

## **SUPPLEMENTARY MATERIALS**

# **Health-Economic Implications of Post-Stroke Dysphagia: A Contemporary Medicare Claims Analysis**

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**S1: ICD-10 CM codes**

The underlying ICD-10 diagnosis codes relied upon in the current analysis included 163\* for ischemic stroke and 161\* for hemorrhagic stroke. The presence of absence of post-stroke complications consisting of dysphagia, pneumonia, or percutaneous endoscopic gastrostomy were determined from the ICD-10 codes listed in Table S1.1 below.

Further, for the percutaneous endoscopic gastrostomy (PEG) subgroup, any claims with a tracheostomy -- determined based on ICD-10-PCS codes of: 0B110F4, 0B113F4, 0B114F4, 0BW10FZ, 0BW13FZ, 0BW14FZ, 0BW17FZ, 0BW18FZ, 0BW1XFZ, 0B21XFZ, or ICD10-CM diagnosis codes of Z43.0 or Z93.0 -- were excluded.

**Table S1.1:** Post-stroke Complications and corresponding ICD-10 diagnosis codes

|                                           | <b>ICD-10 CM Code</b>                                                                                                                                                                                                 |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dysphagia                                 | R13.10, R13.12, R13.13, R13.14, R13.19                                                                                                                                                                                |
| Pneumonia                                 | J69.0, J69.8, B59, J10.0, J10.1, J10.8, J11.0, J11.1, J11.8, J12.1, J12.3, J12.9, J13.9, J14.9, J15.0, J15.1, J15.2, J15.3, J15.4, J15.5, J15.6, J15.7, J15.8, J15.9, J16.8, J17.2, J17.8, J18.0, J18.1, J18.8, J18.9 |
| Percutaneous endoscopic gastrostomy (PEG) | 0DH63UZ, 0DH64UZ, 0DHA3UZ, 0DHA4UZ, 0DH67UZ, 0DH68UZ, 0DH673Z, 0DH683Z (plus tracheostomy exclusion as stated in text above)                                                                                          |

## S2: CHEERS 2022 Checklist

**Table S2.1:** CHEERS 2022 Checklist

|                               | Item | Guidance for Reporting                                                                                                    | Reported in section  |
|-------------------------------|------|---------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>TITLE</b>                  |      |                                                                                                                           |                      |
| Title                         | 1    | Identify the study as an economic evaluation and specify the interventions being compared.                                | Title page, line 1   |
| <b>ABSTRACT</b>               |      |                                                                                                                           |                      |
| Abstract                      | 2    | Provide a structured summary that highlights context, key methods, results and alternative analyses.                      | Page 2, Abstract     |
| <b>INTRODUCTION</b>           |      |                                                                                                                           |                      |
| Background and objectives     | 3    | Give the context for the study, the study question and its practical relevance for decision making in policy or practice. | Page 4, Introduction |
| <b>METHODS</b>                |      |                                                                                                                           |                      |
| Health economic analysis plan | 4    | Indicate whether a health economic analysis plan was developed and where available.                                       | Page 5, Methods      |
| Study population              | 5    | Describe characteristics of the study population (such as age range, demographics,                                        | Page 5, Methods      |

|                                                  |    |                                                                               |                 |
|--------------------------------------------------|----|-------------------------------------------------------------------------------|-----------------|
|                                                  |    | socioeconomic, or clinical characteristics).                                  |                 |
| Setting and location                             | 6  | Provide relevant contextual information that may influence findings.          | Page 5, Methods |
| Comparators                                      | 7  | Describe the interventions or strategies being compared and why chosen.       | Page 5, Methods |
| Perspective                                      | 8  | State the perspective(s) adopted by the study and why chosen.                 | Page 5, Methods |
| Time horizon                                     | 9  | State the time horizon for the study and why appropriate.                     | Page 5, Methods |
| Discount rate                                    | 10 | Report the discount rate(s) and reason chosen.                                | Not applicable. |
| Selection of outcomes                            | 11 | Describe what outcomes were used as the measure(s) of benefit(s) and harm(s). | Page 5, Methods |
| Measurement of outcomes                          | 12 | Describe how outcomes used to capture benefit(s) and harm(s) were measured.   | Page 5, Methods |
| Valuation of outcomes                            | 13 | Describe the population and methods used to measure and value outcomes.       | Page 5, Methods |
| Measurement and valuation of resources and costs | 14 | Describe how costs were valued.                                               | Page 5, Methods |

