tube was left in place.

An e-tube-associated discharge was defined as secretion from the stoma site, which was culture negative or in which cytology did not identify intracellular bacteria. Alternatively, for cases that did not have cytology or culture performed, this was defined as a secretion that resolved spontaneously without topical or systemic antimicrobial therapy. This was not considered a complication if it was the only finding identified.

A clinically relevant e-tube infection was defined as signs of stoma site inflammation, in which bacteria were cultured, or in which intracellular bacteria were identified on cytology of the discharge or antimicrobial therapy was necessary to achieve clinical resolution.

Diseases were categorized to allow for exploration of these underlying associations with outcomes of interest. The categories of disease were gastrointestinal, hepatic, pancreatic, traumatic, neoplastic, respiratory, cardiac, urogenital, septic, and infectious. Cats had their disease categorized as "other" if they did not fit into these categories. If a cat had more than 1 condition, the condition that was most likely to be the cause of the presenting clinical signs was used. Survival time was defined as survival to the last documented time point in the clinical records. If a cat had several e-tubes placed over time, only the first tube was included, to minimize clustering and artificially skewing the data.

Data were organized in Microsoft Excel© 2013 version 15 (Microsoft Corporation, Redmond, WA, USA), and statistical analyses were performed using SPSS© Statistics for Windows, version 24.0 (IBM Corp, Armonk, NY, USA). Incidence over time was evaluated by splitting the time of data collection into equal time frames and comparing with a contingency table. Continuous data were tested for normality by manual inspection of Q-Q plots and skewness, kurtosis analysis.[11,12]

Univariate binary logistic regression was performed to assess the association of variables with outcomes of interest. One of the variables of interest was death, with potential associated factors including age, weight, BCS, the presence of systemic inflammation (based on the final diagnosis and whether this would be expected to cause systemic inflammation, e.g., pancreatitis), presence of systemic infection (based on the final diagnosis and whether this would be expected to cause systemic infection, e.g., sepsis), classification of underlying disease, glucocorticoids or oncolytic agents administered, and institution where the tube was placed. The other variable of interest was infection of the stoma site, with the following variables assessed for a relationship: age, weight, BCS, systemic inflammation presence, systemic infection presence, glucocorticoids and chemotherapy agents medications administered, antibiotics administered prior to tube placement, antibiotics administered after tube placement, number of days the tube was in place, classification of underlying disease, presence of discharge at the stoma site, tube gauge, make of tube, type of tube, and institution where the tube was placed. Multivariable binary logistic regression for each outcome of interest was performed using risk factors with liberal associations in univariable modeling ($P < .2$). Multivariable models were constructed as manual backward stepwise procedures, using the Hosmer-Lemeshow test and the Omnibus test of model coefficients, final model variables were examined for correlations and interactions.

For normally distributed data, comparisons were made using 2-sided unpaired Student's *t*-tests. Data not normally distributed were analyzed using the Mann-Whitney *U* test. Categorical data were analyzed using contingency tables, with Chi-squared or Fisher's exact test used for comparisons. Significance was accepted at $P < .05$.

3 | RESULTS

3.1 | Population

A total of 880 cats were identified from a clinical record search, of which 248 cats met the inclusion criteria and were analyzed in the study; 189 of these were from Center A and 59 from Center B. The majority of the cats (59.3%) were domestic shorthaired cats, followed by domestic longhaired (7.7%), British Shorthaired (4.8%), Maine Coon (4%), and Bengal cats (4%); the remainder were a combination of other breeds. The age of the cats was normally distributed, with a mean of 7 years 7 months old (SD of 4 years 5 months, range of 6 months to 22 years old). There were 146 male cats, of which 142 were neutered, and 102 female cats, of which 98 were neutered.

Weight data were available for 237 cats; the data were not normally distributed, with a median of 4.2 kg (range 1.46-8.3 kg, with quartiles 3.41 and 5 kg), recording BCS was frequently absent, with 108 cases having scores recorded. The median score was 4 (range of 1-9, with quartiles of 3 and 5).

The underlying conditions for which the cats were presented for are summarized in Table 1. The infectious diseases diagnosed were 5 cats with toxoplasmosis, 3 with feline infectious peritonitis, 2 with feline calici virus infection, and 1 each of feline immunodeficiency virus-associated disease, salmonellosis, cow pox viral infection, mycobacteriosis, and *Mycoplasma felis* infection.

