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The excess cost of inter-island transfer of intracerebral hemorrhage patients

Kazuma Nakagawa, MD[1,2], **Alexandra Galati, BA**[2], and **Deborah Taira Juarez, ScD**[3]

[1]Neuroscience Institute, The Queen's Medical Center, Honolulu, HI, USA

[2]John A. Burns School of Medicine, University of Hawaii, Honolulu, HI, USA

[3]Daniel K. Inouye College of Pharmacy, University of Hawaii, Hilo, HI, USA

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. SNP was defined as any neurosurgical procedure or conventional cerebral angiogram. Total excess cost was estimated as the cost of inter-island transfer multiplied by the number of inter-island 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/year). Multivariable analyses showed age (OR 0.95, 95% CI: 0.94, 0.96), lack of hypertension (OR 1.62, 95% CI: 1.002 to 2.61), initial Glasgow Coma Scale (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 intraventricular hemorrhage (IVH) (OR 4.40, 95% CI: 1.77, 10.94), and any IVH (OR 2.47, 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.

Keywords

Intracerebral hemorrhage; Triage; costs and Cost analysis

Corresponding Author: Kazuma Nakagawa, MD, The Queen's Medical Center, Neuroscience Institute, 1301 Punchbowl Street, Honolulu, HI 96813, Phone: (808) 691-7152/Fax: (808) 691-4001, kazuma.nakagawa@hawaii.edu.

INTRODUCTION

Spontaneous intracerebral hemorrhage (ICH) is a hemorrhagic stroke with high morbidity and mortality, and accounts for 10–15% 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 (ICU).[5] As a result, the majority of ICH patients seen in the Emergency Department are being transferred to a higher-level facility with NSICU and neurosurgical coverage in accordance with Emergency Medical Treatment and Active Labor Act (EMTALA).[6,7]

In Hawaii, ICH patients who initially present to hospitals on islands other than Oahu often utilize 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 non-tertiary facility. In these cases, the cost of inter-island medical air transport may potentially be considered as excess cost. Therefore, we sought to assess the annual excess cost of inter-island 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.

METHODS

We received approval from the Queen's Medical Center (QMC) Research and Institutional Review Committee to conduct a retrospective study of all spontaneous ICH patients hospitalized at QMC between January 1, 2006, and December 31, 2013. QMC 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 U.S. territories of Guam). QMC 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.

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 since these conditions are managed differently from spontaneous ICH.

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 (CAD) 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 the initial international normalized ratio (INR) >1.4. All initial head computed tomography (CT) 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.

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.

Statistical Analysis

Patient characteristics were summarized using descriptive statistics appropriate to variable type. Minimum cost of inter-island transfer for ICH patients was conservatively estimated to be $15,000 per inter-island transfer based on the informal survey of a local company that provides medical air transport. Total excess cost was estimated as cost per inter-island transfer multiplied by the number of inter-island transferred patients not receiving any SNP. In sensitivity analyses, we varied the cost of inter-island 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 chi-square 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 $P < 0.10$ 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 since 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 beta coefficients and their standard errors. Levels of $P < 0.05$ were considered statistically significant. Data were analyzed using commercially available statistical software (SPSS 22.0, IBM SPSS Inc., New York, USA).

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 inter-island transfer. Overall, the proportion of patients who received inter-island transfer was stable during the study period: 9/70 (13%) in 2006, 6/73 (8%) in 2007, 5/82 (6%) in 2008, 9/103 (9%) in 2009, 14/126 (11%) in 2010, 20/142 (14%) in 2011, 16/112 (14%) in 2012, 21/117 (18%) in 2013 ($P = 0.20$). 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. Since 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/year) 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/year to a high of $215,625/year (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 to 0.96), lack of hypertension (OR 1.62, 95% CI: 1.002 to 2.61), initial GCS (OR 0.94, 95% CI: 0.89 to 0.98), lobar hemorrhage (OR 2.74, 95% CI: 1.59 to 4.71), cerebellar hemorrhage (OR 5.47, 95% CI: 2.78 to 10.76), primary IVH (OR 4.40, 95% CI: 1.77 to 10.94), and any IVH (OR 2.47, 95% CI: 1.53 to 3.97) are independently associated with receiving SNP.