|                                      |    |                                                                                                                                                 |                 |
|--------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Currency, price date, and conversion | 15 | Report the dates of the estimated resource quantities and unit costs, plus the currency and year of conversion.                                 | Page 5, Methods |
| Rationale and description of model   | 16 | If modelling is used, describe in detail and why used. Report if the model is publicly available and where it can be accessed.                  | Not applicable. |
| Analytics and assumptions            | 17 | Describe any methods for analysing or statistically transforming data, any extrapolation methods, and approaches for validating any model used. | Page 5, Methods |
| Characterizing heterogeneity         | 18 | Describe any methods used for estimating how the results of the study vary for sub-groups.                                                      | Page 5, Methods |

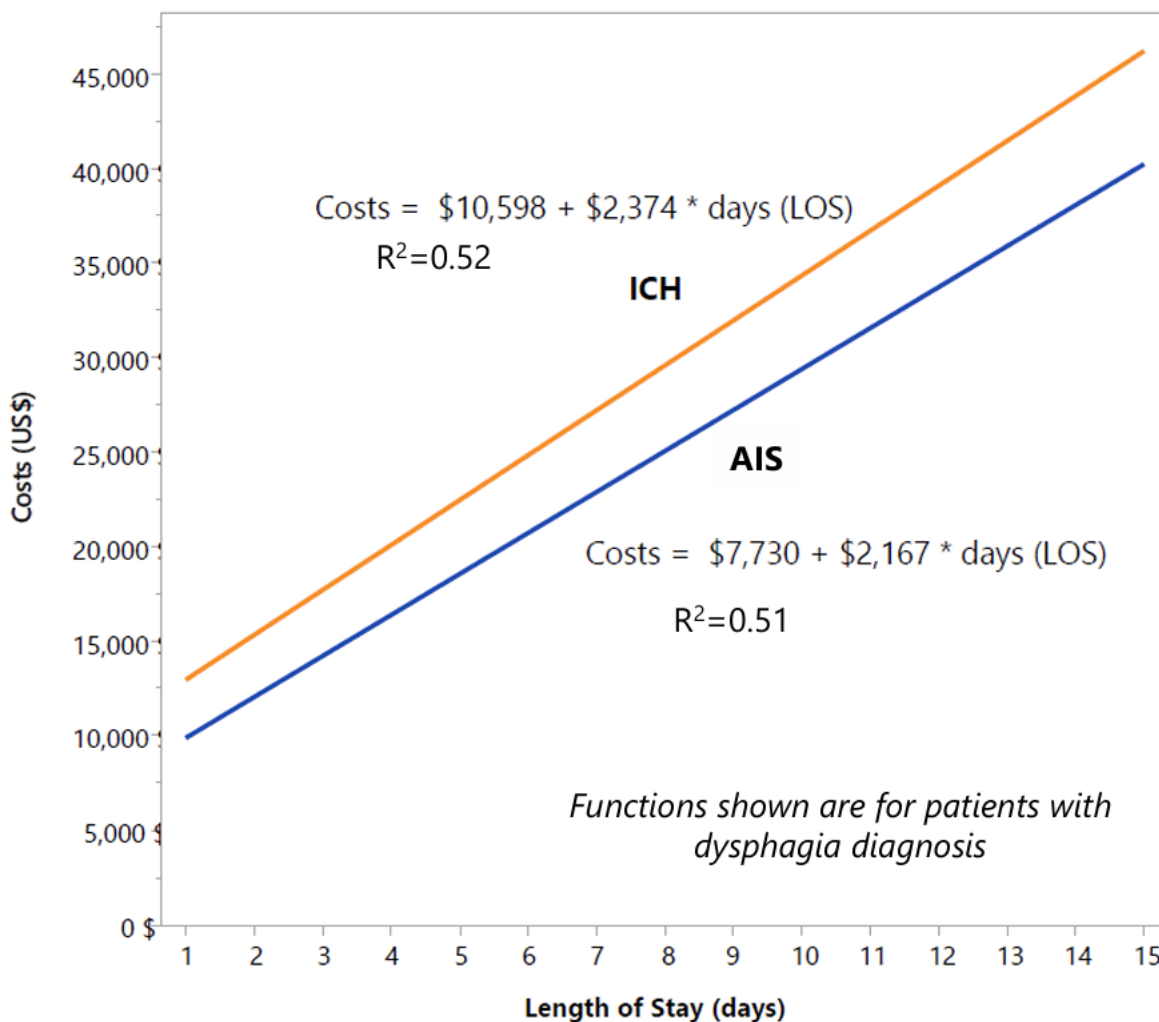
|                                                                       |    |                                                                                                                                                                             |                            |
|-----------------------------------------------------------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Characterizing distributional effects                                 | 19 | Describe how impacts are distributed across different individuals or adjustments made to reflect priority population.                                                       | Page 5, Methods            |
| Characterizing uncertainty                                            | 20 | Describe methods to characterize any sources of uncertainty in the analysis.                                                                                                | Not applicable.            |
| Approach to engagement with patients and others affected by the study | 21 | Describe any approaches to engage patients or service recipients, the general public, communities, or stakeholders (e.g., clinicians or payers) in the design of the study. | Not applicable.            |
| <b>RESULTS</b>                                                        |    |                                                                                                                                                                             |                            |
| Study parameters                                                      | 22 | Report all analytic inputs (e.g., values, ranges, references) including uncertainty or distributional assumptions.                                                          | Supplemental Materials, S1 |

