American Journal of Emergency Medicine 33 (2015) 512–515

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

The excess cost of interisland transfer of intracerebral hemorrhage patients ☆

Kazuma Nakagawa, MD [a,b,*], Alexandra Galati, BA [b], Deborah Taira Juarez, ScD [c]

[a] Neuroscience Institute, The Queen's Medical Center, Honolulu, HI, USA
[b] John A. Burns School of Medicine, University of Hawaii, Honolulu, HI, USA
[c] Daniel K. Inouye College of Pharmacy, University of Hawaii, Hilo, HI, USA

ARTICLE INFO

Article history:
Received 4 November 2014
Received in revised form 1 January 2015
Accepted 3 January 2015

ABSTRACT

Background: Currently, intracerebral hemorrhage (ICH) patients from neighbor islands are air transported to a higher-level facility on Oahu with neuroscience expertise. However, the majority of them do not receive subspecialized neurosurgical procedures (SNP) upon transfer. Hence, their transfer may potentially be considered as excess cost.
Methods: Consecutive ICH patients hospitalized at a tertiary center on Oahu between 2006 and 2013 were studied. *Subspecialized neurosurgical procedure* was defined as any neurosurgical procedure or conventional cerebral angiogram. Total excess cost was estimated as the cost of interisland transfer multiplied by the number of interisland transfer patients who did not receive any SNP.
Results: Among a total of 825 patients, 100 patients (12%) were transferred from the neighbor islands. Among the neighbor-island patients, 69 patients (69%) did not receive SNP, which translates to $1 035 000 of excess cost over an 8-year period (approximately $129 375/y). Multivariable analyses showed age (odds ratio [OR], 0.95; 95% confidence interval [CI]: 0.94-0.96), lack of hypertension (OR, 1.62; 95% CI: 1.002-2.61), initial Glasgow Coma Scale (OR, 0.94; 95% CI: 0.89-0.98), lobar hemorrhage (OR, 2.74; 95% CI: 1.59-4.71), cerebellar hemorrhage (OR, 5.47; 95% CI: 2.78-10.76), primary intraventricular hemorrhage (OR, 4.40; 95% CI: 1.77-10.94), and any intraventricular hemorrhage (OR, 2.47l 95% CI: 1.53-3.97) to be independent predictors of receiving SNP.
Conclusion: Approximately two-thirds of ICH patients who were air transferred did not receive SNP. Further study is needed to assess the cost-effectiveness of creating a triage algorithm to optimally select ICH patients who would benefit from air transport to a higher-level facility.

1. Introduction

Spontaneous intracerebral hemorrhage (ICH) is a hemorrhagic stroke with high morbidity and mortality, and accounts for 10% to 15% of the approximately 700 000 annual strokes in the United States [1–3]. The current guidelines recommend all ICH patients be managed initially in a facility with neuroscience expertise, preferably in a dedicated neuroscience intensive care unit (NSICU) with the capacity to perform subspecialized neurosurgical procedures (SNP) [4]. It has been suggested that the admission of ICH patients to a dedicated NSICU is associated with improved outcomes compared to admission to a general intensive care unit [5]. As a result, the majority of ICH patients seen in the emergency department (ED) are being transferred to a higher-level facility with NSICU and neurosurgical coverage in accordance with the Emergency Medical Treatment and Active Labor Act [6,7].

In Hawaii, ICH patients who initially present to hospitals on islands other than Oahu often use the medical air transport services to be transferred to a tertiary center on Oahu. However, not all ICH patients who are transferred to a higher-level facility receive SNP. Hence, the management of these patients does not differ significantly from what it would have been had they remained at the initial nontertiary facility. In these cases, the cost of interisland medical air transport may potentially be considered as excess cost. Therefore, we sought to assess the annual excess cost of interisland transfer of ICH patients who were transferred to a tertiary center on Oahu and the clinical factors that would predict receiving SNP in all ICH patients.

