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**How Much Does Dysphagia Cost? An Estimation of the Additional
Annual Cost of Dysphagia in Patients Hospitalised with Stroke**

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WORKING PAPER

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How Much Does Dysphagia Cost? An Estimation of the Additional Annual Cost of Dysphagia in Patients Hospitalised with Stroke

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Abstract:

Introduction: Stroke-related dysphagia poses a substantial challenge, both in terms of its prevalence and the economic costs associated with its management. Despite its significance, there is a lack of comprehensive studies focusing on the economic burden of stroke-related dysphagia in the New Zealand context. The aims of this research are to estimate the economic costs and quality of life of patients with stroke-related dysphagia in New Zealand, emphasising the importance of understanding and addressing this issue from a healthcare management perspective.

Methods: Secondary analysis of data from the REGIONS Care study, a New Zealand wide sample of all patients hospitalised with stroke within a 6-month period (between 1st May 2018 and 30th October 2018) including follow-up up to 12 months. Patients were identified as dysphagic if they received a swallow screen during hospital admission and were seen by a Speech Language Therapist (SLT). Severe dysphagia was identified if the patients had a nasogastric feeding tube during their hospital admission and were seen by an SLT. Optimal linear propensity score matching was utilised to acquire a better counterfactual group for dysphagic stroke patients. All cost estimates were converted to NZ\$2021 to compare to existing literature.

Results: Of all patients with stroke in the REGIONs Care study, 40% (952/2,379) were identified as dysphagic and 5% (119/2,379) as severely dysphagic. Using these percentages and the total number of reported strokes in 2021/22 in New Zealand, we estimated that 3,588 were dysphagic and 449 were severely dysphagic. These stroke-related dysphagic patients in 2021 presented a total additional cost of \$89.6 million to New Zealand society, or a marginal cost of \$25,000 per dysphagic patient. This estimate includes the additional hospitalisation costs (\$16,100), community rehabilitation services (\$1,370), hospital-level aged residential care (\$4,030) and reduced quality of life (QoL) over a 12-month period post-hospital admission (\$3,470). The total marginal cost of severely dysphagic stroke -related patients was \$19.9 million overall, or \$44,300 per patient.

Discussion/Conclusion: The costs derived from the REGIONS Care study and the estimates of reduced QoL due to dysphagia provide a novel contribution for New Zealand, and internationally. While there is international literature estimating the marginal cost of dysphagic stroke-related hospitalisation, few extend this analysis to post-hospitalisation care and even fewer to the costs of reduced QoL. By quantifying this economic burden, we can advocate for improved dysphagia management strategies and ultimately enhance the overall quality of care for stroke survivors.

Keywords: Dysphagia, stroke-related, economic cost, quality of life, New Zealand

JEL Classifications: I1

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Introduction

In New Zealand, stroke-related dysphagia poses a substantial challenge, both in terms of its prevalence and the economic costs associated with its management. Despite its significance, there is a lack of comprehensive studies focusing on estimating the economic burden of stroke-related dysphagia in the New Zealand context. This work seeks to shed light on the economic costs and quality of life of stroke-related dysphagia in New Zealand, emphasising the importance of understanding and addressing this issue from a healthcare management perspective. By quantifying the economic burden, we can advocate for better resource allocation, improved dysphagia management strategies, and ultimately enhance the overall quality of care for stroke survivors in New Zealand.

To our knowledge, only two studies estimate the additional cost of stroke-related dysphagia in the New Zealand population [1, 2]. Both studies use data from the Canterbury District Health Board (CDHB) in New Zealand to estimate the additional cost of stroke-related hospitalisation due to dysphagia as \$11,700 and \$12,200 (2021\$ NZD). The estimation of costs beyond hospitalisation are based on international literature, leading to estimated costs not truly representing the New Zealand population. To address this critical knowledge gap, we therefore utilise data from the REGIONS Care (Reducing Ethnic and Geographic Inequities in NZ Stroke Care) research project, a New Zealand wide research project that collected hospitalisation and follow-up outcome data from patients with stroke throughout New Zealand [3-6].

Materials and Methods

We utilise data from the New Zealand wide REGIONS Care research project in our analysis. The project monitors the care provided to patients admitted to a hospital with stroke to assess best-practise stroke care and patient outcomes. As a part of the project, data on all patients with stroke hospitalised in New Zealand within a six-month study period (between the 1st May 2018 and 30th October 2018) was recorded. For consenting participants, follow-up surveys and observations were collected at 3-, 6-, and 12-months post stroke admission. Over the six-month study period, 2,379 patients were hospitalised with stroke and of these 1,086 (5%) consented to study participation. We focus only on the 1,086 consenting participants within this analysis.