The 29 "other" cases were those in which a diagnosis was not achieved; the presenting complaint was noted instead, as were the conditions that did not belong to any other category. These included a combination of anorexia, weight loss, anemia, ataxia, pyrexia of unknown origin, seizures, hemophagocytic syndrome, peripheral vestibular syndrome, dysautonomia, hypereosinophilic syndrome, orofacial pain syndrome, coagulopathy, primary hyperparathyroidism, tooth root abscess, necrotic ventral abdominal fat, hypertrophic cardiomyopathy, total ear canal ablation, peritoneopericardial diaphragmatic hernia, chronic nasal discharge, tricuspid valve endocarditis, biliary carcinoma, temporomandibular joint dysplasia, and diabetic ketoacidosis.

The glucocorticoids prednisolone, dexamethasone, and budenoside were administered while the tube was being placed, or was in place. The chemotherapeutics that were administered were vincristine, cyclophosphamide, doxorubicin, lomustine, and mitoxantrone.

TABLE 1 The underlying diseases that necessitated esophageal feeding tube placement. Several of these categories are expanded upon in the main manuscript

Disease category	Number	Percentage
Traumatic	40	16.1
Neoplastic	40	16.1
Pancreatic	35	14.1
Other	29	11.7
Gastrointestinal	28	11.3
Hepatopathy	23	9.3
Urogenital	17	6.9
Infectious	15	6.0
Septic	12	4.8
Respiratory	9	3.6
Total	248	100

"Other" stands for those in which the final diagnosis did not fall into any of the other categories, or in those cases where a diagnosis was not reached.

3.2 | E-tubes description and complications

The majority of the e-tubes were placed either on the day of presentation (63/248, 25.4%) or the following day (79/248, 31.9%). The most common tube manufacturer was Surgivet (silicone, 75/248, 30%), followed by Mila (polyurethane, 54/248, 21.8%), Cook (polyurethane, 20/248, 8.1%), and Portex (polyvinyl chloride, 16/248, 6.5%); 83 cases did not have the tube make recorded. Mila tubes were the most commonly utilized in the Royal (Dick) School of Veterinary Studies and Surgivet in Anderson Moores.

The tube size was recorded in 152 cases. The most common tube sizes were 19Fr (68/152) and 14Fr (66/152), with 14Fr being most commonly used in the Royal (Dick) School of Veterinary Studies, whereas in Anderson Moores it was 19Fr.

Of the 162 cats that survived (162/248, 65.3%), the tube was in place for a median of 11 days (range from 1 to 93 days, with quartiles of 7 and 20 days); 78 of these 162 cats (48.1%) experienced a complication associated with their tube. Of the 86 cats that died (86/248, 34.7%), death occurred at a median of 4 days after presentation (range 0 to 66 days, and quartiles of 2 and 8 days); 11 of these 86 cats (12.8%) had a complication associated with their e-tube.

Complications associated with having an e-tube in place were reported in 89 cats (35.9% of all cats). The frequency of complications is detailed in Table 2. The most common complication was dislodgement of the tube, which occurred due to entire removal by the cat (17/89, 19.1%), dislodged by the cat necessitating removal (11/89, 12.4%), and dislodged by the cat, followed by re-positioning and re-suturing (8/89, 9%). No cat had more than 1 complication recorded. There was no significant difference between complications and when they were placed within the 12 years of data collection ($P = .725$).

Infection associated with the tube was the second most common complication encountered in the study (30/89, 33.7%). An additional 45 cats had a discharge at the stoma site that was self-limiting and did not necessitate treatment, so was not considered an infection. The median time to stoma discharge was 6 days (range 1 to 62 days, with quartiles of 3 and 7 days).

Additional complications, which occurred with the same frequency as each other, were vomiting resulting in regurgitation of the tube (7/89, 7.9%) and tube blockage whether it was resolved or not (7/89, 7.9%). Of the 7 cats recorded as having a blockage; 5 had tube size information available, 3 recorded as 19Fr, 1 as 14Fr and 1 as 12Fr. Seven cats had "vomited e-tube" recorded as a complication, of these only 1 had tube size available, which was 12Fr. Nineteen cats had "dislodged" recorded as a complication; of these, 8 had no e-tube size recorded, of those with e-tube size recorded, 4 were 19Fr, 1 16Fr and 6 14Fr. There were also complications that occurred in individual cats, including temporary laryngeal paralysis, focal esophageal rupture, irritation of the tube site despite grossly-normal appearance of the stoma, displacement of the tube causing a pharyngeal obstruction, inflamed stoma in the absence of infection, dry discharge at the tube site in the absence of infection, mucoid discharge surrounding the tube, sterile necrosis surrounding the stoma site, and vomiting following tube placement.