2. Methods

We received approval from the Queen's Medical Center (QMC) Research and Institutional Review Committee to conduct a retrospective

Abbreviations: AV, arteriovenous; CI, confidence interval; GCS, Glasgow Coma Scale; ICH, intracerebral hemorrhage; ICP, intracranial pressure; IVH, intraventricular hemorrhage; MI, myocardial infarction; NSICU, neuroscience intensive care unit; OR, odds ratio; QMC, Queen's Medical Center; SNP, subspecialized neurosurgical procedure.

☆ Source of support: This study and Dr Nakagawa were supported in part by a research grant from the National Institute on Minority Health and Health Disparities of the National Institutes of Health (P20MD000173) and in part by the American Heart Association (11CRP7160019).

* Corresponding author. The Queen's Medical Center, Neuroscience Institute, 1301 Punchbowl St, Honolulu, HI 96813. Tel.: +1 808 691 7152; fax: +1 808 691 4001.
E-mail address: kazuma.nakagawa@hawaii.edu (K. Nakagawa).

http://dx.doi.org/10.1016/j.ajem.2015.01.001
0735-6757/

study of all spontaneous ICH patients hospitalized at QMC between January 1, 2006, and December 31, 2013. Queen's Medical Center is a 505-bed medical center located in Honolulu, Oahu, the largest hospital in Hawaii and the tertiary referral center for the Pacific Basin (Hawaii, American Samoa, the Commonwealth of the Northern Mariana Islands, Micronesia, and the US territories of Guam). Queen's Medical Center has the only Joint Commission–certified Primary Stroke Center, the only American College of Surgeons–verified trauma center with full neurosurgical coverage, and the only dedicated NSICU in the state of Hawaii.

2.1. Patients

All patients hospitalized at QMC between January 1, 2006, and December 31, 2013, with a diagnosis of spontaneous ICH were retrospectively identified using the institution's stroke database. Case ascertainment of admissions for ICH was conducted by prospective clinical identification and retrospective verification by a review of electronic medical record (Epic). Patients with ICH related to trauma, ruptured cerebral aneurysm, or ischemic stroke with hemorrhagic conversion were excluded because these conditions are managed differently from spontaneous ICH.

2.2. Data collection

Patient demographics; whether the patient was transferred from a neighbor-island hospital; medical history including history of hypertension, diabetes mellitus, atrial fibrillation/atrial flutter, coronary artery disease, or prior myocardial infarction (MI); and smoking were obtained from the database. Initial Glasgow Coma Scale (GCS) score and coagulopathy were obtained from the electronic medical record. *Coagulopathy* was defined as initial international normalized ratio greater than 1.4. All initial head computed tomography scans were retrospectively reviewed by a board-certified neurologist/neurointensivist using a standardized protocol. Hematoma volume was measured using the previously described ABC/2 method [8]. Presence of intraventricular hemorrhage (IVH) was recorded; and ICH location was coded as basal ganglia, lobar, thalamus, brainstem, cerebellar, or primary IVH. Our institution had a transfer guideline for ICH patients (Table 1) during the study period. However, the decision to ultimately accept and transfer the ICH patients from another hospital was done on a case-by-case basis at the discretion of the on-call neurointensivist who received the transfer request. Inherent practitioner-dependent variability in the triage process likely existed during the study period. The data on ICH patients who were not transferred and remained at the initial hospital were not available for analysis.

2.3. Outcome measure

Patients were considered to have received SNP if any neurosurgical procedure (craniotomy, craniectomy, ventricular drainage, and/or intracranial pressure [ICP] monitor placement) or conventional cerebral angiogram (diagnostic and/or therapeutic) was performed.