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/year is being spent in unnecessary medical air transport for inter-island transfers. Since the cost of medical air transport ranges widely based on the acuity of the patient, the actual excess cost in this patient population is speculated to be much higher than our conservative estimate of $15,000 per inter-island transfer. In addition to the direct cost of patient air transfer, other adverse consequences beyond the cost of air transfer may also exist, such as the cost incurred by family members to visit the patient, or potential separation of the patient from his or her family, if the family is not able to travel.

The independent predictors of receiving SNP in the multivariable analyses are consistent with the known clinical factors associated with SNP (younger age, lack of vascular risk factors, worse neurological status, lobar or cerebellar location of hemorrhage, and IVH), [4] and suggest that practitioners at the hospital receiving the transfers were determining the need for SNP in accordance with the current ICH guidelines. Also, as compared to the ICH patients from Oahu, the neighbor island patients were significantly younger and were more likely to receive cerebral angiogram, a procedure typically performed to diagnose arteriovenous malformation (AVM) or dural arteriovenous (AV) fistula. This likely represents the higher predilection for the on-call neurointensivists to accept younger patients with a higher clinical suspicion for atypical causes of ICH such as underlying vascular lesion (i.e. AVM, dural AV fistula, etc.) that may require higher-level neurosurgical intervention. Since older patients have higher prevalence of hypertension-related ICH, which typically do not require cerebral angiogram, some of the older patients with hypertension-related hemorrhage may have been triaged to stay at the neighbor island hospitals. Furthermore, older ICH patients may also have had advance directive or other directives that may have stated their wish for non-heroic measures, and thus not prompting inter-hospital transfer.

Although neurosurgical resection of ICH has been practiced in the past, current management of ICH is mainly supportive and non-surgical since there are no randomized trials to date that have proven the efficacy of surgery in reducing death or disability.[4] Two of the largest randomized trials in ICH that assessed the efficacy of early surgical intervention, Surgical Trial in Intracerebral Hemorrhage (STICH)[9] and STICH II, [10] both failed to show efficacy of early surgical hematoma evacuation over conservative medical treatment. As a result of these two trials, significant reduction in the practice of surgical hematoma evacuation has been seen in contemporary ICH management. However, other neurosurgical procedures such as placement of ventricular drainage for ICH with IVH and hydrocephalus, ICP monitor placement for GCS ≤ 8 and/or with herniation syndrome, surgical resection of selected lobar and cerebellar hemorrhage, and conventional cerebral angiogram for ICH with high clinical suspicion for underlying vascular lesion, are still being practiced despite the lack of strong evidence supporting their efficacy.[4] The rate of surgical intervention among the transferred ICH patients in our study (31%) is comparable to another single-center study from the U.S. mainland (35%).[11]

Despite the emerging literature that has failed to show the efficacy of surgery in most ICH cases, many practitioners in the Emergency Department still have the sentiment that all ICH patients should be transferred to a facility that can perform neurosurgical intervention. As a result, many ICH patients from neighbor islands are being transferred to a tertiary center with NSICU and neurosurgical coverage even though higher-level neurosurgical procedures may not be appropriate for them.

Furthermore, hospital transfer by helicopter or small airplane can be costly, ranging from $12,000 to $25,000 per flight, [12] and may be associated with adverse medical outcomes. [13–15] One study that specifically assessed the impact of inter-hospital transfer in ICH patients showed that ICH patients who were admitted from inter-hospital transfer had worse functional outcome and greater neurological decline compared to those who were admitted directed from the Emergency Department.[16] Authors of this study speculate that lack of optimal medical management prior to and during transfer may have lead to potentially devastating neurological consequences. One could argue that ICH patients who do not require SNP should be immediately admitted to the general ICU of their local hospital and urgently receive an optimal medical management rather than delaying the process by arranging the inter-island transfer. Therefore, it would be most cost effective to only select ICH patients that would most likely receive SNP to be air transported via inter-island transfer. Further prospective study is needed to assess the safety and cost-effectiveness of creating a standardized triage algorithm to optimally select ICH patients who would benefit from medical air transport to a higher-level tertiary center.

