Predictors of Direct Enteral Tube Placement After Acute Stroke

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Objective: To determine predictors of direct enteral tube (DET) placement after acute stroke. *Methods:* We used the Ontario Stroke Registry to identify patients who received direct enteral tubes (gastrostomy or jejunostomy) during hospital stay after acute ischemic stroke or intracerebral hemorrhage from July 1, 2003 to March 31, 2013. We used multivariable logistic regression to identify predictors of receiving DET after stroke. *Results:* Among 38,192 patients with acute stroke who met inclusion criteria, 1851 (4.9%) had DET placement during admission. We identified multiple variables significantly associated with DET placement, spanning patient demographics, comorbid illnesses, clinical, and hospital factors. The strongest predictors of receiving DET were stroke severity (adjusted odds ratio [aOR] 4.77 for severe versus mild stroke, 95% confidence interval [CI] 4.20-5.41), receiving a swallowing test within 72 hours (aOR 3.46, 95% CI 3.0-3.99), and in-hospital stroke (aOR 2.07, 95% CI 1.57-2.72). *Conclusions:* There are a number of predictors of DET placement within multiple domains. These findings may facilitate discussions around the possibility of requiring DET during admission. Further work is required to improve patient selection and timing of DET placement after acute stroke.

Key Words: stroke—dysphagia—feeding tubes—registries—gastrostomy.

Introduction

Dysphagia occurs commonly after stroke and is associated with multiple complications.[1,2] The rate of dysphagia in acute stroke varies widely, from 37% when using screening methods to 78% with instrumental testing.[2] For dysphagia that precludes safe oral intake, guidelines recommend time-limited trials of nasogastric tube feeding for 2-4 weeks.[3–5,37,38] While dysphagia may recover in the initial period,[6] approximately 5% of ischemic stroke and 9% of hemorrhagic stroke patients may undergo direct enteral tube (DET) insertion for persistent dysphagia[7], typically through gastrostomy or jejunostomy.

The decision to place DET after stroke is complex and involves multiple factors – including the degree of dysphagia, hospital practices, and patient or family care goals and preferences. Several small studies (n < 100) have identified additional factors associated with DET placement after acute stroke, including older age, black race, lower Glasgow coma scale score, higher National Institutes of Health Stroke Scale (NIHSS) score, stroke size, bilateral strokes, midline shift, edema, mechanical ventilation, and aspiration pneumonia.[8–12] Large studies using US administrative data have found associations with age, sex, race, comorbidities, socioeconomic status, and hospital type.[7,13–15] However, it is unclear if some factors are related to stroke severity, which could not be accounted for in these models

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and is the primary driver of dysphagia. In addition, although studies have addressed the impact of language barrier, marital status, and living arrangements on stroke outcomes,[16–18] these social factors may impact on communication and decision making after stroke and have yet to be evaluated in the context of tube feeding.

A greater understanding of factors associated with DET placement may yield important insights into our current practices, allow early counseling of patients and families, and assist in resource planning. We sought to evaluate predictors of DET placement after acute stroke in a large population, using a wide variety of variables in demographic, comorbid, clinical, socioeconomic, and hospital-level domains. We included stroke severity in our model and had subgroup analyses to account for social barriers, in-hospital mortality and palliation, and center type to develop a comprehensive understanding of the factors driving DET placement after stroke.

Methods

Setting, Data Sources, and Study Sample

The province of Ontario, Canada, has a population of approximately 13 million people. Residents receive publicly funded coverage for hospital care, diagnostic tests, and physicians' services, including DET placement. The Ontario Stroke Registry was used to collect detailed clinical information on all consecutive patients with acute stroke or transient ischemic attack (TIA) seen at one of 11 regional stroke centers as well as on a population-based sample of patients from every acute care hospital in the province.[19] Stroke cases were identified using International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada codes (see Supplementary Table 1), with the diagnosis verified by study coordinators based on chart review. Validation by duplicate chart abstraction has shown excellent agreement for key variables.[20] Stroke severity was assessed on admission with the Canadian Neurological Scale (CNS). The CNS includes orientation, level of consciousness, speech, and motor function, and lower scores on the CNS indicate greater stroke severity.[21] Stroke severity was categorized as mild (CNS $\geq$ 8; equivalent to a NIHSS score of $\leq$8), moderate (CNS 5-7; equivalent to NIHSS 9-13), or severe (CNS 0-4; equivalent to NIHSS $\geq$ 14), on the basis of previous studies.[22,23]