Within the REGIONS care research project, the presence of dysphagia within stroke patients is not directly recorded. However, several variables indicating the presence of the condition are captured. Through combining these variables, we create two '*dysphagia identifiers*':

- Dysphagia identifier 1 – A Speech Language Therapist (SLT) was seen during the patient’s hospital admission and the patient had nasogastric feeding tube.
- Dysphagia identifier 2 – A swallow screen was received by the patient during hospital admission and a SLT was seen.

We anticipate ‘dysphagia identifier 1’ will capture stroke patients with the most severe dysphagia due to the requirement of a nasogastric feeding tube, while ‘dysphagia identifier 2’ will identify dysphagia in patients with a range of severities.

Of the 1,086 stroke patients who consented to participation in the follow-up study, 47 participants (4%) are identified (using ‘dysphagia identifier 1’) as having severe dysphagia, while 365 participants (34%) are identified as having mild to moderate dysphagia (using ‘dysphagia identifier 2’ minus the 47 severe cases). Mean values of several explanatory variables of severely dysphagic, mild-moderately dysphagic and non-dysphagic patients are presented in Table 1. Females represent 46% of mild-moderately dysphagic and non-dysphagic patients but only 40% of severely dysphagic patients.

On average, severely dysphagic patients experienced more severe strokes (mean stroke severity score 0.81) and were more dependent pre-stroke (mean mRS score 0.66) than mild-moderately dysphagic and non-dysphagic patients. On average, mild-moderately dysphagic patients experienced more severe strokes than non-dysphagic patients (stroke severity score of 1.72 vs 2.30, respectively) and were more dependent pre-stroke than non-dysphagic patients (mRS score 0.54 vs 0.40, respectively). European patients represent around 80% of both mild-moderately dysphagic and non-dysphagic groups but only 68% of severely dysphagic patients while Māori/ Pasifika patients represent around 15% of both mild-moderately dysphagic and non-dysphagic groups but 21% of severely dysphagic patients.

To identify the best matching method for this data, we utilise multiple methods with different specifications and compare which best balances the explanatory variables while retaining as many observations as possible. We find a full optimal matching utilising linear propensity scores with a Probit link is preferred with this data. All analyses involve double robust regressions (formula presented in equation 1) on all matched variables to account for any remaining imbalance within the variables.

$$\begin{aligned} \text{Outcome variable} = & \alpha + \beta_1 * \text{dysphagia identifier} + \beta_2 * \text{stroke severity score} + \beta_3 * \text{age} + \beta_4 * \text{sex} + \beta_5 * \\ & \text{modified Rankin Scale score pre-admission} + \beta_6 * \text{ethnicity} + \beta_7 * \text{primary diagnosis} + \beta_8 * \text{DHB} \\ & \text{present to} + \beta_9 * \text{employment pre-stroke} + \beta_{10} * \text{living situation pre-stroke} + \varepsilon_i; \end{aligned}$$

Equation 1.

Within the REGIONS care project, the EuroQol-3L instrument was used to capture patient quality of life. EQ-5D-3L index and visual analogue scores (VAS) were recorded at the 3-, 6- and 12-months post-hospital admission. New Zealand population value sets from were used to calculate EQ-5D index scores [7]. The lowest theoretically possible index score, for a health profile of 33333 where the patient indicates the worst possible state in each health domain, is -0.113. The EQ VAS scores are bound by 0 and 100 so health states lower than 0 are not possible with this instrument.

Results

Estimated impact of stroke-related dysphagia

To estimate the impact of dysphagia on stroke patient outcomes in-hospital and at 3-, 6-, and 12-months post hospital admission, we use regression models including the appropriate dysphagia identifier and matched explanatory variables. It should be highlighted that all the estimated effects represent the *additional* complications suffered by dysphagic stroke patients as compared to non-dysphagic stroke patients. Also, given that all models use matched data and double-robust regressions, the estimated impacts of dysphagia should not be obscured by any systematic comorbidities, differences in patients' demographic characteristics or differences in the severity of the primary diagnosis; i.e., stroke.

Hospitalisation

First, we investigate the impact of dysphagia on hospitalisation (regression results presented in Table 2). We find dysphagic stroke patients are estimated to spend an additional 8.8 days in hospital compared to non-dysphagic stroke patients while severely dysphagic stroke patients are estimated to spend an additional 14.6 days in hospital compared to non-dysphagic stroke patients. This total length of hospital stay includes the patient's acute stroke unit and inpatient rehabilitation length of stay.

