

# Incidence and impact of dysphagia in patients receiving prolonged endotracheal intubation after cardiac surgery

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**Background:** Cardiac surgery is frequently associated with prolonged endotracheal intubation. Because oral feeding is an important component of patient recovery after high-risk surgery, we sought to examine the contribution of dysphagia in the recuperation process after prolonged endotracheal intubation.

**Methods:** All 254 adult patients who survived cardiac surgery between 2001 and 2004 at the Toronto General Hospital and in whom endotracheal intubation lasted for 48 hours or longer were eligible for our retrospective review. We used multivariate regression analysis and parametric modelling to identify patient-specific characteristics associated with postextubation dysphagia and the subsequent resumption of normal oral feeding.

**Results:** Dysphagia was diagnosed in 130 (51%) patients. Incremental factors associated with an increased risk for postextubation dysphagia included duration of endotracheal intubation ( $p < 0.001$ ), the occurrence of a perioperative cerebrovascular event ( $p = 0.014$ ) and the presence of perioperative sepsis ( $p = 0.016$ ). Neither preoperative patient risks nor index procedural characteristics were influential factors. The occurrence of dysphagia ( $p < 0.001$ ) and the duration of endotracheal intubation ( $p < 0.001$ ) were the only independent factors associated with a delayed return to normal oral feeding. In contrast, several independent factors were associated with a delay to hospital discharge, including the presence of dysphagia ( $p < 0.001$ ), occurrence of perioperative stroke ( $p < 0.001$ ), duration of endotracheal intubation ( $p < 0.001$ ) and number of endotracheal intubation events ( $p < 0.006$ ).

**Conclusion:** Dysphagia is more common in patients with prolonged endotracheal intubation after cardiac surgery than has previously been reported. The duration of postoperative endotracheal intubation is a strong predictor of subsequent dysphagia that both prolongs the return to normal oral feeding and delays subsequent hospital discharge. Patient- or procedure-specific factors are not good predictors. To accelerate discharge of high-risk patients, aggressive nutritional supplementation should preempt extubation and swallowing surveillance should follow.

**Contexte :** La chirurgie cardiaque nécessite souvent une intubation endotrachéale prolongée. Étant donné que l'alimentation orale est un élément important du rétablissement de tout patient ayant subi une chirurgie à risque élevé, nous avons voulu évaluer la contribution de la dysphagie au processus de rétablissement après une intubation endotrachéale prolongée.

**Méthodes :** Les 254 patients adultes qui ont survécu à une chirurgie cardiaque entre 2001 et 2004 à l'Hôpital Toronto General et dont l'intubation a duré 48 heures ou plus ont été jugés admissibles à cette analyse rétrospective. Nous avons utilisé une analyse de régression multivariée et une modélisation des paramètres afin de relever les caractéristiques spécifiques aux patients qui sont associées à la dysphagie post-extubation et à la reprise subséquente de l'alimentation orale normale.

**Résultats :** Cent trente patients (51 %) ont reçu un diagnostic de dysphagie. Les autres facteurs associés à un risque accru de dysphagie après l'extubation incluaient : la durée de l'intubation endotrachéale ( $p < 0,001$ ), la survenue d'un événement vasculaire cérébral périopératoire ( $p = 0,014$ ) et la présence d'une infection périopératoire ( $p = 0,016$ ). Ni les facteurs de risque préopératoires des patients ni les caractéristiques indiciaires de l'intervention n'ont été considérés comme des facteurs influents. La survenue de la dysphagie ( $p < 0,001$ ) et la durée de l'intubation endotrachéale ( $p < 0,001$ ) ont été les seuls facteurs indépendants associés à un retard du retour à une alimentation orale normale. En revanche, plusieurs facteurs indépendants ont été associés au

report du congé hospitalier, dont la dysphagie ( $p < 0,001$ ), la survenue d'un accident vasculaire cérébral périopératoire ( $p < 0,001$ ), la durée de l'intubation endotrachéale ( $p < 0,001$ ) et le nombre d'événements associés à l'intubation endotrachéale ( $p < 0,006$ ).