3.3 | Antimicrobials

Antimicrobial drugs were given to 167 cats, while their e-tubes were in place; 85 started receiving them prior to tube placement and 82 started them after placement. The remaining 81 cats did not receive antibiotics, while their e-tubes were in place, although 23 of these cats had received antibiotics prior to tube placement. A single antibiotic was given to 121 cats, while 31 cats received 2, 14 cats received 3, and 1 cat received 4 antibiotics. The antibiotic drugs prescribed, their combinations, and the frequency of each are available in the supplementary materials. The cat that received 4 antibiotics was given a combination, although not concurrently, of amoxicillin-clavulanate, clindamycin, marbofloxacin, and trimethoprim sulphonamide.

TABLE 2 The complication types encountered in the study population. Those complications comprising the "Other" category are detailed further in the manuscript

Complication type	Number	Percentage
None	159	64.1
Stoma site infection	30	12.1
Removed by cat	17	6.9
Dislodged by cat, removed	11	4.4
Other	9	3.6
Dislodged by cat, resutured	8	3.2
Tube vomited out	7	2.8
Tube blockage	7	2.8
Total	248	100

"Other" stands for those in which the final diagnosis did not fall into any of the other categories, or in those cases where a diagnosis was not reached.

TABLE 3 Univariate analysis of association of variables with stoma site infection

Variable	N	B	SE	Wald	df	Sig	OR	Lower 95% OR	Upper 95% OR
Age	248	0.004	0.004	0.97	1	0.33	1.00	0.99	1.01
Weight	237	−0.10	0.17	0.35	1	0.55	0.90	0.65	1.26
Institution	248	0.37	0.43	0.72	1	0.40	1.44	0.62	3.34
Systemic infection	248	−19.36	7463.65	0.000	1	0.99	0.00	0.00	
Systemic inflammation	248	−0.25	0.40	0.39	1	0.53	0.78	0.35	1.71
Glucocorticoid or oncolytic administration	248	0.72	0.41	3.03	1	0.082	2.05	0.91	4.60
BCS	108			3.52	8	0.90			
Death	248	−2.17	0.75	8.5	1	0.004	0.11	0.03	0.49
ABs with tube	248	0.33	0.44	0.55	1	0.46	1.38	0.59	3.26
Prior ABs	248	−0.18	0.40	0.19	1	0.66	0.84	0.38	1.84
Days in place	248	0.01	0.01	0.33	1	0.57	1.01	0.98	1.03
Home with tube		0.26	0.39	0.44	1	0.51	1.3	0.60	2.78
Class of disease	248			1.744	9	0.99			
Discharge at e-tube site	248	4.71	1.03	20.91	1	0.000	112	14.8	841
Type of e-tube:	248			7.125	4	0.13			
Baseline is "type not recorded"	83						1		
SurgiVet	75	0.392	0.531	0.545	1	0.46	1.48	0.52	4.19
Mila	54	1.132	0.513	4.870	1	0.027	22 222	1.14	8.48
Cook	20	−0.560	1.099	0.259	1	0.61	0.57	0.066	4.93
Portex	16	−0.323	1.106	0.085	1	0.77	0.72	0.083	6.32
Size of e-tube	152			0.90	5	0.97			

Abbreviations: Abs, antimicrobials; B, B statistic; BCS, body condition score; Df, degrees of freedom; N, number; OR, odds ratio; SE, standard error; Sig, significance; Wald, Wald statistic.

An infection was documented after the placement of an esophageal e-tube in 30 cats, 19 of these had a culture performed, of which 1 recorded no growth and was instead diagnosed based on a combination of cytology and a failure to resolve spontaneously. Culture identified only 1 organism in 12 cases: *Escherichia coli* (n = 5), *Streptococcus canis* or Beta hemolytic *Streptococci* (n = 2), *Pasteurella multocida* (n = 2), *Enterococcus* spp. (n = 1), *Staphylococcus* spp. (n = 1), and *Pseudomonas aeruginosa* (n = 1). Three cats had 2 organisms isolated: *E. coli* with *Enterococcus* spp. (n = 2), and *Pasteurella multocida* with *Staphylococcus aureus* (n = 1). Two cats had 3 organisms identified; *Streptococcus zooepidemicus*, *Enterococcus* spp. and *E. coli*; and *Candida* spp., *Enterococcus* spp. and *E. coli*. The remaining cat had 4 organisms cultured; methicillin resistant *Staphylococcus pseudintermedius*, *E. coli*, *Pasteurella multocida* and *Pasteurella pneumotropica*. The resistance patterns of these isolates are listed in Appendix 1. Of the 30 cats with an infection, 22 received antibiotics, 8 prior to tube placement, and 14 afterward