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Abbreviations

AV	Arteriovenous
AVM	Arteriovenous malformation
CAD	Coronary artery disease
CI	Confidence interval
CT	Computed tomography
EMTALA	Emergency Medical Treatment and Active Labor Act
GCS	Glasgow Coma Scale
ICH	Intracerebral hemorrhage
ICP	Intracranial pressure
ICU	Intensive care unit
INR	International normalized ratio
IVH	Intraventricular hemorrhage
MI	Myocardial infarction
NSICU	Neuroscience intensive care unit
OR	Odds ratio
QMC	Queen’s Medical Center
SNP	Subspecialized neurosurgical procedures
STICH	Surgical Trial in Intracerebral Hemorrhage

References

1. van Asch CJ, Luitse MJ, Rinkel GJ, van der Tweel I, Algra A, Klijn CJ. Incidence, case fatality, and functional outcome of intracerebral haemorrhage over time, according to age, sex, and ethnic origin: a systematic review and meta-analysis. Lancet Neurol. 2010; 9:167–76. [PubMed: 20056489]
2. Elijovich L, Patel PV, Hemphill JC 3rd. Intracerebral hemorrhage. Semin Neurol. 2008; 28:657–67. [PubMed: 19115172]

3. Qureshi AI, Mendelow AD, Hanley DF. Intracerebral haemorrhage. Lancet. 2009; 373:1632–44. [PubMed: 19427958]

4. Morgenstern LB, Hemphill JC 3rd, Anderson C, et al. Guidelines for the management of spontaneous intracerebral hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2010; 41:2108–29. [PubMed: 20651276]

5. Diringer MN, Edwards DF. Admission to a neurologic/neurosurgical intensive care unit is associated with reduced mortality rate after intracerebral hemorrhage. Crit Care Med. 2001; 29:635–40. [PubMed: 11373434]

6. Peth HA Jr. The Emergency Medical Treatment and Active Labor Act (EMTALA): guidelines for compliance. Emergency medicine clinics of North America. 2004; 22:225–40. [PubMed: 15062507]

7. Bitterman RA. EMTALA and the ethical delivery of hospital emergency services. Emergency medicine clinics of North America. 2006; 24:557–77. [PubMed: 16877130]

8. Kothari RU, Brott T, Broderick JP, et al. The ABCs of measuring intracerebral hemorrhage volumes. Stroke. 1996; 27:1304–5. [PubMed: 8711791]

9. Mendelow AD, Gregson BA, Fernandes HM, et al. Early surgery versus initial conservative treatment in patients with spontaneous supratentorial intracerebral haematomas in the International Surgical Trial in Intracerebral Haemorrhage (STICH): a randomised trial. Lancet. 2005; 365:387–97. [PubMed: 15680453]

10. Mendelow AD, Gregson BA, Rowan EN, Murray GD, Gholkar A, Mitchell PM. Early surgery versus initial conservative treatment in patients with spontaneous supratentorial lobar intracerebral haematomas (STICH II): a randomised trial. Lancet. 2013; 382:397–408. [PubMed: 23726393]

11. Maas MB, Rosenberg NF, Kosteva AR, et al. Surveillance neuroimaging and neurologic examinations affect care for intracerebral hemorrhage. Neurology. 2013; 81:107–12. [PubMed: 23739227]

12. [Accessed 09/25, 2014] Air ambulances leave some with sky-high bills. 2009. at http://www.msnbc.msn.com/id/34419018/ns/health-health_care/t/air-ambulances-leave-some-sky-high-bills/

13. Cunningham P, Rutledge R, Baker CC, Clancy TV. A comparison of the association of helicopter and ground ambulance transport with the outcome of injury in trauma patients transported from the scene. The Journal of trauma. 1997; 43:940–6. [PubMed: 9420109]

14. Shatney CH, Homan SJ, Sherck JP, Ho CC. The utility of helicopter transport of trauma patients from the injury scene in an urban trauma system. The Journal of trauma. 2002; 53:817–22. [PubMed: 12435928]

15. Eckstein M, Jantos T, Kelly N, Cardillo A. Helicopter transport of pediatric trauma patients in an urban emergency medical services system: a critical analysis. The Journal of trauma. 2002; 53:340–4. [PubMed: 12169944]

16. Naval NS, Carhuapoma JR. Impact of pattern of admission on ICH outcomes. Neurocrit Care. 2010; 12:149–54. [PubMed: 19915983]