The registry is housed at the Institute for Clinical Evaluative Sciences (ICES) where it is linked to administrative databases using unique encoded identifiers. We used the registry to provide information on a range of baseline patient characteristics. Information on ethnicity was missing in over 50% of patients. Therefore, we linked to the Ontario Registered Persons Database and used validated surname algorithms to identify people of Chinese and South Asian descent (the major ethnic groups in Canada).[24,25] We used the Canada Census to provide information on median neighborhood income.[26] We categorized participating hospitals as regional stroke centers or non-regional centers.

Our initial search included consecutive patients with transient ischemic attack (TIA) or stroke seen at participating hospitals between July 1, 2003 and March 31, 2013. Patients were excluded if they were younger than 18 years of age, were not admitted, were hospitalized with a stroke more than 72 hours from symptom onset, or had a TIA, subarachnoid hemorrhage, or isolated intraventricular hemorrhage. If there were multiple captured events during the study time frame, only the first was kept. We identified those who received DET placement from either the registry or the Canadian Institute for Health Information (CIHI) databases using Canadian Classification of Interventions procedure codes (see Supplementary Table 1), excluding codes for nasogastric, nasojejunal, or open surgical placement of feeding tubes. We excluded patients with DET placement prior to the index stroke. The majority of patients with Canadian Classification of Interventions codes received gastrostomy (81%), and the remainder received jejunostomy.

Analysis

SAS 9.4 (SAS Institute Inc., Cary, NC, USA) was used to conduct all analyses. We first performed a collinearity test, and all variables had a variance inflation factor less than 3, indicating no strong multicollinearity. We compared baseline characteristics in patients with and without DET placement using $\chi 2$ tests for categorical variables and t tests or Kruskal-Wallis tests for continuous variables, as well as standardized differences. We used multivariable logistic regression with backward selection to determine variables that were independent predictors of DET placement. We included an extensive list of preselected predictors grouped into the following domains: demographics (age, sex, income [quintile based on median neighborhood income], ethnicity [Chinese, South Asian, and white/other], and rural versus urban residence), comorbidities (history of stroke, dementia, atrial fibrillation, hypertension, diabetes, hyperlipidemia, current smoking, congestive heart failure, coronary artery disease, peripheral artery disease, depression, peptic ulcer, gastrointestinal bleed, renal failure, and cancer), baseline clinical variables (pre-event independence, arrival from long-term care, stroke severity, stroke type [ischemic versus intracerebral hemorrhage (ICH)]), and processes of care (in-hospital versus out-of-hospital stroke, receipt of swallowing assessment within 72 hours, admission to the intensive care unit (ICU), direct admission to a stroke unit, delayed admission to a stroke unit [if the patient was initially admitted to any other unit, then later transferred to a stroke unit], and hospital type [regional versus non-regional center]). Regional stroke centers are large institutions with advanced stroke care resources and expertise analogous to comprehensive stroke centers in the US. Non-regional centers are acute

care hospitals that can provide stroke care but do not have similar resources.

We conducted 3 subgroup analyses: (1) excluding patients who died or were made palliative in hospital, (2) analyzing only years 2003-2007 to include variables of language barrier (speaking a language other than English or French), marital status, and living alone, which were only collected during that time frame, and (3) comparing predictors among patients in regional versus non-regional centers, given the possibility of baseline differences between groups.

Results

Among 38,192 patients with acute ischemic stroke or ICH who met inclusion criteria, 1851 (4.9%) had DET placement during admission. Compared to those without DET placement, patients with DET were older and were more likely to be of Chinese ethnicity, have a language barrier, have prior stroke or atrial fibrillation, have in-hospital stroke, have greater stroke severity, have ICH, receive assessment for dysphagia, be admitted to a regional stroke center, be admitted to the ICU, and have delayed admission to a stroke unit, and were less likely to be independent pre-admission, or to live in a rural area ($P < .05$ and standardized difference >.1 for comparisons; Table 1).