TABLE 4 Multivariate analysis of association of variables with stoma site infection

	B	S.E.	Wald	df	Sig.	OR	Lower 95% CI	Upper 95% CI
Glucocorticoids or chemotherapy agents used?	1.36	0.63	4.68	1	0.031	3.9	1.14	13.44
Died	−1.7	0.86	3.86	1	0.050	0.18	0.03	0.99
E-tube site discharge?	5.07	1.09	21.7	1	0.000	159.79	18.90	1351
E-tube type			10.90	4	0.028			
Baseline is "type not recorded"						1		
SurgiVet	−0.93	0.69	1.85	1	0.17	0.39	0.10	1.51
Mila	1.51	0.75	4.10	1	0.043	4.51	1.05	19.4
Cook	−0.69	1.37	0.25	1	0.62	0.50	0.04	7.3
Portex	1.14	1.51	0.58	1	0.45	3.14	0.16	60

Abbreviations: Abs, antimicrobials; B, B statistic; BCS, body condition score; Df, degrees of freedom; N, number; OR, odds ratio; SE, standard error; Sig, significance; Wald, Wald statistic.

TABLE 5 Univariate analysis of association of variables with death

Variable	N	B	SE	Wald	df	Sig	OR	Lower 95% OR	Upper 95% OR
Age	248	0.006	0.003	5.28	1	0.022	1.01	1.001	1.011
Weight	237	−0.34	0.13	7.35	1	0.007	0.71	0.56	0.91
Institution	248	0.15	0.31	0.23	1	0.63	1.16	0.63	2.13
Systemic infection	248	−0.01	0.42	0.001	1	0.98	0.99	0.44	2.24
Systemic inflammation	248	0.50	0.27	3.49	1	0.062	1.66	0.98	2.81
Glucocorticoids or oncolytic agents used	248	0.15	0.31	0.23	1	0.63	1.16	0.63	2.13
Body condition score	108			4.9	8	0.77			
Disease category (baseline = primary GI)	28			29.35	9	0.001	1		
Hepatopathy	23	1.08	0.77	1.94	1	0.16	2.94	0.65	13.40
Pancreas	35	1.59	0.70	5.13	1	0.024	4.92	1.24	19.57
Trauma	40	0.73	0.73	1.02	1	0.31	2.08	0.50	8.67
Other	29	1.16	0.74	2.44	1	0.12	3.18	0.75	13.51
Neoplastic	40	2.74	0.7	15.53	1	0.000	15.48	3.96	60.45
Respiratory	9	2.34	0.91	6.67	1	0.010	10.42	1.76	61.67
Urogenital	17	1.51	0.79	3.63	1	0.057	4.55	0.96	21.56
Septic	12	1.02	0.90	1.28	1	0.26	2.78	0.47	16.35
Infectious	15	2.25	0.80	7.92	1	0.005	9.52	1.98	45.75

(but were being administered at the time the infection was identified). The remaining 8 did not receive antibiotics systemically and the stoma site infections were managed topically.

Univariate binary logistic regression for stoma site infections identified that the use of glucocorticoids and chemotherapy agents, presence of a discharge at the stoma site, whether the cat died, and the tube manufacturer as potential explanatory variables for infection. These were taken forward to the multivariable analysis (Table 3). Multivariable logistic regression showed cats with a discharge at the stoma site (OR = 159.79, lower 95% OR 18.9, upper 95% OR 1351), Mila feeding tubes (OR = 4.51, lower 95% OR 1.05, upper 95% OR 19.4), and those receiving glucocorticoids or chemotherapy agents (OR = 3.9, lower 95% OR 1.14, upper 95% OR 13.44) had an increased odds of developing a clinically relevant infection necessitating

