

ORIGINAL RESEARCH

# Determinants of Admission to Inpatient Rehabilitation Among Acute Care Survivors of Hypoxic-Ischemic Brain Injury: A Prospective Population-Wide Cohort Study



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## Abstract

**Objective:** To investigate demographic and acute care clinical determinants of admission to inpatient rehabilitation (IR) among patients with hypoxic-ischemic brain injury (HIBI) who survive the initial acute care episode.

**Design:** Population-wide prospective cohort study using Canadian Institutes for Health Information administrative health data from Ontario, Canada. All patients who survived their HIBI acute care episode during the study period remained eligible for the outcome, admission to IR, for 1 year postacute care discharge.

**Setting:** Inpatient rehabilitation.

**Participants:** We included all patients with HIBI using *International Classification of Diseases, Tenth Revision, Canadian Enhancement* codes recorded at acute care admission who were  $\geq 20$  years old (N=599) and discharged from acute care between the 2002 and 2010 fiscal years, inclusive. Six patients were excluded from analyses because of missing data.

**Interventions:** Not applicable.

**Main Outcome Measure:** Admission to IR.

**Results:** Of HIBI survivors admitted to IR within 1 year of acute care discharge (n=169), most (56.2%) had an IR admitting diagnosis indicating anoxic brain damage. Younger age, being a man, lower comorbidity burden, longer length of stay of preceding acute care episode, and shorter duration in special care were most predictive of admission to IR in multivariable regression models. Women had an almost 2-fold lower incidence of admission to IR (risk ratio, .62; 95% confidence interval, .46–.84).

**Conclusions:** Older age, higher comorbidity burden, and shorter lengths of stay and delayed discharge from acute care are associated with lower incidence of IR admission for patients with HIBI. That women are almost 2-fold less likely to receive rehabilitation requires further investigation. Archives of Physical Medicine and Rehabilitation 2016;97:885-91

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Acquired brain injury (ABI) arising from either traumatic brain injury (TBI) or nontraumatic brain injury (NTBI) is a leading cause of death and disability worldwide.<sup>1,2</sup> TBI is defined as damage to the brain by an external force, whereas its counterpart, NTBI, is more heterogeneously defined, capturing all other ABI etiologies (eg, stroke, nontraumatic hemorrhage, tumor, infectious diseases, hypoxic injuries, metabolic disorders, toxic exposure). Given this heterogeneity, evaluation of health services outcomes by distinct NTBI subgroup is warranted. Diverse injury mechanisms can lead to important distinctions in etiology and prognosis,

the investigation of which can inform tailoring of more specific and efficient NTBI rehabilitation guidelines.

Adult-onset hypoxic-ischemic brain injury (HIBI) is a sparsely studied NTBI caused by a deficient supply of oxygen to the brain.<sup>3,4</sup> Recent data from Ontario, Canada, demonstrates that approximately 10% of all NTBI cases in the emergency department and 15% of all NTBI cases in acute care were caused by HIBI.<sup>5</sup> The poor outcomes experienced by patients with HIBI are well-documented and include cognitive impairments, neurologic abnormalities, motor deficits, and psychosocial and psychological difficulties.<sup>6-10</sup> Consequently, providing appropriate rehabilitation for this group is of the utmost importance. Although the evidence supports the effectiveness of postacute care rehabilitation among patients with HIBI, it suggests that its efficiency could be increased. For example, HIBI sufferers demonstrate lower cognitive and motor outcomes at discharge from rehabilitation relative to patients with TBI matched on demographic and clinical characteristics<sup>11-13</sup> and are less likely to be discharged home after rehabilitation.<sup>14</sup> Additionally, access issues may plague admission to rehabilitation in this group because they have been observed less likely to be referred, and if referred, to wait longer for admission to rehabilitation relative to other brain injury populations.<sup>14-17</sup> It is plausible that access to supplemental insurance is contributing to this discrepancy because, relative to TBI, many patients with HIBI would be less likely to receive benefits associated with injuries such as those sustained from motor vehicle collisions.<sup>17,18</sup>

Although a number of studies have examined referral to rehabilitation among the TBI population,<sup>19-21</sup> to date, no population-wide study has focused on survivors of HIBI. This paucity of information limits our understanding of the apparent reduced effectiveness of inpatient rehabilitation (IR) relative to TBI. Using a cohort design, we identified patients with HIBI who survived their acute care episode in Ontario, Canada, from administrative health data and describe determinants of their admission to IR. Extending on prior evidence indicating that determinants of discharge destination from acute care differ across types of ABI,<sup>21</sup> the objective of this study was to investigate predictors of IR specific to survivors of HIBI, focusing on characteristics of the acute care episode, prior health care utilization, and sociodemographic factors. Our findings will potentially inform rehabilitation program planning for HIBI survivors and help identify gaps and inequities in access to IR among this distinct NTBI population.