At hospital discharge, we estimate dysphagic stroke patients are 12 percentage points more likely to be referred to community rehabilitation than non-dysphagic stroke patients and are 3.5 times more likely than non-dysphagic patients to be discharged to a hospital level ARC facility rather than being discharged home.

Community Rehabilitation

Outcomes at 3-, 6-, and 12-months post hospital discharge are summarised in Table 3. Community rehabilitation utilisation was only recorded within the REGIONS care study at 3-months post-admission. At this point, dysphagic stroke patients encountered community rehabilitation services, on average, 4.3 times more than non-dysphagic stroke patients and were 12.1 percentage points more likely to be receiving ongoing community rehabilitation beyond the 3-month mark. Severely dysphagic stroke patients encountered community rehabilitation services, on average, 5.7 times more than non-dysphagic stroke patients and were 13.1 percentage points more likely to be receiving ongoing community rehabilitation beyond the 3-month mark.

Quality of Life

The impact of dysphagia on EQ-5D index and VAS scores are presented for 3-, 6-, and 12-months post-hospital admission in Table 4. The impact on EQ-5D index scores are presented graphically for 3-, 6-, and 12-months post-hospital admission in Figure 1 where 'x' represents the baseline QoL of the non-dysphagic reference groups, either all non-dysphagic stroke patients or non-severely dysphagic stroke patients. For illustration purposes, we refer to 'x' as the baseline QoL for both groups to isolate the impact of dysphagia over the 12-months post-hospital admission but note that the baselines are in reality different for each group at each time point (i.e., 'x' takes on different values). A linear rate of decay of QoL due to dysphagia between the 3-, 6-, and 12-month follow-up periods is assumed.

We find that dysphagic stroke patients have EQ-5D index scores 0.05 points lower on average than non-dysphagic stroke patients at 3-months post-hospital admission. This gap grows to EQ-5D index scores 0.081 points lower at 6-months post-hospital admission and 0.085 points lower at 12-months post-hospital admission. Severely dysphagic stroke patients have EQ-5D index scores 0.10 points lower on average than non-dysphagic stroke patients at 3-months post-hospital admission. This difference increases to 0.12 points at 6-months post-hospital admission and 0.15 points at 12-months post-hospital admission. These results indicate that dysphagia negatively impacts stroke patients' health-related quality of life, with larger reductions in quality of life in follow-up periods further from hospital admission.

Minimally important differences (MIDs) are the smallest changes in health-related quality of life scores that are considered clinically meaningful and should lead to a consideration of change in management [8]. MIDs in the EQ-5D index are estimated within Korean stroke patients to range from 0.08-0.12 [9]. While this research was based on a Korean population, estimates are reported to be

similar to the results of other researchers where estimates were based on the United Kingdom and United States populations [10]. We therefore interpret the reduced quality of life due to dysphagia at 6- and 12-months post- hospital discharge - as well as the reduced quality of life due to severe dysphagia at 3-, 6-, and 12-months post-discharge - as clinically meaningful.

Estimated economic cost of dysphagia

Hospitalisation

The weighted average estimated cost per day for stroke-related Diagnostic Related Groups (DRGs) from the 2021/22 National Minimum Dataset are used to estimate hospitalisation cost. Funding is provided based on total hospital event length of stay so these values are applied to the weighted average estimated cost per day for a stroke-related hospital stay of \$1,840. We estimate the presence of dysphagia to increase the average cost of a stroke patient's hospitalisation by \$16,100 and the presence of severe dysphagia to increase the average cost of a stroke patient's hospitalisation by \$26,800. We present our estimated costs of stroke-related dysphagia hospitalisation alongside similar international estimates, also converted to 2021\$ NZD, in Table 5 [11-14]. Our appears mid-range compared to other New Zealand hospitalisation estimates and international estimates from Switzerland, the United States and France which vary widely from \$5,300 to \$45,400, and therefore seem broadly comparable to existing literature.

Community Rehabilitation Services

National prices for community service purchase units are used to estimate the additional cost community rehabilitation services. We estimate dysphagic stroke patients to utilise 4.3 more community rehabilitation sessions than non-dysphagic stroke patients, although service provided is not specified. The cost of a professional nursing session, enteral feeding assistance, an hour of home help and an hour of personal care. We consequently estimate the additional cost of community rehabilitation services per dysphagic stroke patient to be \$740 over the first 3-months post-hospital admission. Severely dysphagic stroke patients are found to utilise on average 5.7 more community rehabilitation sessions than non-dysphagic stroke patients costing an additional \$980 over the first 3-months post-hospital admission.