|                                                                      |    |                                                                                                                                                         |                       |
|----------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Summary of main results                                              | 23 | Report the mean values for the main categories of costs and outcomes of interest and summarise them in the most appropriate overall measure.            | Page 6-7, Results     |
| Effect of Uncertainty                                                | 24 | Describe how uncertainty about analytic judgments, inputs, or projections                                                                               | Not applicable.       |
| Effect of engagement with patients and others affected by the study  | 25 | Report on any difference patient/service recipient, general public, community, or stakeholder involvement made to the approach or findings of the study | Not applicable.       |
| <b>DISCUSSION</b>                                                    |    |                                                                                                                                                         |                       |
| Study findings, limitations, generalizability, and current knowledge | 26 | Report key findings, limitations, ethical or equity considerations not captured, and how these could impact patients, policy, or practice.              | Page 7-11, Discussion |
| <b>OTHER RELEVANT INFORMATION</b>                                    |    |                                                                                                                                                         |                       |
| Source of funding                                                    | 27 | Describe how the study was funded and any role of the funder in the identification, design, conduct, and reporting of the analysis                      | Page 12               |
| Conflicts of interest                                                | 28 | Report authors conflicts of interest according to journal or International Committee of Medical Journal Editors requirements.                           | Page 12               |

### S3: Expanded results of regression analyses

#### Ordinary Linear Regression

**Figure S3.1:** Regression analyses showing relationship between days of length of stay (LOS) and estimated costs for stroke patients with acute ischemic stroke (AIS) or intracerebral haemorrhage (ICH) and concurrent diagnosis of dysphagia.



Legend: AIS: Acute ischemic stroke, ICH: intracerebral haemorrhage; LOS: Length of stay.

The slope amount (\$2,167 for AIS and \$2,374 for ICH) denotes the incremental cost per day. A reduction by a day of LOS would yield these amounts as savings, a two-day reduction twice the amount, etc., while extra days of LOS would add to these costs. The  $R^2$  coefficient can be expected to reflect variation in costs between hospitals across the nation (see data further below).

Detailed costs observed for different LOS are presented in Table S3.2 and Table S3.3 below, for AIS and ICH groups, respectively. The variation observed between mean, median, and quartile values for each LOS demonstrate the variation in costs across the sample, and can be expected to be heavily driven by differences in hospital costs across the nation, as well as differences in stroke severity.