**Conclusion :** Contrairement à ce que laissent entendre des rapports antérieurs, la dysphagie est plus fréquente chez les patients dont l'intubation a duré plus longtemps après une chirurgie cardiaque. La durée de l'intubation endotrachéale postopératoire constitue un important prédicteur d'une dysphagie subséquente, phénomène qui retarde le retour à une alimentation orale normale et, de ce fait, le congé hospitalier. Les facteurs spécifiques au patient ou à l'intervention ne sont pas de bons prédicteurs en la matière. Pour accélérer le congé des patients à risque élevé, il faudrait faire précéder l'extubation d'une supplémentation nutritionnelle énergétique et surveiller par la suite la déglutition.

**P**ostoperative dysphagia following cardiac surgery may lead to aspiration, susceptibility to postoperative infection and delays in resumption of oral feeding and hospital discharge.<sup>1-3</sup> Prolonged endotracheal intubation is an important cause of postoperative dysphagia.<sup>1-5</sup> Cardiac surgery patients frequently experience lengthy periods of endotracheal intubation,<sup>6,7</sup> and recovery may be complicated by dysphagia in many of these patients.

In the general intensive care population, endotracheal intubation lasting longer than 48 hours has been shown to substantially increase the risk for dysphagia, with a reported prevalence of 34%–56%.<sup>5,8</sup> However, for patients undergoing cardiac surgery, independent risk factors for dysphagia with prolonged endotracheal intubation have not been clearly defined. An association has been suggested between timing of postsurgical extubation and increased risk for dysphagia, but comparisons across studies are limited by inconsistencies in their definitions of prolonged endotracheal intubation, which range from 24 hours<sup>1</sup> to more than 8 days.<sup>9</sup>

Knowledge of perioperative predictors of elevated risk for dysphagia following cardiac surgery would help optimize postoperative care and nutritional support. The aim of our study was to characterize predictors for cardiac surgery patients with prolonged endotracheal intubation. We reviewed the medical charts of all 254 adult patients at the Toronto General Hospital who survived cardiac surgery (on cardiopulmonary bypass) between 2001 and 2004 and in whom endotracheal intubation lasted longer than 48 hours. We identified risk factors by exploring the relations among dysphagia and perioperative patient-specific characteristics, duration of prolonged endotracheal intubation, postoperative complications, resumption of oral feeding and delayed hospital discharge.

## METHODS

### *Study population*

We performed a retrospective chart review on all adult patients who survived cardiac surgery with cardiopulmonary bypass between 2001 and 2004 at our institution and spent a prolonged postsurgical period with an endotracheal tube.

In keeping with previous research, we defined prolonged endotracheal intubation as 48 hours or longer.<sup>8,10,11</sup> We defined dysphagia as any abnormal swallowing physiology within the upper aerodigestive tract, including aspiration but excluding esophageal dysphagia. We identified the presence of dysphagia through speech-language pathology assessment and the need for a modified texture diet. We excluded patients if they were not weaned off the ventilator, underwent tracheotomy, were unresponsive postextubation or died in hospital. The University Health Network Human Research Ethics Board approved our study protocol. We obtained demographic and clinical data for all patients from hospital and clinical records, including the cardiovascular and speech-language pathology databases.

### *Swallowing intervention*

A speech-language pathologist offered swallowing assessments and treatment in accordance with published best practice guidelines.<sup>12</sup> In brief, intensive care nursing staff screened all patients with prolonged endotracheal intubation in the cardiac surgical unit for dysphagia. If dysphagia was suspected, a speech-language pathologist conducted a full swallowing assessment at the bedside in addition to a more objective videofluoroscopic assessment if required. If the speech-language pathologist identified dysphagia during clinical or videofluoroscopic assessment, subsequent treatment was initiated according to dysphagia type and severity. Namely, the speech-language pathologist would first educate the patient and/or the patient's family about the swallowing disorder and then implement behavioural and dietary changes to improve the efficiency and safety of the swallow. Typically, treatment focused on postural changes, swallowing manoeuvre and/or texture modifications. On average, the speech-language pathologist assessed patient status 2–3 times per week for the duration of the hospital stay.