Both dysphagic and severely dysphagic patients are also estimated to be more likely to have ongoing community rehabilitation services past the 3-month point. The 2021/22 National Minimum Dataset reports that the total number of stroke hospitalisations between 1 July 2021 and 30 June 2022 was 8,970. We assume the same rate of dysphagia as within the REGIONS data and the same rate of ongoing community rehabilitation services past the 3-months post-hospitalisation. As a

baseline, we calculate the per patient cost of ongoing community services until 12-months post hospitalisation to be \$3,500 for *non-dysphagic* patients. We then estimate the *additional* annual cost of ongoing community rehabilitation for dysphagic patients to be \$630 per person, or \$2.26 across the population. We similarly estimate the additional annual cost of ongoing community rehabilitation services for severely dysphagic patients to be \$10,040 per person, or \$4.50 million overall.

Hospital-Level Aged Residential Care

To estimate the additional cost of dysphagic patients' increased rate of admission to hospital-level ARC facilities, we use the average annual cost of hospital-level aged residential care from the New Zealand Treasury [15]. We estimate the additional cost of dysphagic patients' use of hospital-level ARC facilities as \$4,025 per patient, or \$14.9 million in total.

Quality of Life

Over the first-year post-hospital admission, we estimate dysphagia to reduce a stroke-patient's quality of life by a total of 0.064 index points and severe dysphagia to reduce the quality of life by 0.120 index points. The value of a statistical life, \$54,080 (2021\$ NZD) [15], is then applied to the estimated reductions in quality of life. This translates to dysphagia reducing a stroke patient's quality of life in the year following their hospital admission by \$3,470. Severe dysphagia reduces a stroke patient's quality of life \$6,500.

Our estimates of the total stroke-related dysphagic population within the REGIONS study and within New Zealand in 2021 are presented in Table 6 alongside estimates for the total additional cost of stroke-related dysphagia. We estimate the cost of the stroke-related disorder over a 12-month period post-hospital admission to be \$25,000 per dysphagic patient. This equates to an overall, annual additional cost of \$89.6 million in 2021 attributable to stroke-related dysphagia. We similarly estimate the cost of severe stroke-related dysphagia to be \$44,300 per severely dysphagic patient, or \$19.9 million in 2021 overall.

Discussion/Conclusion

Using the REGIONS care research data alongside matching methods and double robust regressions, we estimate stroke-related dysphagic patients in 2021 to present a total *additional* cost of \$25,000 per patient, or \$89.6 million overall, to New Zealand society. This estimate includes the additional cost of their hospitalisation, community rehabilitation services, hospital-level aged residential care and reduced quality of life over a 12-month period post-hospital admission. We similarly estimate

the additional cost of severely dysphagic stroke-related patients to be \$44,300 per patient, or \$19.9 million overall.

While there is international literature estimating the additional cost of dysphagic stroke-related hospitalisation, few extend this analysis to post-hospitalisation care and even fewer to the costs of reduced quality of life [16]. One study that does attempt to extend analysis past hospitalisation estimate the 1-year direct costs (not including QoL costs) of stroke-related dysphagia in the United States (South Carolina) [17]. By examining the 1-year cost to Medicare of ischaemic stroke patients with and without dysphagia the annual additional cost of dysphagia to Medicare and the patient is estimated to be \$19,500 (2021\$, NZD). Another study from the United States uses data from the Nationwide Inpatient Sample to estimate the annual additional cost of ischemic stroke-related dysphagia to be \$19,000 (2021\$, NZD) per patient and uses existing literature to estimate the cost to be \$83,200 (2021\$, NZD) per patient [14]. Our estimates therefore appear very comparable with existing literature, noting quality of life reductions are not included within their estimates.

In summary, this work builds on the previous literature through further insight into the 1-year hospitalisation and post-hospitalisation cost of stroke-related dysphagia. Our estimation of the cost of reduced quality of life due to dysphagia provides a novel contribution both in New Zealand, and internationally. While the development of dysphagia within stroke patients may be unavoidable, our analysis identifies significant scope for cost avoidance and enhanced QoL for dysphagic patients through improved treatment and/or management of the disorder.

Statements

Statement of Ethics

The data used in this study was obtained from the University of Otago under a Data Sharing Agreement, therefore no ethics approval was sought specifically for the secondary use of the research data.