TABLE 6 Multivariate analysis of association of variables with death

	B	SE	Wald	df	Sig	OR	95% CI for OR	
							Lower	Upper
Weight (kg)	−0.29	0.14	4.53	1	0.033	0.75	0.57	0.98
Institution (A)	0.49	0.37	1.78	1	0.18	1.63	0.8	3.33
Age (months)	0.003	0.003	0.76	1	0.38	1.003	0.99	1.10
Disease category								
Compared to primary GI			26.13	9	0.002	1		
Hepatopathy	1.14	0.79	2.07	1	0.15	3.11	0.66	14.62
Pancreas	1.47	0.74	3.92	1	0.048	4.33	1.02	18.47
Trauma	0.71	0.80	0.78	1	0.38	2.03	0.42	9.74
Other	1.43	0.77	3.44	1	0.064	4.17	0.92	18.89
Neoplastic	2.74	0.73	13.92	1	0.000	15.44	3.67	65.07
Respiratory	2.98	0.99	9.01	1	0.003	19.66	2.81	137.48
Urogenital	1.75	0.82	4.54	1	0.033	5.78	1.15	28.99
Septic	1.25	0.92	1.82	1	0.18	3.48	0.57	21.28
Infectious	2.45	0.83	8.68	1	0.003	11.57	2.27	58.94

Abbreviations: Abs, antimicrobials; B, B statistic; BCS, body condition score; Df, degrees of freedom; N, number; OR, odds ratio; SE, standard error; Sig, significance; Wald, Wald statistic.

treatment. Cats that died had a decreased odds of developing an infection requiring treatment (OR = 0.18, lower 95% OR 0.03, upper 95% OR 0.99). This is summarized in Table 4. There were no interactions between variables in the final model and no problems with collinearity.

Univariate binary logistic regression for death highlighted older age, decreased weight, disease category, and the presence of systemic inflammation as potential explanatory variables. These variables were then taken forward to the multivariable analysis (Table 5). Also included within the multivariate analysis was the institution the case was managed at as this was a potential confounding variable. The final multivariate model (summarized in Table 6) showed that death was influenced by cat weight (OR = 1.33 for lower weight, lower 95% OR 0.57, upper 95% OR 0.98), and respiratory (OR = 19.66, lower 95% OR 2.81, upper 95% OR 137.5), neoplastic (OR = 15.44, lower 95% OR 3.67, upper 95% OR 65.07), infectious (OR = 11.57, lower 95% OR 2.27, upper 95% OR 59.9), urogenital (OR = 5.78, lower 95% OR 1.15, upper 95% OR 29), and pancreatic (OR = 4.33, lower 95% OR 1.02, upper 95% OR 18.5) diseases. Age did not have a significant effect, but its inclusion improved the model, and there are clear a priori reasons for its inclusion. There were no interactions between variables in the final model and no problems with collinearity.

4 | DISCUSSION

This large-scale study investigates the placement of e-tubes in companion animal medicine, alongside the consequences, their predisposing factors, and outcomes of having these tubes in place. The median time from hospitalization to e-tube placement was 1 day. This is appropriate given that nutritional support of anorexic cats should be commenced within 3 days of anorexia, or moderate hyporexia, to minimize the risk of secondary hepatic lipidosis.[1] However, the current study did reveal that having an e-tube in place is not entirely benign, as it carried a complication rate of 35.8%, increasing to 48% in the cats that survived to discharge. The most frequent complication was tube dislodgement, followed by a clinically stoma site infection. Other problems ranged in severity from tube obstruction, and temporary laryngeal paralysis to focal esophageal rupture. No cats in this study died from or suffered from severe morbidity related to the tube that was not remedied by its removal. Previous studies have assessed the relative merits and complications of different types of feeding tube. Naso-gastric[13] and endoscopically placed low profile gastrostomy tubes in dogs and cats[14] have complication rates of 37% and 62.5%, respectively, compared to a complication rate of 71% in cats with e-tubes in a previous study.[11] The reasons for the discrepancy between the latter study and the current 1 are unclear, but could include different clinic populations, or improvements in e-tube materials, placement techniques, and aftercare in the last 15 years.

Stoma site infection was the second most commonly encountered complication, occurring in 12.1% of cases. Organisms associated with stoma site infections can originate from the skin, oral cavity, gastrointestinal tract, in-contact animals and humans, or, potentially, the environment. Most of the infections in this study involved commensal organisms rather than primary pathogens or environmental organisms. *E. coli* and *Enterococcus* spp. were the 2 most commonly isolated bacteria; together they comprised 13 of the 28 (46.4%) bacteria isolated. These are normal commensals of the gastrointestinal tract.[15,16] *Pasteurella* species were isolated in 3 of the cases (10.7%). *Pasteurella* spp. are common commensals of the feline oral cavity and respiratory tract,[17] with 1 study identifying them in 90% of feline gingival margins.[17] *Streptococcus canis* is also a natural commensal of the canine and feline respiratory tract,[18] and a variety of staphylococcal species can be isolated from skin and mucocutaneous sites.[19]

There are several ways bacteria can contaminate stoma sites. Direct contact could occur when cats adopt a natural sleeping position, curled up with their head close to their perineum. This presents an opportunity for perineal fecal contamination (either gross or microscopic) to contact the stoma site or dressings. Such contamination could be facilitated by poor stoma site hygiene, prolonged duration between bandage changes, and can be complicated by conditions, which result in altered fecal consistency.