### *Statistical analysis*

We extracted variables such as demographic, clinical and perioperative characteristics from medical charts and the in-hospital cardiovascular database. Data are described as

frequencies, medians with ranges and means with standard errors (SE), as appropriate. We compared demographic, clinical and perioperative frequencies using  $\chi^2$  and unpaired 2-tailed  $t$  tests, as appropriate. We performed time-related analyses initially using Kaplan–Meier principles and then modelled parametrically exploring multiple hazard phases if present.<sup>13</sup> We explored transformations to improve linear calibration of continuous variables. We performed multivariate risk-hazard analysis by forward stepwise regression, examining hazard phases separately. We imputed missing values with the mean for that variable and created a general missing value indicator (which we then tested as a covariate). We suppressed variables with excessive (> 75%) missing values or associated with fewer than 5 events to avoid overdetermination. We used multiple logistic and linear regression to identify associations between covariates and time-independent binary or continuous variables, respectively. Our final variable selection was guided by bootstrap bagging<sup>14</sup> to provide an assessment of reliability ( $n = 1000$ , threshold for inclusion  $p < 0.1$ ). We considered variables appearing in less than 50% bootstrap resamples to be unreliable as risk factors and did not include them in our final models. We performed all statistical analyses with SAS statistical software version 9.1 (SAS Institute, Inc.), and we considered  $p < 0.05$  to be statistically significant.

## RESULTS

### *Incidence of dysphagia*

A total of 6099 patients underwent and survived cardiac surgery between 2001 and 2004 at our institution. Of these, we extracted variables for all 254 patients with endotracheal intubation lasting longer than 48 hours; we included those who met our eligibility criteria in our analyses. We identified postextubation dysphagia in 130 patients (51.2%). Most of these patients (82.3%) presented with a disorder at the pharyngeal level.

### *Patient and surgical characteristics*

The baseline characteristics of the study population and differences between those who did and did not subsequently experience dysphagia are shown in Table 1. Patients in whom dysphagia developed were not easily distinguished by baseline preoperative characteristics including demographics, smoking history, presence of diabetes, cardiorespiratory status, renal function or history of cerebrovascular accidents. In particular, preoperative left ventricular performance, history of recent myocardial infarction and baseline New York Heart Association classifications were not discriminatory in predicting postoperative dysphagia. However, the presence of congestive cardiac failure at the time of surgery was associated with significantly higher incidence of dysphagia ( $p = 0.017$ ).

Coronary artery bypass grafting was associated with a lower incidence of dysphagia than valve surgeries ( $p = 0.044$ ), but neither repeat surgery nor surgical urgency were discriminatory (Table 2).

The occurrence of postoperative dysphagia was instead strongly associated with postoperative features. A greater number of endotracheal intubation events was associated with higher unadjusted incidence of dysphagia ( $p = 0.006$ ) (Table 3). In risk-adjusted multivariable analyses, the most reliable determinants of postoperative dysphagia included the total duration of endotracheal intubation ( $p < 0.001$ ), the occurrence of a perioperative stroke ( $p = 0.014$ ) and established perioperative sepsis ( $p = 0.016$ ).

### *Return to oral feeding*

The resumption of oral feeding is an important milestone in patient recuperation after major surgery. Although as many as 21 (8.3%) of all 254 patients required more than 10 days to resume oral feeding after extubation, the mean interval from extubation to oral intake was 76.6 hours and the interval was less than 24 hours in 86 (33.9%) patients. Independent postoperative features associated with delayed return to normal oral feeding included longer postoperative endotracheal intubation ( $p < 0.001$ ) and the occurrence of dysphagia ( $p < 0.001$ ) (Fig. 1). The presence of dysphagia was the most important determinant of delayed return to oral intake and more than doubled the hazard for delayed resumption of normal oral feeding, although the clinical implications of delayed return to feeding were not delineated in this investigation. The association between dysphagia and delayed oral feeding was reflected in a significantly high incidence of a feeding tube regimen in patients with dysphagia compared with patients without dysphagia (89% v. 11%,  $p < 0.001$ ) (Table 3). The total duration of endotracheal intubation conferred a less pronounced influence on resumption of normal oral feeding; the relation was almost linear with no obvious “threshold” effect.