Conflict of Interest Statement

The author's have no conflicts of interest to disclose.

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Author Contributions

All authors contributed to the conception and design of the work, analysis and interpretation of the data, drafting and/or critical review of work and final approval for publication. All authors agree to be accountable for all aspects of the work.

Data Availability Statement

The data in this study was obtained from the University of Otago under a Data Sharing Agreement between the data provider (University of Otago) and the University of Canterbury. The data is therefore unable to be shared with third parties. Such dataset may be requested from Professor Anna Ranta, anna.ranta@otago.ac.nz.

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Fig. 1. Reduced Quality of Life over 12-months Post-hospital Admission for all Dysphagic and Severely Dysphagic Stroke Patients

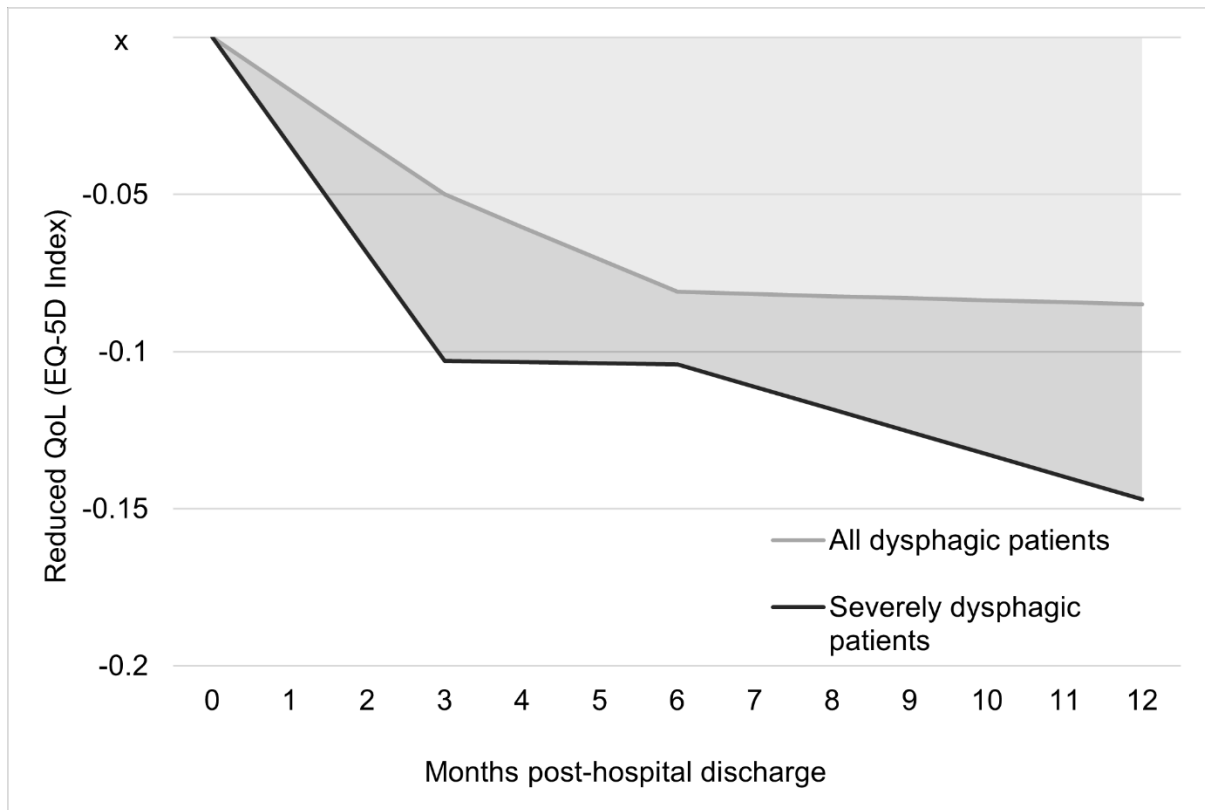


Table 1 - Outcome and Explanatory Variables from REGIONS Care Data

Variable Name	Variable Description
Hospital Outcome Variables	
Patient admitted to Acute Stroke Unit	0=No, 1=Yes
Total Acute Stroke Unit length of stay	Days
Aspiration pneumonia acquired	0=No, 1=Yes
Patient admitted to inpatient rehabilitation	0=No, 1=Yes
Total time spent in inpatient rehabilitation	Days
Total hospital event length of stay	Days
Patient referred to community rehab at hospital discharge	0=No, 1=Yes
Living situation at hospital discharge	0=Home (alone or with partner/carer), 1=Relative/ carer's home, 2=ARC, 3=Hospital level ARC, 4=other
Follow-up Outcome Variables at 3, 6, and 12 Months Post-Hospital Discharge	
Number of community rehab encounters at 3 months post hospital discharge	Number of visits
Ongoing community rehab beyond 3 months	0=No, 1=Yes
General Practitioner seen post hospital admission	0=No, 1=Yes
Number of General Practitioner visits	Number of visits
Specialist seen post hospital admission	0=No, 1=Yes
Number of specialist visits	Number of visits
Living situation	0=Home (alone or with partner/carer), 1=Relative/ carer's home, 2=ARC, 3=Hospital level ARC, 4=other
Readmitted to hospital	0=No, 1=Yes
Number of hospital readmissions	Number of readmissions
Death	0=No, 1=Yes
EuroQoL-5D index	-0.113 – 1