An additional source of infection is esophageal contents. *Streptococcus* spp. are isolated in 98-99% cases of esophageal cultures in humans, with other pathogens being isolated with individual variation including *Fusobacterium* spp., *Neisseria* spp., *Hemophiluus* spp., and *Prevotella* spp[20]. Currently, there is not comparable data on the normal flora of the feline esophagus, making it difficult to determine if bacteria originate from the esophagus or from elsewhere. The upper gastrointestinal tract remains patent when an e-tube is in place, and bacteria can still be ingested when the cats groom themselves (as evidenced by 1 of the tubes becoming blocked by hair), or through ingestion of food or prey. In addition, swallowed oral secretions and, potentially, refluxed gastrointestinal contents could contaminate the stoma internally. This, in those cats where immunocompetence was inadequate, could then progress to an infection. This could influence local flora, with selection pressures allowing certain bacteria to grow unopposed. Bacteria from the gastrointestinal tract of prey species cannot be ruled out as potential source of infection, although this is less likely as cats with e-tubes are often too ill to be hunting or are usually kept indoors.

It is clear that e-tubes predispose to infections with opportunistic bacteria. Importantly, the normal anatomical protective mechanisms of the skin are bypassed once the tube is in place. It also creates a connection between 2 populations of flora that are naturally separated, altering interactions and potentially allowing overgrowth of certain populations. The e-tube itself will cause local tissue irritation, precipitated by chronic micro-movements and foreign body reaction despite the tubing material being relatively inert. Self-trauma, secondary to discomfort or irritation, could cause secondary wounds or damage to the tube, gross or microscopic, allowing bacteria to colonize more readily and potentially form antibiotic-resistant biofilms.[21] In addition, it is likely that immunosuppression secondary to underlying disease might play a role in the development of infection.[22] Administration of glucocorticoids or chemotherapeutic medications was associated with an increased odds of developing a stoma site infection. This is not an unexpected finding with a higher rate and severity of complications previously reported in veterinary cats receiving prednisolone at the time of percutaneous gastrostomy tube placement.[23] The current study supports the concept that owners and the veterinary health care team should be aware of the potentially increased risk of stoma site infection if the cats are receiving glucocorticoids or chemotherapy agents, and that the importance of appropriate stoma site hygiene should be stressed.

In this study, the information available in the multivariate model showed that Mila tubes were associated with a higher odds of developing an infection, suggesting that it might be prudent to use e-tubes made from other materials. The gauge of the tube did not influence the odds of infection, potentially suggesting that the widest gauge possible should be used to facilitate ease of feeding and minimizing the risk of blockage, that is, so long as it is not so large as to cause discomfort. However, these findings should be interpreted with caution as the tube manufacturer was only available for a subset (n = 165) of the cats, and 83 of the cats (33.4%) did not have the tube type or size recorded.

Cats that died were at a lower risk of e-tube complications, including stoma site infection. Cats died a median of 4 days after presentation to the referral center, whereas the median time to stoma site discharge and infection occurred at day 6. The most likely explanation for these findings is that the cats that died due to their underlying condition did so before there was time to acquire an e-tube infection. One cat developed subcutaneous emphysema secondary to focal esophageal rupture, at a site separate from the intubation site. This cat presented with a megaesophagus and was diagnosed with dysautonomia on histopathology, and esophageal ulceration was noted on gross pathology. The site of focal rupture was 5 cm distal to the intubation site and was not believed to be related to the tube placement.

The length of time that the tube was in place, whether the cat was discharged home with the tube still in place, and the underlying disease process were not associated with an increased odds of infection. This suggests that when appropriate care is taken of the stoma site, these tubes can be left in for long periods of time and managed at home by owners, without expecting an increase in stoma site infections. While the median time the tubes were in place were 11 days, 1 case it was in place for 94 days, so protracted periods of e-tube placement was assessed. This information can be useful in assisting owners with informed decision making as to whether they would like to proceed with e-placement, taking into account the stoma site care involved, and likely duration.