### *Predictors for delayed discharge*

In addition to the number of endotracheal intubation events ( $p < 0.006$ ) and total duration of endotracheal intubation ( $p < 0.001$ ), the diagnosis of postoperative dysphagia was a useful indicator of subsequent delay to hospital discharge ( $p < 0.001$ ). In this context, dysphagia represents a surrogate for other unfavourable features, particularly the occurrence of postoperative stroke, which was a very strong independent determinant of delayed discharge from hospital ( $p < 0.001$ ).

## DISCUSSION

More than half of the patients in our study experienced postextubation dysphagia, suggesting that dysphagia is

more prevalent in cardiovascular surgery patients with prolonged endotracheal intubation than has been previously reported.<sup>1-3</sup> We identified 3 independent predictors of dysphagia: the occurrence of cerebrovascular stroke or sepsis either during or immediately after surgery and prolonged endotracheal intubation. As with previous work, the preoperative presence of congestive heart failure (CHF) was more common in patients with dysphagia;<sup>1</sup> however, in our study CHF did not prove to be independently associated with dysphagia. In fact, we identified no preoperative risk factors for the presence of postextubation dysphagia.

Our study verified lengthy endotracheal intubation as an independent predictor of postextubation dysphagia.

Furthermore, the consequences of dysphagia and lengthy endotracheal intubation were independently associated with delayed return to a normal oral diet. These variables, along with the number of postsurgical endotracheal intubation events were each independently associated with delayed hospital discharge.

Our study was retrospective, and by definition has limitations. Retrospective data extraction did not allow for capture of desired variables such as preoperative dysphagia, esophageal dysphagia or transesophageal echocardiogram, and restricted the definition of postoperative dysphagia to that recorded in speech-language pathology medical reports. We collected data from a single cardiac centre;

**Table 1. Preoperative demographics and presenting clinical features**

Variable	Patients; no. (%)*			p value
	All, n = 254	Without dysphagia, n = 124	With dysphagia, n = 130	
Age, mean (SD) yr	64.5 (12.6)	63.5 (13.0)	65.4 (12.1)	0.22
Male sex	176 (69.3)	85 (68.5)	91 (70.0)	0.80
Smoker†	36 (14.2)	19 (15.4)	17 (13.1)	0.52
Ex-smoker†	116 (45.7)	51 (41.5)	65 (50.0)	0.23
Family history of heart disease	117 (46.1)	54 (43.9)	63 (49.2)	0.43
Diabetes risks				
Insulin-controlled diabetes mellitus	18 (7.1)	7 (5.6)	11 (8.5)	0.51
Oral hypoglycemics	47 (18.5)	21 (16.9)	26 (20.0)	0.52
Cardiovascular surgical risks				
Circulatory shock	16 (6.3)	5 (4.0)	11 (8.5)	0.15
Non-Q-wave infarction	35 (13.8)	21 (16.9)	14 (10.8)	0.10
Q-wave infarction	28 (11.0)	14 (11.3)	14 (10.8)	0.89
Left ventricular grade‡				
1	72 (28.3)	38 (30.6)	34 (26.4)	0.16
2	74 (29.1)	41 (33.1)	33 (25.6)	0.16
3	68 (26.8)	32 (25.8)	36 (27.9)	0.16
4	39 (15.4)	13 (10.5)	26 (20.2)	0.16
NYHA classification				
I	13 (5.1)	5 (4.0)	8 (6.2)	0.71
II	22 (8.7)	11 (8.9)	11 (8.5)	0.71
III	67 (26.4)	30 (24.2)	37 (28.5)	0.71
IV	152 (59.8)	78 (62.9)	74 (56.9)	0.71
Congestive heart failure	124 (48.8)	51 (41.1)	73 (56.2)	0.017
Hypertension	139 (54.7)	71 (57.3)	68 (52.3)	0.43
Diet- or medically-treated hyperlipidemia	146 (57.5)	75 (60.5)	71 (54.6)	0.34
Previous stroke or transient ischemic heart attack	33 (13.0)	17 (13.7)	16 (12.3)	0.74
Normal sinus rhythm	214 (84.3)	108 (87.1)	106 (81.5)	0.22
Heart block / pacemaker	8 (3.1)	4 (3.2)	4 (3.1)	0.95
Atrial fibrillation or flutter	32 (12.6)	12 (9.7)	20 (15.4)	0.11
Left main artery stenosis	48 (18.9)	24 (19.4)	24 (18.5)	0.86
Respiratory risks				
Severe COPD§	15 (5.9)	7 (5.7)	8 (6.3)	0.85
Renal risks				
Serum creatinine, mean (SD) µmol/L	110.0 (73.6)	109.9 (86.8)	110.1 (58.5)	0.98