EuroQoL self-rated status	0-100
Explanatory Variables	
Stroke severity score	0=Severe stroke – 3=Mild stroke
Modified Rankin Scale (mRS) score pre-admission	0=No disability/dependence – 5=Severe disability/dependence
Primary diagnosis	Intracerebral haemorrhage (I61), Cerebral infarction (I63), Stroke, unspecified (I64)
Known smoker	0=No, 1=Yes
Known previous stroke	0=No, 1=Yes
Known previous Transient Ischemic Attack (TIA)	0=No, 1=Yes
District Health Board (DHB - region of hospital) patient presented to	Northland, Waitemata, Auckland, Counties Manukau, Waikato, Bay of Plenty, Lakes, Tairāwhiti, Taranaki, Whanganui, Hawke's Bay, Midcentral, Wairarapa, Hutt Valley, Capital & Coast, Nelson Marlborough, West Coast, Canterbury, South Canterbury, Southern
Female	0=Male, 1=Female
Age	Years
Ethnicity	European, Māori, Pasifika, Asian, Indian, Middle Eastern, Other ethnicity, Unknown ethnicity
Living situation	Home with others, Rest home, Other
Employment pre-stroke	In paid employment pre-stroke. 0=No, 1=Yes

Table 2 - Comparison of Explanatory Variables between Severely Dysphagic, Mild-Moderately Dysphagic and Non-dysphagic Patients

Explanatory Variables	(1) Severely dysphagic patients (n=47)	(2) Mild and moderately dysphagic patients (n=365)	(3) Non-dysphagic patients (n=674)
	Mean (SD)	Mean (SD)	Mean (SD)
Stroke Severity Score (0=Severe stroke – 3=Mild stroke)	0.81 (1.10)	1.72 (1.05)	2.30 (0.90)
Modified Rankin Scale score Pre-Admission (0=No disability/dependence – 5=Severe disability/dependence)	0.66 (1.11)	0.54 (1.00) [†]	0.41 (0.87)
Known smoker (0/1)	0.13 (0.34)	0.14 (0.35)	0.13 (0.34)
Known previous stroke (0/1)	0.13 (0.34)	0.22 (0.41)	0.19 (0.39)
Known previous Transient Ischemic Attack (TIA) (0/1)	0.15 (0.36)	0.13 (0.34)	0.13 (0.33)
Female (0/1)	0.40 (0.49)	0.46 (0.50)	0.46 (0.50)
Age (years)	72.98 (15.35)	74.91 (11.5)	72.93 (13.66)
Ethnicity (0/1):			
European	0.68 (0.47)	0.79 (0.40)	0.80 (0.40)
Māori/ Pasifika	0.21 (0.41)	0.15 (0.36)	0.14 (0.35)
Employment pre-stroke (0/1)	0.25 (0.44)	0.19 (0.40)	0.27 (0.45) ^{††}

Notes: Dataset also includes information on patient primary diagnosis, living situation pre-stroke, and the District Health Board the patient presented to. † Information available for 361 patients, †† Information available for 673 patients