**Table S3.2:** AIS dysphagia cost by day of LOS (from MEDPAR dataset)

| LOS (days) | Costs    |          |          |          | N    |
|------------|----------|----------|----------|----------|------|
|            | Mean     | Median   | Q1       | Q3       |      |
| 1          | \$8,464  | \$6,992  | \$5,216  | \$9,445  | 2679 |
| 2          | \$10,701 | \$8,441  | \$6,597  | \$11,946 | 4648 |
| 3          | \$12,964 | \$10,386 | \$7,952  | \$14,635 | 5524 |
| 4          | \$15,495 | \$12,437 | \$9,359  | \$18,215 | 5657 |
| 5          | \$17,284 | \$14,076 | \$10,675 | \$20,352 | 5236 |
| 6          | \$19,994 | \$16,232 | \$12,087 | \$23,999 | 4860 |
| 7          | \$22,078 | \$18,638 | \$13,657 | \$26,776 | 4201 |
| 8          | \$24,679 | \$20,647 | \$15,410 | \$29,834 | 3792 |
| 9          | \$26,655 | \$22,751 | \$16,649 | \$33,316 | 3135 |
| 10         | \$29,395 | \$25,157 | \$18,329 | \$35,791 | 2707 |
| 11         | \$31,095 | \$27,353 | \$19,854 | \$38,362 | 2360 |
| 12         | \$34,072 | \$29,242 | \$21,630 | \$42,804 | 2111 |
| 13         | \$35,841 | \$31,035 | \$23,113 | \$43,859 | 1850 |
| 14         | \$39,779 | \$35,114 | \$24,880 | \$48,251 | 1681 |
| 15         | \$42,232 | \$36,828 | \$27,175 | \$51,084 | 1363 |

Legend: AIS: Acute ischemic stroke, LOS: Length of stay.

**Table S3.3:** ICH dysphagia cost by day of LOS (from MEDPAR dataset)

| LOS (days) | Costs    |          |          |          | N    |
|------------|----------|----------|----------|----------|------|
|            | Mean     | Median   | Q1       | Q3       |      |
| 1          | \$10,819 | \$7,424  | \$4,668  | \$12,124 | 447  |
| 2          | \$11,573 | \$9,574  | \$6,780  | \$13,622 | 578  |
| 3          | \$14,764 | \$11,884 | \$8,277  | \$18,588 | 787  |
| 4          | \$17,545 | \$14,301 | \$10,298 | \$21,512 | 918  |
| 5          | \$19,757 | \$16,319 | \$11,885 | \$23,660 | 994  |
| 6          | \$22,366 | \$18,716 | \$13,775 | \$27,179 | 1057 |
| 7          | \$24,042 | \$20,904 | \$14,771 | \$28,918 | 983  |
| 8          | \$27,417 | \$23,032 | \$17,105 | \$33,710 | 951  |
| 9          | \$29,450 | \$26,290 | \$18,827 | \$36,759 | 849  |
| 10         | \$30,808 | \$27,637 | \$20,353 | \$36,710 | 777  |
| 11         | \$34,771 | \$30,678 | \$22,145 | \$42,626 | 704  |
| 12         | \$36,986 | \$32,634 | \$23,726 | \$45,208 | 651  |
| 13         | \$41,747 | \$36,824 | \$26,698 | \$52,082 | 556  |
| 14         | \$41,414 | \$36,357 | \$27,206 | \$51,070 | 546  |
| 15         | \$46,669 | \$39,984 | \$30,964 | \$56,032 | 494  |

Legend: ICH: intracerebral haemorrhage; LOS: Length of stay.

### **Generalized Linear Model (GLM) Regression**

Data in Table 3 in the main manuscript were derived from a Generalized Linear Model (GLM) with intent to facilitate more detailed cost calculations that reflect stroke severity.

In absence of variables such as The National Institutes of Health Stroke Scale (NIHSS) in the MEDPAR administrative data set, total length of stay (LOS), ICU days, and ventilation status were used as best available predictors.