## Methods

### Study design and data sources

All data used herein were provided through the Ontario Cancer Data Linkage Program, an initiative of the Ontario Institute for Cancer Research/Cancer Care Ontario Health Services Research

#### *List of abbreviations:*

|               |  |
|---------------|--|
| <b>ABI</b>    | <b>acquired brain injury</b>                                   |
| <b>ALC</b>    | <b>alternate level of care</b>                                 |
| <b>HIBI</b>   | <b>hypoxic-ischemic brain injury</b>                           |
| <b>ICD-10</b> | <b>International Classification of Diseases, 10th Revision</b> |
| <b>IR</b>     | <b>inpatient rehabilitation</b>                                |
| <b>LOS</b>    | <b>length of stay</b>  |
| <b>NTBI</b>   | <b>nontraumatic brain injury</b>                               |
| <b>TBI</b>    | <b>traumatic brain injury</b>                                  |

Program, whereby risk-reduced coded data from the Institute for Clinical Evaluative Sciences Data Repository managed by the Institute for Clinical Evaluative Sciences are provided directly to researchers with the protection of a comprehensive data use agreement. The population-wide cohort was identified from the Canadian Institute for Health Information Discharge Abstract Database, which contains diagnostic, intervention, and care information on all Ontario inpatient hospital stays. The cohort included all individuals who had an inpatient hospital stay from the 2002 through 2010 fiscal years in Ontario, Canada. Canadian Institutes for Health Information Discharge Abstract Database data were linked to the National Rehabilitation Reporting System, which captures admission, discharge, and treatment episode information on all IR stays province-wide.<sup>22</sup>

### Case definition

Patients with HIBI aged  $\geq 20$  years were identified in the Canadian Institutes for Health Information Discharge Abstract Database by the presence of an *International Classification of Diseases, Tenth Revision* (ICD-10) code for anoxic brain damage (G93.1) as the most responsible diagnosis. Patients with anoxic brain damage as a secondary diagnosis were additionally included given it was coincident with a most responsible diagnosis indicative of probable causative conditions, namely cardiac (I46.0) and respiratory arrest or asphyxia (R09.0, R09.2, T71, R09.0, and T75.1) and conditions likely to involve anoxia (G92, T58, and T70.2).

### Predisposing variables of interest

Potential predictors of admission to IR were chosen based on previous research on determinants of acute care discharge destination and referral to rehabilitation among ABI populations<sup>19,21</sup> and data availability of the Canadian Institutes for Health Information Discharge Abstract Database and National Rehabilitation Reporting System. Sociodemographic variables included age, sex, income quintile, and rurality, the latter 2 based on dissemination area, the smallest divisible geographic Canadian census unit. Prior extent of health care utilization and derived comorbidity burden over the 2 years prior to the acute care episode were captured using Johns Hopkins Aggregated Diagnosis Groups. Health care utilization was measured using Adjusted Clinical Groups Resource Utilization Band score,<sup>23,24</sup> and a comorbidity index was derived from a weighted sum of Aggregated Diagnosis Groups accumulated over the 2 years prior to the admission for the HIBI acute care episode.<sup>25</sup>

Acute care episode characteristics included comorbidity burden, length of stay (LOS) and hours spent in a special care unit, psychiatric comorbidity, and number of alternate level of care (ALC) days during the preceding acute care episode. Psychiatric comorbidities were defined as any mental health or behavioral disorder diagnosis (ICD-10 F chapter heading) in any secondary Canadian Institutes for Health Information Discharge Abstract Database diagnostic field.<sup>26</sup> Number of ALC days were included as a marker of acute care delayed discharge, defined as days on which the attending physician deems the patient no longer requires acute care services while occupying an acute care bed.<sup>27</sup> ALC days exclude those spent in special care units. Additionally, we considered fiscal year of acute care discharge to capture trends in IR admission with time and adjust for associated residual confounding.

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