Table 3 - Dysphagia Impact on Hospital Outcomes of Stroke Patients

Hospital outcome variables	Model type	Dysphagia identifier 1 – severe dysphagia	Dysphagia identifier 2 – all dysphagia
Patient admitted to Acute Stroke Unit (0/1)	Probit (n=1,071)	0.067 (-0.053-0.187)	0.091*** (0.043-0.139)
Total Acute Stroke Unit length of stay (days)	Tobit (n=1,071)	4.704*** (3.072-6.336)	1.884*** (1.184-2.584)
Aspiration pneumonia acquired (0/1)	Probit (n=1,071)	0.077*** (0.038-0.117)	0.084*** (0.051-0.117)
Patient admitted to inpatient rehabilitation (0/1)	Probit (n=1,071)	0.436*** (0.273-0.600)	0.234*** (0.184-0.285)
Total time spent in inpatient rehabilitation (days)	Tobit (n=1,071)	18.54*** (10.21-26.88)	17.59*** (13.60-21.60)
Total hospital event length of stay (days)	Tobit (n=1,071)	14.60*** (10.15-19.05)	8.78*** (6.92-10.64)
Patient referred to community rehab at hospital discharge (0/1)	Probit (n=1,071)	0.065 (-0.073-0.204)	0.120*** (0.064-0.176)
Living situation at hospital discharge (0 base) (0 – Home (alone or with partner/carer), 1 – Relative/ carer’s home, 2- ARC, 3 – Hospital level ARC, 4 – other)	Multinomial logit (n=1,063)	1. 1.62 (0.251-10.50) 2. 1.21 (0.328-4.494) 3. 1.903 (0.509-7.11) 4. 0.674 (0.132-3.43)	1. 0.421* (0.166-1.069) 2. 1.20 (0.582-2.47) 3. 3.49*** (1.56-7.82) 4. 1.78 (0.693-4.56)

Notes: In all Probit models, 0 values represent ‘no’ and ‘unknown’. *, **, and *** indicate statistical significance at the 90%, 95% and 99% confidence level, respectively. Full sample size n=1,071.

Table 4 - Dysphagia Impact on Outcomes of Stroke Patients 3, 6, and 12 Months Post-Hospital Discharge

Outcome variables	Model type	3 months post hospital discharge		6 months post hospital discharge		12 months post hospital discharge	
		Dysphagia identifier 1 – severe dysphagia	Dysphagia identifier 2 – all dysphagia	Dysphagia identifier 1 – severe dysphagia	Dysphagia identifier 2 – all dysphagia	Dysphagia identifier 1 – severe dysphagia	Dysphagia identifier 2 – all dysphagia
Number of community rehab encounters (number of visits)	Tobit	5.74* (-0.297-11.77)	4.30*** (1.59-7.01)				
Ongoing community rehab beyond 3 months (0/1)	Probit	0.131** (0.026-0.236)	0.121*** (0.072-0.169)				
General Practitioner seen post hospital admission (0/1)	Probit	0.076 (-0.049-0.202)	0.056** (0.004-0.107)	0.081 (-0.044-0.205)	0.090*** (0.037-0.142)	-0.004 (-0.118-0.110)	0.046* (-0.005-0.096)
Number of General Practitioner visits	Tobit	0.216 (-0.393-0.825)	0.178 (-0.079-0.434)	0.911* (-0.029-1.851)	0.196 (-0.163-0.555)	0.340 (-0.890-1.570)	0.534** (0.044-1.025)
Specialist seen post hospital admission (0/1)	Probit	-0.082 (-0.226-0.062)	-0.048 (-0.105-0.010)	0.031 (-0.111-0.173)	0.020 (-0.039-0.079)	-0.071 (-0.217-0.074)	-0.035 (-0.206-0.136)
Number of specialist visits	Tobit	-0.107 (-0.833-0.619)	-0.208 (-0.507-0.091)	0.066 (-0.828-0.961)	-0.003 (-0.377-0.372)	-0.308 (-1.465-0.849)	-0.208 (-0.634-0.219)
Living situation (0 base) (0 – Home (alone or with partner/carer), 1 – Relative/carer’s home, 2- ARC, 3 – Hospital level ARC, 4 – other)	Multinomial logit	1. 1.09 (0.00-18200) 2. 4.515 (0.260-78.33) 3. 1.523 (0.533-4.35) 4. -	1. 0.001 (0.000-2,810) 2. 1.11 (0.209-5.96) 3. 1.386 (0.783-2.45) 4. 3.04 (0.026-361.4)		1. – 2. 182.34(1.33x10 ⁻⁶ -1.50x10 ¹⁰) 3. 1.09 (0.558-2.132) 4. 0.955 (0.004-237.0)		1. 1.205 (0.133-10.89) 2. – 3. 1.395 (0.712-2.733) 4. 2.777 (0.257-29.961)
Readmitted to hospital (0/1)	Probit	-0.037 (-0.168-0.094)	-0.040* (-0.088-0.007)	-0.139* (-0.302-0.025)	0.001 (-0.049-0.052)	0.030 (-0.108-0.169)	0.008 (-0.048-0.065)
Number of hospital readmissions	Tobit	-0.335 (-1.17-0.498)	-0.223 (-0.523-0.077)	-1.417* (-2.965-0.131)	-0.139 (-0.609-0.330)	-0.329 (-1.549-0.890)	-0.261 (-0.700-0.177)
Death (0/1)	Probit			0.014 (-0.047-0.076)	-0.012 (-0.045-0.021)	0.023 (-0.049-0.095)	-0.009 (-0.046-0.027)