For the cohort of patients with AIS and dysphagia, the resulting calculation of costs is provided as follows:

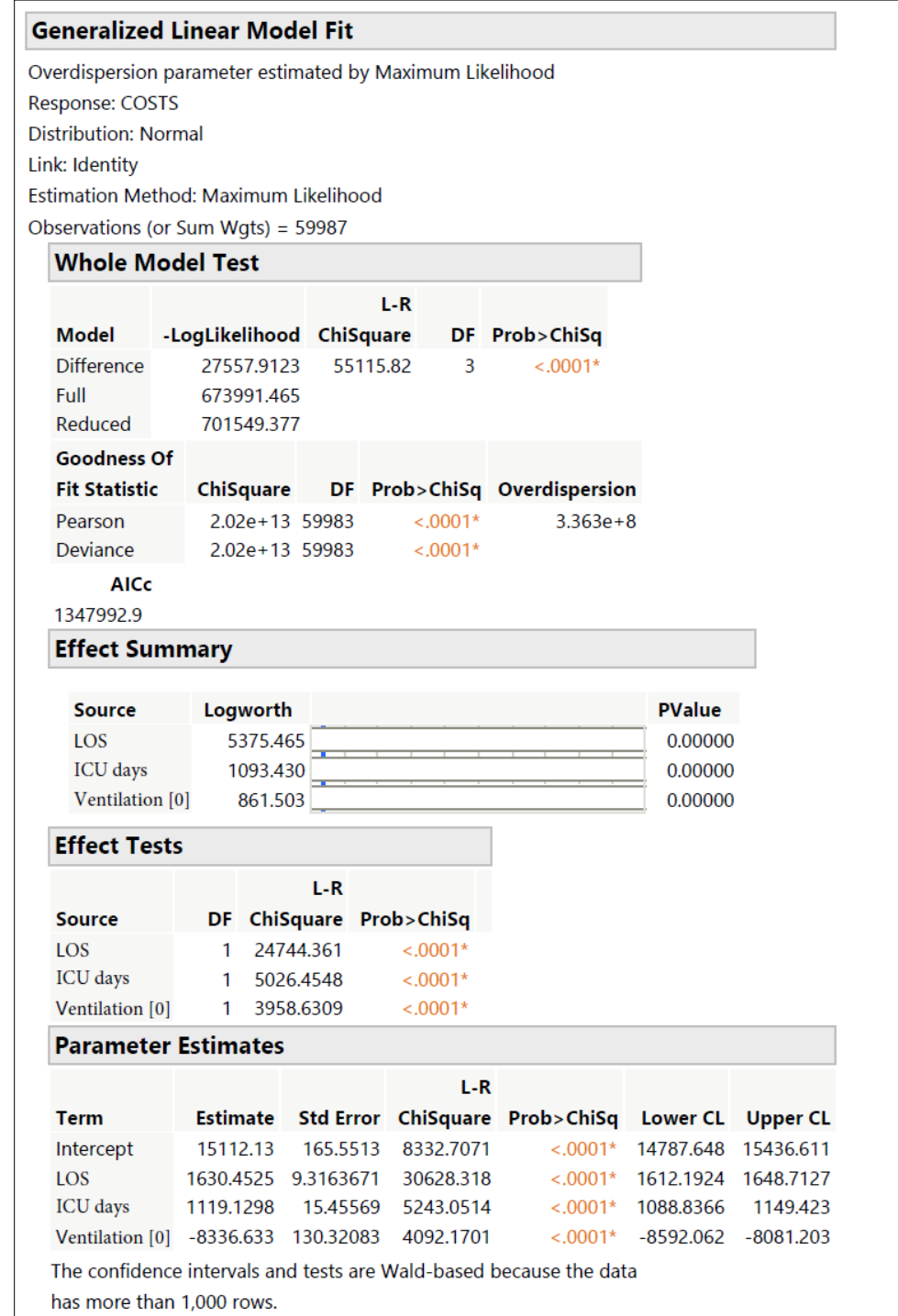
$$\text{Costs} = \$15,112 + \$1,630 * \text{days LOS} + \$1,119 * \text{days ICU} - \$8,337 * \text{Ventilation status [0]}$$

For the cohort of patients with ICH and dysphagia, the resulting calculation of costs is provided as follows:

$$\text{Costs} = \$13,452 + \$1,635 * \text{days LOS} + \$1,528 * \text{days ICU} - \$7,337 * \text{Ventilation status [0]}$$