COPD = chronic obstructive pulmonary disease; NYHA = New York Heart Association; SD = standard deviation.  
 \*Unless otherwise indicated.  
 †Missing value: 1 patient without dysphagia.  
 ‡Missing value: 1 patient with dysphagia.  
 §Missing value: 1 patient without dysphagia and 2 patients with dysphagia.

therefore, it is not yet known whether results can be generalized to other cardiac centres. In addition, we included only patients with prolonged endotracheal intubation. It is possible that this restriction might have biased our findings to capture more patients with dysphagia.

Despite the limits on scope, our findings have important clinical implications. Specifically, the potential for a high incidence of dysphagia following cardiovascular surgery

highlights the need for clinicians to monitor its presence, especially in patients with perioperative complications and/or those with prolonged endotracheal intubation. Our study suggests that patients with endotracheal intubation lasting longer than 48 hours are at high risk for dysphagia, which has both nutritional consequences such as delayed return to oral feeding, and resource implications such as delayed hospital discharge.

**Table 2. Perioperative characteristics of patients with and without dysphagia following cardiac surgery**

Variable	Patients; no. (%)			p value
	All, n = 254	Without dysphagia, n = 124	With dysphagia, n = 130	
<b>Procedure</b>				
Coronary artery bypass graft	123 (48.4)	66 (53.2)	57 (43.8)	0.044
Valve	59 (23.2)	22 (17.7)	37 (28.5)	0.13
Other	72 (28.3)	36 (29.0)	36 (27.7)	0.83
<b>Urgency</b>				
Elective	103 (40.6)	52 (41.9)	51 (39.2)	0.66
Inpatient	79 (31.1)	34 (27.4)	45 (34.6)	0.22
Urgent	38 (15.0)	24 (19.4)	14 (10.8)	0.11
Emergent	34 (13.4)	14 (11.3)	20 (15.4)	0.30
<b>Perioperative complications</b>				
Stroke*	21 (8.3)	5 (4.1)	16 (12.4)	0.06
Sepsis†	21 (8.3)	4 (3.3)	17 (13.2)	0.004
Use of dopamine in intensive care	233 (92.5)	110 (89.4)	123 (95.3)	0.09
<b>Intra-aortic balloon pump</b>				
Preoperative	36 (14.2)	17 (13.7)	19 (14.6)	0.60
Postoperative	62 (24.4)	30 (24.2)	32 (24.6)	0.99
Low-output syndrome‡	87 (34.3)	39 (31.5)	48 (36.9)	0.66

\*Evidence of persistent neurologic deficit.  
†Positive blood culture.  
‡Use of inotrope or mechanical devices for more than 30 minutes to maintain a blood pressure greater than 90 mm Hg with a confidence interval less than 2.2 l/m/m<sup>2</sup>; Missing values: 1 patient without dysphagia; 1 patient with dysphagia.