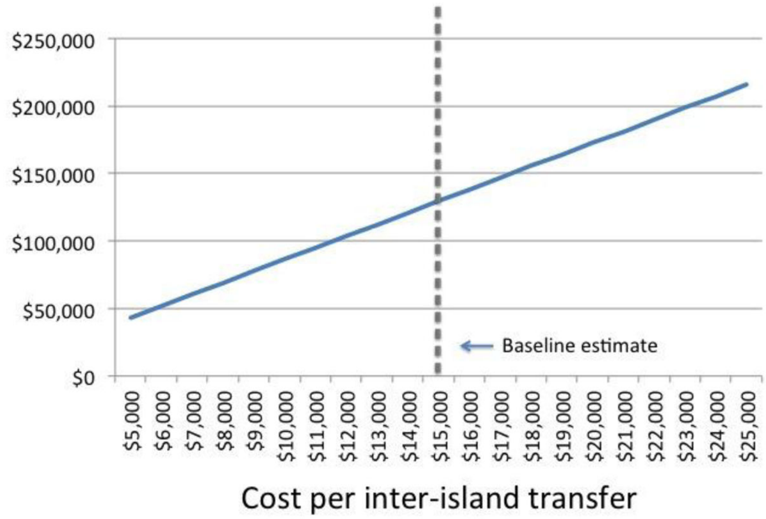

Figure.

Sensitivity Analysis: Annual Estimated Excess Cost Related to Cost per Inter-Island Transfer

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). • Intraventricular hemorrhage 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.

Table 2

Comparison of ICH patients transferred from the neighbor islands and those from Oahu between 2006 and 2013

	Oahu	Neighbor Islands	*P*
No. of patients	725	100	
Age, years	64 ± 17	58 ± 17	0.001
Female	318 (44)	38 (38)	0.27
Race			0.001
Whites	102 (14)	26 (26)	
Asians	466 (64)	45 (45)	
NHOPI	127 (18)	25 (25)	
Other	30 (4)	4 (4)	
Hypertension	569 (79)	72 (72)	0.14
Diabetes Mellitus	185 (26)	20 (20)	0.23
Hypercholesterolemia	274 (38)	27 (27)	0.04
Coronary artery disease or prior MI	89 (12)	13 (13)	0.84
Atrial fibrillation	99 (14)	12 (12)	0.65
Smoking	216 (30)	37 (37)	0.14
Prior stroke	98 (14)	5 (5)	0.02
Coagulopathy	83 (11)	13 (13)	0.65
Initial Glasgow Coma Scale	14 [6, 15]	14 [8, 15]	0.36
Hematoma location			0.18
Basal ganglia	235 (32)	32 (32)	
Lobar	215 (30)	35 (35)	
Thalamus	136 (19)	12 (12)	
Cerebellum	67 (9)	15 (15)	
Brainstem	40 (6)	4 (4)	
Primary intraventricular hemorrhage	32 (4)	2 (2)	
Intraventricular hemorrhage	323 (45)	50 (50)	0.27
Hematoma volume (cm^3)	35 ± 46	36 ± 42	0.83
Subspecialized neurosurgical procedures	122 (16)	31 (31)	0.001
Craniotomy or craniectomy	55 (8)	11 (11)	0.24
EVD or ICP monitor placement	53 (7)	11 (11)	0.20
Cerebral angiogram	55 (8)	22 (22)	<0.0001
Hospital mortality	187 (26)	22 (22)	0.41

Table 3

Characteristics of ICH patients that received subspecialized neurosurgical procedures (SNP)

	No SNP	SNP	*P*
No. of patients	672	153	
Age, years	66 ± 16	52 ± 17	<0.0001
Female	295 (44)	61 (40)	0.36
Race			0.45
Whites	105 (16)	23 (15)	
Asians	421 (63)	90 (59)	
NHOPI	117 (17)	35 (23)	
Other	29 (4)	5 (3)	
Hypertension	545 (81)	96 (63)	<0.0001
Diabetes Mellitus	170 (25)	35 (23)	0.53
Hypercholesterolemia	264 (39)	37 (24)	<0.001
Coronary artery disease or prior MI	95 (14)	7 (5)	0.001
Atrial fibrillation	94 (14)	17 (11)	0.35
Smoking	201 (30)	52 (34)	0.32
Prior stroke	88 (13)	15 (10)	0.27
Coagulopathy	77 (12)	19 (12)	0.74
Initial Glasgow Coma Scale	14 [8, 15]	10 [7, 14]	<0.0001
Hematoma location			<0.0001
Basal ganglia	230 (34)	37 (24)	
Lobar	197 (29)	53 (35)	
Thalamus	127 (19)	21 (14)	
Cerebellum	55 (8)	27 (18)	
Brainstem	42 (7)	2 (1)	
Primary intraventricular hemorrhage	21 (3)	13 (8)	
Intraventricular hemorrhage	276 (41)	97 (64)	<0.0001
Hematoma volume (cm^3)	34 ± 47	37 ± 34	0.57