In the multivariable analyses, significant predictors of receiving DET were older age (for age 80+ versus 18-59 years; adjusted odds ratio [aOR] 1.32, 95% confidence interval [CI] 1.13-1.56), male sex (aOR 1.25, 95% CI 1.13-1.38), Chinese ethnicity (versus white/other; aOR 1.47, 95% CI 1.15-1.87), prior stroke (aOR 1.31, 95% CI 1.16-1.47), hypertension (aOR 1.18, 95% CI 1.05-1.33), diabetes (aOR 1.15, 95% CI 1.02-1.28), stroke severity (severe versus mild: aOR 4.77, 95% CI 4.20-5.41; moderate versus mild: aOR 2.42, 95% CI 2.12-2.76), ICH (versus ischemic; aOR 1.50, 95% CI 1.32-1.69), in-hospital stroke (aOR 2.07, 95% CI 1.57-2.72), receipt of a swallowing screen (aOR 3.46, 95% CI 3.0-3.99), admission to a regional stroke center (aOR 1.53, 95% CI 1.35-1.73), admission to the ICU (aOR 1.47, 95% CI 1.29-1.68), and delayed, but not direct, admission to a stroke unit (aOR 1.40, 95% CI 1.22-1.60; see Fig 1). There were lower odds of receiving DET in patients with rural residence (aOR .72, 95% CI .60-.86), pre-admission independence (aOR .78, 95% CI .69-.88), dementia (aOR .77, 95% CI .65-.91), renal disease (aOR .70, 95% CI .53-.92), and hyperlipidemia (aOR .89, 95% CI .80-.99; Fig 1).

In the first subgroup analysis, after removing patients who died or were made palliative in hospital, dementia, diabetes, and hyperlipidemia were no longer significantly associated with DET placement, whereas significant associations emerged for current smoking (aOR 1.20, 95% CI 1.03-1.41) and cancer (aOR 1.26, 95% CI 1.03-1.55). In the second subgroup analysis, language barrier (aOR 1.28, 95% CI 1.06-1.56; Fig 1), but not marital status or living alone, was significantly associated with DET placement. In the third subgroup analysis, there were significant differences between patients who were admitted to regional and non-regional centers (Supplementary Table 2), so we performed the analysis in the 2 subgroups separately (see Supplementary Table 3).

Discussion

Our study demonstrates that a wide array of demographic, clinical, and hospital process factors are associated with DET placement after acute stroke. Stroke severity was the strongest predictor. Our subgroup analyses revealed differences related to in-hospital mortality/palliation and stroke center type.

The largest prior study on predictors of gastrostomy tube placement after stroke used the US Nationwide Inpatient Sample and identified a number of demographic, comorbid, and socioeconomic predictors of tube placement.[13] Consistent with this study, we found that older age, male sex, and center type were predictive of feeding tube placement. Our study differed in that dementia was associated with lower, rather than higher, odds of placement, which may reflect practice differences in adherence to guidelines recommending against tube feeding in patients with advanced dementia,[27] or withdrawal of life-sustaining care. We also found that previous stroke and pre-admission dependence were associated with DET placement, in keeping with the known adverse effect of prior disability on stroke outcomes,[28] or bilateral infarcts causing moderate-severe dysphagia.[29] In addition, those with in-hospital stroke had higher odds of DET placement, which may be due to known differences with community-onset stroke, including older age, more comorbid illness, and higher stroke severity.[30]

We had nearly complete capture of data on stroke severity, and found that greater stroke severity was associated with higher odds of DET placement, as in prior reports.[8,9,11,31] In addition, ICH and ICU admission were significant predictors, likely reflecting higher degrees of disability and need for life-sustaining care in these patients. Admission to the ICU and mechanical ventilation has been associated with worse outcome after stroke, and may be related to decreased level of consciousness[32] or complications such as sepsis.[33] Lastly, delayed, but not direct, admission to a stroke unit was associated with DET placement. This may reflect a survival bias in initially unstable or severely affected patients who may have required intensive care on arrival but survived for delayed stroke unit admission.