Table 1
Institutional transfer guideline for ICH patients

Highly consider transfer:
• Cerebellar hemorrhage with mass effect, especially with (*a*) >3 cm diameter, (*b*) neurological deterioration, and/or (*c*) obstructive hydrocephalus
• Supratentorial lobar hemorrhage with (*a*) mass effect, (*b*) good baseline function, AND (*c*) superficial (<1 cm from the surface)
• IVH with obstructive hydrocephalus
• Any ICH with clinical and/or radiographic suspicion for underlying vascular lesion
May not need transfer:
• Lobar hemorrhage without mass effect
• Comatose patients with brainstem, thalamic, or basal ganglia hemorrhage with poor prognosis based on clinical and/or radiographic data

2.4. Statistical analysis

Patient characteristics were summarized using descriptive statistics appropriate to variable type. Minimum cost of interisland transfer for ICH patients was conservatively estimated to be $15 000 per interisland transfer based on the informal survey of a local company that provides medical air transport. Total excess cost was estimated as cost per interisland transfer multiplied by the number of interisland transferred patients not receiving any SNP. In sensitivity analyses, we varied the cost of interisland transport from $5000 to $25 000 (baseline = $15 000).

In the univariate analyses, patients that received SNP were compared to those that did not receive SNP using the χ^2 test for categorical data; 2-tailed *t* test for normally distributed, continuous variables; and Mann-Whitney *U* test for nonparametric data (GCS). Multivariable analyses were performed by including the variables with $P < .10$ in the univariate analyses to identify independent factors associated with receiving SNP. In the model, when assessing the impact of hematoma location, basal ganglia hemorrhage was used as the reference location because basal ganglia hemorrhage was clinically considered the least likely location to receive SNP. Odds ratio (OR) and 95% confidence interval (CI) were calculated from the β coefficients and their standard errors. Levels of $P < .05$ were considered statistically significant. Data were analyzed using commercially available statistical software (SPSS 22.0; IBM SPSS Inc, Armonk, NY).

3. Results

A total of 825 spontaneous ICH patients hospitalized at QMC between 2006 and 2013 were identified. A total of 100 patients (12%) were transferred to QMC from the neighbor islands through interisland transfer. Overall, the proportion of patients who received interisland transfer was stable during the study period: 9 (13%) of 70 in 2006, 6 (8%) of 73 in 2007, 5 (6%) of 82 in 2008, 9 (9%) of 103 in 2009, 14 (11%) of 126 in 2010, 20 (14%) of 142 in 2011, 16 (14%) of 112 in 2012, and 21 (18%) of 117 in 2013 ($P = .20$). The clinical characteristics of ICH patients who were transferred from the neighbor islands and those patients from Oahu are shown in Table 2. Overall, ICH patients who were transferred from neighbor islands were younger, had less vascular risk factors, and were more likely to receive cerebral angiogram.

Among the ICH patients who were transferred from the neighbor islands, only 31 patients (31%) received SNP. Because the remaining 69 patients (69%) did not receive SNP, this translates to $1 035 000 of total excess cost over an 8-year period (approximately $129 375/y) that could have been avoided if these patients had not been transferred and had instead received similar care at the local hospital. Varying the cost of an interisland transport from $5000 to $25 000 (from a baseline of $15 000) in sensitivity analysis resulted in annual excess cost estimates ranging from a low of $43 125/y to a high of $215 625/y (Figure).

Univariate analyses comparing all ICH patients who received SNP and those who did not receive SNP are shown in Table 3. Multivariable analyses showed that age (OR, 0.95; 95% CI: 0.94-0.96), lack of hypertension (OR, 1.62; 95% CI: 1.002-2.61), initial GCS (OR, 0.94; 95% CI: 0.89-0.98), lobar hemorrhage (OR, 2.74; 95% CI: 1.59-4.71), cerebellar hemorrhage (OR, 5.47; 95% CI: 2.78-10.76), primary IVH (OR, 4.40; 95% CI: 1.77-10.94), and any IVH (OR, 2.47; 95% CI: 1.53-3.97) are independently associated with receiving SNP.

4. Discussion

This study showed that only about one-third of the ICH patients who were transferred from the neighbor islands actually received higher-level subspecialty care requiring neurosurgical procedures upon transfer to Oahu. Our conservative cost analysis demonstrates that approximately $129 375/y is being spent in unnecessary medical air transport for interisland transfers. Because the cost of medical air transport ranges widely based on the acuity of the patient, the actual excess cost in this