In the multivariate model, the main factors associated with death were body weight and certain disease processes. Those with a lower body weight had an increased odds ratio of dying of their disease. Lower body weight has been previously shown to be associated with a poorer prognosis in a number of conditions.[24–26] Unfortunately, the BCS was not available for a large number of the cats in the current study, so it is difficult to identify whether it was the thinner cats that had the poorer prognosis or just those with a smaller stature. The explanation for why certain disease processes were associated with a poorer prognosis is less apparent. As with all veterinary studies concerning survival, a major confounding factor is the role of the owner and their wishes for when euthanasia is performed. Cats with traumatic and septic illness necessitating e-tube placement incurred a more favorable prognosis; part of this might be that the owners were aware of the underlying disease process at the time of e-tube placement and were invested in continuing in the knowledge of the prognosis and required management intensity. With the other conditions, it might be that euthanasia occurred as a result of certain diagnoses with a genuine or perceived poor prognosis, although this is purely speculative.

There are a number of limitations to this study. The main limitation was the retrospective nature of the data. As the data were collated over a 12-year period, there will have been variation in the personnel involved in each institution, as well as a lack of a standardized approach to tube placement. There is also the inherent lack of standardized record keeping, which can result in incomplete or inconsistent record keeping. In addition, there might have been minor complications that were not considered concerning enough to document, or if any stoma-site discharges were self-limiting. This could have resulted in an artificially low complication rate. Another difficulty was that the anorexia necessitating tube placement was usually secondary to an underlying medical condition, which might have required different management strategies or antimicrobial therapy. Antimicrobial use will have varied over the study timescale. Additionally, it was not possible to garner from the clinical records the frequency and method of stoma site maintenance and dressing, which might have had an impact. A prospective study would be required to determine the risk factors for stoma site infections in more detail. This would allow a standardized protocol for tube placement and post-operative management, as well as the selection of cases with a common disease process of similar severity. The results from such a study would help inform evidence-based recommendations for management strategies and antimicrobial use with e-tubes. Additionally, the current study was conducted over 2 referral centers, with considerable experience in the placement and maintenance of these tubes. Complications rates and associated morbidity might be higher in those practices in which these are rarely placed.

In conclusion, e-tubes remain a crucial part of providing a cat's nutritional demands, although they are not without potential complications. They are relatively easily placed with few complications incurred at the time of placement, provided tube placement is confirmed both visually and radiographically or endoscopically prior to anesthetic recovery. While none of the cats in this study died as a result of tube placement, incorrect placement or tube migration could result in death. The tubes are generally well tolerated, with only a relatively small proportion being removed by the cat prematurely. The tubes were in place for a median of 11 days, with the longest duration of 94 days, without an increased odds of complications. Stoma site infection is a relatively frequent complication and should be discussed with the owners prior to placement, particularly when there are additional predisposing factors such as receiving systemic glucocorticoids or chemotherapy agents.

CONFLICT OF INTEREST DECLARATION

Authors declare no conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

HUMAN ETHICS APPROVAL DECLARATION

Authors declare human ethics approval was not needed for this study.