Patients with language barriers had greater odds of DET placement, consistent with previous findings, potentially due to a desire for aggressive care among patients or families that could be related to ethnicity, religion, or other sociocultural factors.[16] There were greater odds of

Table 1. *Characteristics of patients with acute stroke who received or did not receive direct enteral tubes*

Variable	N (%) No DET, N = 33,938 to 36,341	DET, N = 1732 to 1851	S Diff*	*P* value
Age 80+ years	13,441 (37.0)	752 (40.6)	.08	.002
Female	17,653 (48.6)	871 (47.1)	.03	.20
Ethnicity				<.001
Chinese	873 (2.4)	81 (4.4)	.11	
South Asian	527 (1.5)	25 (1.4)	.009	
White/other	34,941 (96.1)	1745 (94.3)	.09	
Language barrier**	1,734 (12.4)	168 (19.4)	.19	<.001
Married	7,790 (55.5)	475 (54.8)	.02	.91
Lives alone	2,999 (21.4)	156 (18.0)	.09	.02
Income quintile				.33
1 (lowest)	8,424 (23.2)	431 (23.3)	.003	
2	7,732 (21.3)	424 (22.9)	.04	
3	6,942 (19.1)	349 (18.9)	.006	
4	6,488 (17.9)	302 (16.3)	.04	
5 (highest)	6,755 (18.6)	345 (18.6)	.001	
Rural residence	4,522 (12.4)	150 (8.1)	.14	<.001
Long-term care residence	1,954 (5.4)	131 (7.1)	.07	<.001
Pre-admission independence	26,239 (72.2)	1197 (64.7)	.16	<.001
Comorbidities				
Dementia	3,448 (9.5)	199 (10.8)	.04	.07
Atrial fibrillation	6,894 (19.0)	437 (23.6)	.11	<.001
Hypertension	25,026 (68.9)	1357 (73.3)	.10	<.001
Diabetes	9,266 (25.5)	512 (27.7)	.05	.04
Hyperlipidemia	13,868 (38.2)	679 (36.7)	.03	.20
Prior stroke	6,771 (18.6)	437 (23.6)	.12	<.001
CHF	3,032 (8.3)	197 (10.6)	.08	<.001
PAD	1,939 (5.3)	110 (5.9)	.03	.26
CAD	8,767 (24.1)	449 (24.3)	.003	.90
Cancer	3,051 (8.4)	178 (9.6)	.04	.07
Depression	2,692 (7.4)	152 (8.2)	.03	.20
Peptic ulcer	1,129 (3.1)	60 (3.2)	.008	.75
Gastrointestinal bleed	902 (2.5)	49 (2.6)	.01	.66
Renal disease	1,506 (4.1)	57 (3.1)	.06	.02
Current smoking	6,226 (17.1)	297 (16.0)	.03	.23
Stroke severity				<.001
Severe (CNS $\leq$ 4)	5,399 (14.9)	712 (38.5)	.55	
Moderate (4 < CNS $\leq$ 7)	7,321 (20.1)	503 (27.2)	.17	
Mild (CNS > 7)	21,681 (59.7)	474 (25.6)	.73	
ICH	5,561 (15.3)	440 (23.8)	.21	<.001
In-hospital stroke	607 (1.7)	67 (3.6)	.12	<.001
Admitted to regional stroke center	24,793 (68.2)	1482 (80.1)	.27	<.001
Received swallow screen	23,736 (65.3)	1575 (85.1)	.47	<.001
ICU admission	7,812 (21.5)	670 (36.2)	.33	<.001
Stroke unit admission				<.001
Direct admission	15,553 (42.8)	684 (37.0)	.12	
Delayed admission	4,783 (13.2)	457 (24.7)	.30	
In-hospital mortality				
ICH	1,995 (35.9)	72 (16.4)	.46	<.001
Ischemic stroke	3844 (12.5)	291 (20.6)	.22	<.001

CAD, coronary artery disease; CHF, congestive heart failure; CNS, Canadian Neurological Scale; DET, direct enteral tube; PAD, peripheral artery disease, ICH, intracerebral hemorrhage; ICU, intensive care unit.