Notes: *, **, and *** indicate statistical significance at the 90%, 95% and 99% confidence level, respectively. Full sample size n=1,071.

Table 5 - Impact of Dysphagia on EQ-5D Index and VAS Scores at 3, 6, and 12 Months Post-Hospital Discharge

Outcome variables	Model type (n)	Dysphagia identifier 1 – severe dysphagia	Dysphagia identifier 2 – all dysphagia
3 month EQ-5D Index (-0.113-1)	Tobit (1,036)	-0.103** (-0.187- -0.019)	-0.050*** (-0.085- -0.015)
6 month EQ-5D Index (-0.113-1)	Tobit (931)	-0.124** (-0.224- -0.024)	-0.081*** (-0.122- -0.039)
12 month EQ-5D Index (-0.113-1)	Tobit (909)	-0.147*** (-0.259- -0.035)	-0.085*** (-0.132- -0.038)
3 month EQ Self-rated status (0-100)	Tobit (952)	-7.949** (-14.50-1.398)	-3.659*** (-6.275- -1.043)
6 month EQ Self-rated status (0-100)	Tobit (809)	-5.368 (-14.787-4.050)	2.930 (-6.582-0.722)
12 month EQ Self-rated status (0-100)	Tobit (801)	-5.075 (-16.933-6.783)	-2.860 (-7.136-1.415)

Notes: *, **, and *** indicate statistical significance at the 90%, 95% and 99% confidence level, respectively.

Table 6 - Summary of Estimated Dysphagic Populations and Additional Costs of Stroke-Related Dysphagia over 12 Months Post-Hospital Discharge (2021\$ NZD)

<i>Estimated stroke-related dysphagic population (total number of stroke patients)</i>	All dysphagic (Percent of total)	Severely dysphagic (Percent of total)
All REGIONS Care recorded stroke patients (2,379)	944 (40%)	111 (5%)
All New Zealand stroke patients in 2021 (7,983)	3,193 (40%)	399 (5%)
ADDITIONAL COST CATEGORY (2021\$ NZD)	Per dysphagic patient in NZ 2021	Per severely dysphagic patient in NZ 2021
Hospitalisation	\$16,100	\$26,800
Community rehabilitation services (up to 3months post hospital admission)	\$370	\$430
Community rehabilitation services (from 3 months until 12 months post-hospital admission)	\$200	\$230
Hospital-level aged residential care facilities	\$4,030	-
Quality of life	\$3,470	\$6,500
Additional total per patient cost in 2021	\$24,200	\$34,000
Additional total cost to New Zealand society of stroke-related dysphagia in 2021	\$77.2 million	\$13.6 million

Table 7 - Summary of Studies Estimating the Additional Hospitalisation Cost of Stroke-Related Dysphagia

Country	Stroke population	Cost estimate description (attributable to dysphagia)	Reported cost (per patient)	Cost in 2021\$ NZD	Reference
Taiwan	Haemorrhagic stroke	Inpatient rehabilitation cost	\$1393.70 (2016\$, USD)	\$2,300	[11]
Switzerland	Ischemic stroke	Hospitalisation	\$3,424 (2019\$, USD)	\$5,300	[12]
United States	All stroke admissions	Hospitalisation	\$5,107 (2005\$, USD)	\$10,400	[13]
New Zealand	All stroke admissions	Hospitalisation		\$11,700	[2]
New Zealand	All stroke admissions	Hospitalisation		\$12,200	[3]
New Zealand	All stroke admissions	Hospitalisation		\$16,100	Current study
United States	Ischemic stroke	Hospitalisation	\$12,630 (2020\$, USD)	\$19,400	[14]
France	Ischemic stroke	Hospitalisation	\$15,300 (2019\$, USD)	\$24,000	[12]
United States	Ischemic stroke	Hospitalisation	\$29,500 (2020\$, USD)	\$45,400	[14]