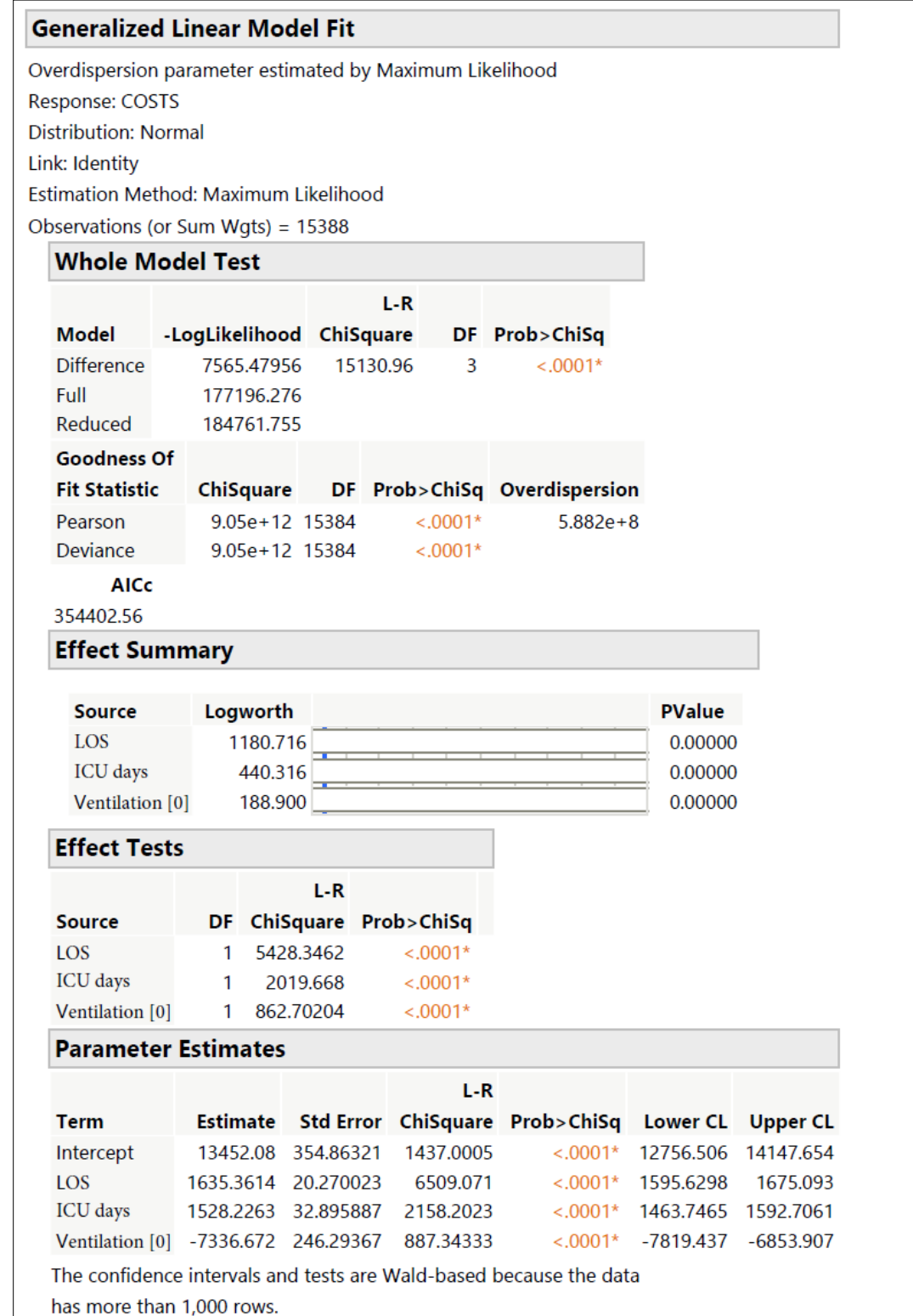
See Figures S3.4 and S3.5 for details about each of these GLMs. Note that overdispersion parameter can be expected to be driven heavily by between-hospital cost differences in this national dataset. Readers interested in hospital-specific cost estimates will benefit from more detailed analyses at the individual hospital level.

**Figure S3.4:** Derived GLM Model for stroke patients with acute ischemic stroke (AIS) and concurrent diagnosis of dysphagia.



Legend: LOS: Length of stay, ICU: Intensive care unit.

**Figure S3.5:** Derived GLM Model for stroke patients with intracerebral hemorrhage (ICH) and concurrent diagnosis of dysphagia.



Legend: LOS: Length of stay, ICU: Intensive care unit.