*S Diff = standardized differences, which express the difference between the means of 2 populations as a proportion of the pooled standard deviation. Unlike traditional hypothesis testing with *P* values, standardized differences are estimates of generalizable parameters and not sensitive to sample size. Standardized differences $\geq$.10 are considered significant.[39]

**Language barrier is defined as speaking a language other than English or French.

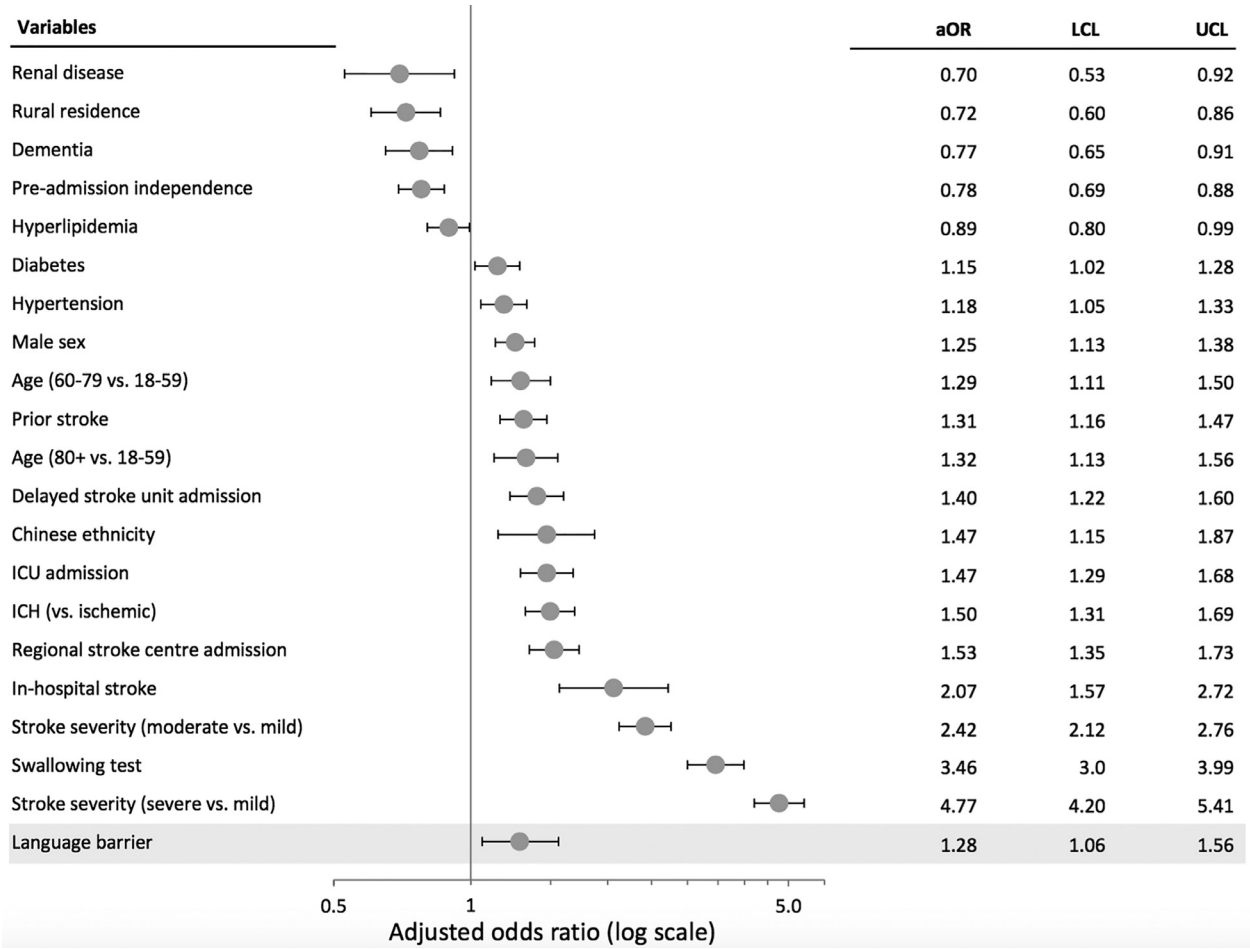

Figure 1. *Variables significantly associated with DET placement in patients with acute stroke. Odds ratios adjusted for age, sex, income quintile, ethnicity, rural residence, various comorbidities, pre-event independence, arrival from long-term care, stroke severity, stroke type, swallowing assessment, in-hospital versus. community-onset stroke, center type, admission to an ICU, and admission to a stroke unit. Greyed area is derived from separate model (2003-2007 for language barrier). Abbreviations: aOR, adjusted odds ratio; DET, direct enteral tube; ICU, intensive care unit; ICH, intracerebral hemorrhage; LCL, lower confidence limit; UCL, upper confidence limit.*

DET with admission to a regional stroke center, and lower odds with rural residence, possibly due to the higher odds of feeding tube placement with greater stroke admission volume,[13] and/or less access to multiple aspects of stroke care among rural patients.[34]

The reasons for lower odds of DET placement with renal disease and hyperlipidemia are not well understood, although may relate to less-disabling lacunar strokes in patients with hyperlipidemia,[35] or higher mortality in renal failure.[36] As DET placement is a marker of initial survival, we performed a subgroup analysis removing patients who died or were made palliative in hospital. The association with dementia, diabetes, and hyperlipidemia was not sustained, whereas significant associations emerged for smoking and cancer, implying interactions between these variables, in-hospital survival, and DET placement.

Our study has limitations. DET placement is a multifaceted decision related to dysphagia, patient characteristics, care goals, and institutional factors, and we could not determine the means by which our variables influenced DET placement. Although we adjusted for stroke severity, we did not have information on additional clinical factors including stroke location and dysphagia severity, and there are likely to be other unmeasured confounders. We did not have details on speech-language pathology