ORCID

Craig R. Breheny https://orcid.org/0000-0002-6933-723X

REFERENCES

1. Chan DL. The inappetent hospitalized cat: clinical approach to maximising nutritional support. *J Feline Med Surg*. 2009;11(11):925-933.
2. Reintam Blaser A, Starkopf J, Alhazzani W, et al. Early enteral nutrition in critically ill patients: ESICM clinical practice guidelines. *Intensive Care Med*. 2017;43(3):380-398.
3. Lippert AC, Fulton RB Jr, Parr AM. A retrospective study on the use of total parenteral nutrition in dogs and cats. *J Vet Intern Med*. 1993;7(2):52-64.
4. Zsombor-Murray E, Freeman LM. Peripheral parenteral nutrition. *Compend Contin Educ Pract Vet*. 1999;21:512-523.
5. Hasebe M, Suzuki H, Ueda Y, et al. Glutamate in enteral nutrition: can glutamate replace glutamine in supplementation to enteral nutrition in burned rats? *JPEN J Parenter Enteral Nutr*. 1999;123(5 Suppl):S78-S82.
6. Inoue S, Lukes S, Silberstein EB, et al. Increased gut blood flow with early enteral feeding in burned guinea pigs. *J Burn Care Rehabil*. 1989;10(4):300-308.
7. Roberts PR, Black KW, Zaloga GP. Enteral feeding improves outcome and protects against glycerol-induced acute renal failure in the rat. *Am J Respir Crit Care Med*. 1997;156(4 Pt 1):1265-1269.
8. Liu DT, Brown DC, Silverstein DC. Early nutritional support is associated with decreased length of hospitalization in dogs with septic peritonitis: a retrospective study of 45 cases (2000–2009). *J Vet Emerg Crit Care (San Antonio)*. 2012;22(4):453-459.
9. Fink L, Jennings M, Reiter AM. Esophagostomy feeding tube placement in the dog and cat. *J Vet Dent*. 2014;31(2):133-138.
10. Jensen KB, Chan DL. Nutritional management of acute pancreatitis in dogs and cats. *J Vet Emerg Crit Care (San Antonio)*. 2014;24(3):240-250.
11. Ireland LM, Hohenhaus AE, Weissman BL. A comparison of owner management and complications in 67 cats with esophagostomy and percutaneous endoscopic gastrostomy tubes. *J Am Anim Hosp Assoc*. 2003;39(3):241-246.
12. Kim H-Y. Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restor Dent Endod*. 2013;38(1):52-54.
13. Abood SK, Buffington CA. Enteral feeding in dogs and cats: 51 cases (1989–1991). *J Am Vet Med Assoc*. 1992;201(4):619-622.
14. Campbell SJ, Marks SL, Fascetti AJ, et al. Complications and outcomes of one-step low-profile gastrostomy devices for long-term enteral feeding in dogs and cats. *J Am Anim Hosp Assoc*. 2006;42(3):197-206.
15. Jayamani E, Mylonakis E. Effector triggered manipulation of host immune response elicited by different pathotypes of *Escherichia coli*. *Virulence*. 2014;5(7):733-739.
16. Miller WR, Munita JM, Arias CA. Mechanisms of antibiotic resistance in enterococci. *Expert Rev Anti Infect Ther*. 2014;12(10):1221-1236.
17. Lloret A, Egberink H, Horzinek MC. *Pasteurella multocida* infection in cats: ABCD guidelines on prevention and management. *J Feline Med Surg*. 2013;15(7):570-572.
18. Morrow BL, McNarr R, Mellits C, et al. Highly pathogenic beta-hemolytic streptococcal infections in cats from an institutionalized hoarding facility and a multi-species comparison. *J Feline Med Surg*. 2016;18(4):318-327.
19. Abraham JL, Morris DO, Griffeth GC, Shofer FS, Rankin SC. Surveillance of healthy cats and cats with inflammatory skin disease for colonization of the skin by methicillin-resistant coagulase-positive staphylococci and Staphylococcus schleiferi ssp. schleiferi. *Vet Dermatol*. 2007;18(4):252-259.
20. Walker MM, Talley MJ. Review article: bacteria and pathogenesis of disease in the upper gastrointestinal tract – beyond the era of Helicobacter pylori. *Aliment Pharmacol Ther*. 2014;39(8):767-779.
21. Singh R, Ray P, Das A, Sharma M. Penetration of antibiotics through Staphylococcus aureus and Staphylococcus epidermis biofilms. *J Antimicrob Chemother*. 2010;65(9):1955-1958.
22. Kanterman J, Sade-Feldman M, Baniyash M. New insights into chronic inflammation-induced immunosuppression. *Semin Cancer Biol*. 2012;22(4):307-318.
23. Aguiar J, Chang YM, Garden OA. Complications of percutaneous endoscopic gastrostomy in dogs and cats receiving corticosteroid treatment. *J Vet Intern Med*. 2016;30(4):1008-1013.
24. Baez JL, Michel KE, Sorenmo K, Shofer FS. A prospective investigation of the prevalence and prognostic significance of weight loss and changes in body condition in feline cancer patients. *J Feline Med Surg*. 2007;9(5):411-417.
25. Krick EL, Cohen RB, Gregor TP, Salah Griessmayr PC, Sorenmo KU. Prospective clinical trial to compare vincristine and vinblastine in a COP-based protocol for lymphoma in cats. *J Vet Intern Med*. 2013;27(1):134-140.
26. Dutelle AL, Bulman-Fleming JC, Lewis CA, Rosenberg MP. Evaluation of lomustine as a rescue agent for cats with resistant lymphoma. *J Feline Med Surg*. 2012;14(10):694-700.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Breheny CR, Boag A, Le Gal A, et al. Esophageal feeding tube placement and the associated complications in 248 cats. *J Vet Intern Med*. 2019;1–9. https://doi.org/10.1111/jvim.15496