**Table 3. Patient outcomes after extubation**

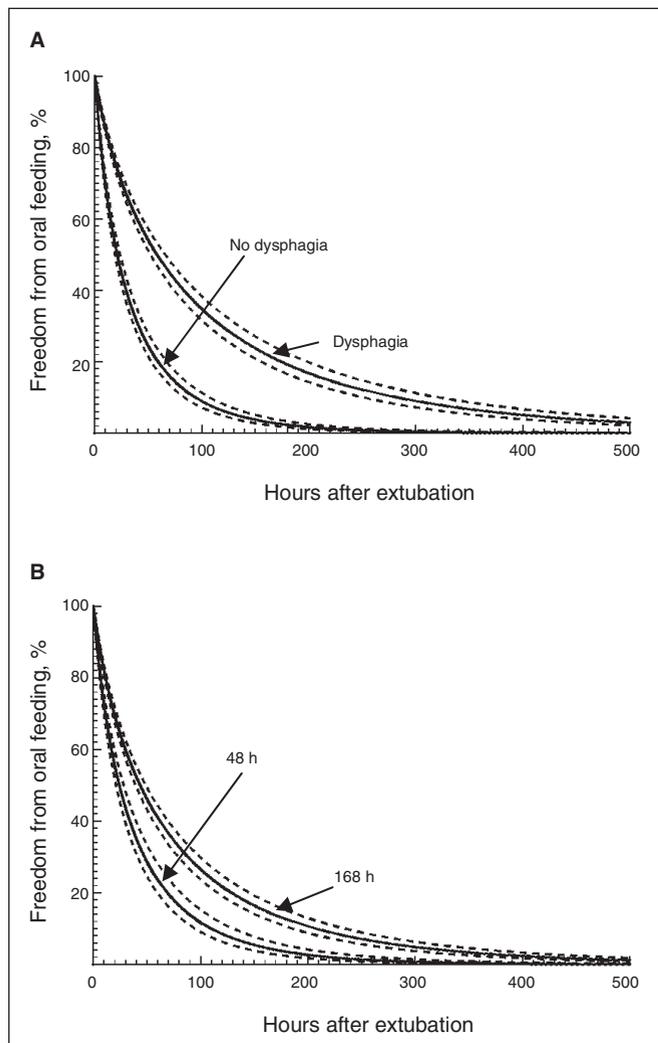
Variable	Patients; no. (%)*			p value
	All, n = 254	Without dysphagia, n = 124	With dysphagia, n = 130	
Endotracheal tube, mean (SD) h	115.4 (60.8)	87.1 (43.3)	142.4 (63.0)	< 0.001
<b>No. of endotracheal intubation events</b>				
1	196 (77.2)	105 (84.7)	91 (70.0)	0.006
2	53 (20.9)	19 (15.3)	34 (26.2)	0.006
3	5 (1.9)	0 (0)	5 (3.8)	0.006
Postextubation NPO, mean (SD) h†	76.6 (90.7)	32.5 (30.5)	118.4 (107.6)	< 0.001
<b>Postextubation tube-feeding‡</b>				
Nasogastric tube	116 (45.7)	13 (10.5)	103 (79.2)	0.001
Gastrostomy tube	5 (2.0)	0 (0)	5 (3.8)	0.001
Oral intake to discharge, mean (SD) h	11.8 (11.2)	10.4 (9.81)	13.2 (12.3)	0.05
Postextubation repeat ICU admission	16 (6.3)	5 (4.0)	11 (8.5)	0.15
<b>Hospital stay, mean (SD) d</b>				
Preoperative	3.04 (10.8)	3.11 (13.5)	2.96 (7.32)	0.91
Postoperative	21.3 (14.4)	16.2 (11.0)	26.1 (15.6)	< 0.001
Total inpatient stay	24.3 (18.7)	19.3 (18.0)	29.0 (18.3)	< 0.001

ICU = intensive care unit; NPO = nil per os (nothing by mouth); SD = standard deviation.  
\*Unless otherwise indicated.  
†Missing value: 1 patient without dysphagia.  
‡Missing values: 5 patients without dysphagia; 5 patients with dysphagia.

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**Contributors:** Ms. Barker and Drs. Martino and Ralph-Edwards designed the study. Ms. Barker and Reichardt and Drs. Martino and Ralph-Edwards acquired the data, which Ms. Barker and Reichardt and Drs. Martino and Hickey analyzed. All authors wrote the article, which Ms. Barker and Drs. Martino, Hickey and Ralph-Edwards reviewed. All authors approved the article for publication.



**Fig. 1:** Time-related return to oral feeding after extubation, stratified by (A) presence or absence of dysphagia and (B) total duration of endotracheal intubation. On average, 168 hours (7 d) after extubation 21% (standard error [SE] 2%) of patients with dysphagia had still not resumed oral feeding compared with 3% (SE 2%) of patients who did not have dysphagia. Longer total duration of endotracheal intubation conferred progressively worse resumption of oral feeding.

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