assessments or instrumental testing (ie, videofluoroscopy) that may have increased the detection of dysphagia. We had no insight into patient and family preferences and goals of care, or time devoted to discussions of feeding approach versus other acute care needs. Similarly, we could not identify cases where DET was considered but not pursued. Our study was not designed to generate a risk prediction score. Finally, DET placement rate and timing may differ between geographic regions, depending on availability of the procedure, inadmissibility to long-term care facilities with nasogastric tubes, and institutional discharge pressures. The results of our analysis differed slightly in patients admitted to regional versus non-regional centers, reflecting either differences in baseline patient characteristics or physician/institutional practices.

Thus, our results may not be fully generalizable to other populations.

We found multiple variables significantly associated with DET placement after stroke. However, the exclusive use of predictors to select for DET or early treatment is not advised, given that our analysis may in large part reflect current practice patterns, which may not be optimal for patients. In addition, there are limited data on outcomes after early placement, and presence of risk factors should not supersede appropriate discussions with patients and families. Lastly, there may be ethical issues in applying group level ethnic or socioeconomic data to individual treatment decisions. Nevertheless, identifying patients at high risk could be useful in terms of resource planning, initiating early discussions regarding the possibility of long-term feeding, or identifying patients who may benefit from novel therapies for dysphagia. Time-limited trials of nasogastric tube feeding remain the recommended approach to allow an opportunity for dysphagia to improve, and to permit discussions regarding goals of care.[37,38] Further studies are needed to optimize appropriateness and timing of DET placement after stroke.

Author contributions

Raed Joundi: Study concept and design, data interpretation, writing manuscript.

Gustavo Saposnik: Study design, critical revision of manuscript.

Rosemary Martino: Study design, critical revision of manuscript.

Jiming Fang: Data analysis and interpretation.

Moira Kapral: Study design, data interpretation, critical revision of manuscript, study supervision.

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Supplementary Materials

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