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# A Descriptive Study of Traumatic Brain Injury Patients and their Transfer within the State of Alaska

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## Introduction

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Patients with head trauma may have traumatic brain injury (TBI) requiring rapid and decisive neurosurgical intervention. Providing definitive TBI management for the 59% of Alaskans who live outside the Anchorage metropolitan area is a challenge; many patients with head trauma must be transferred for neurosurgical specialty care hundreds of miles away in Anchorage or Seattle, Washington.<sup>1</sup> Transfers come at a high cost; the Medicare air ambulance rate in rural Alaska starts at a base rate of \$4753 for a fixed wing one-way transfer and \$5525 for a rotary one-way transfer. There is an additional fee of \$12.80 and \$34.80 per mile for fixed wing and rotary flights, respectively.<sup>2</sup> In addition, the

hazards of flying through rural Alaska are quite real, including limited radar coverage, unpredictable weather and rough terrain. Not surprisingly, Alaskan pilots demonstrate a work-related mortality rate of 410 per 100,000, which is nearly five times the rate of pilots in the rest of the United States.<sup>3</sup> In 2004, in order to provide the best possible care without excessive transfers across the vast rural and remote settings of Alaska, the Alaska Trauma Systems Review Committee adopted the *Alaska State Guidelines for the Management of Acute Head Trauma in Remote and Rural Locations* henceforth referred to as “the Alaska guidelines.”<sup>4</sup> These guidelines were presented at the annual State of Alaska Emergency Medical Services (EMS) Symposium in 2004. They were further distributed by being placed on the Alaska EMS website and continue to be available for free download and unlimited distribution at the Alaska Department of Health and Social Services website. The Alaska guidelines have not yet been validated in any studies.

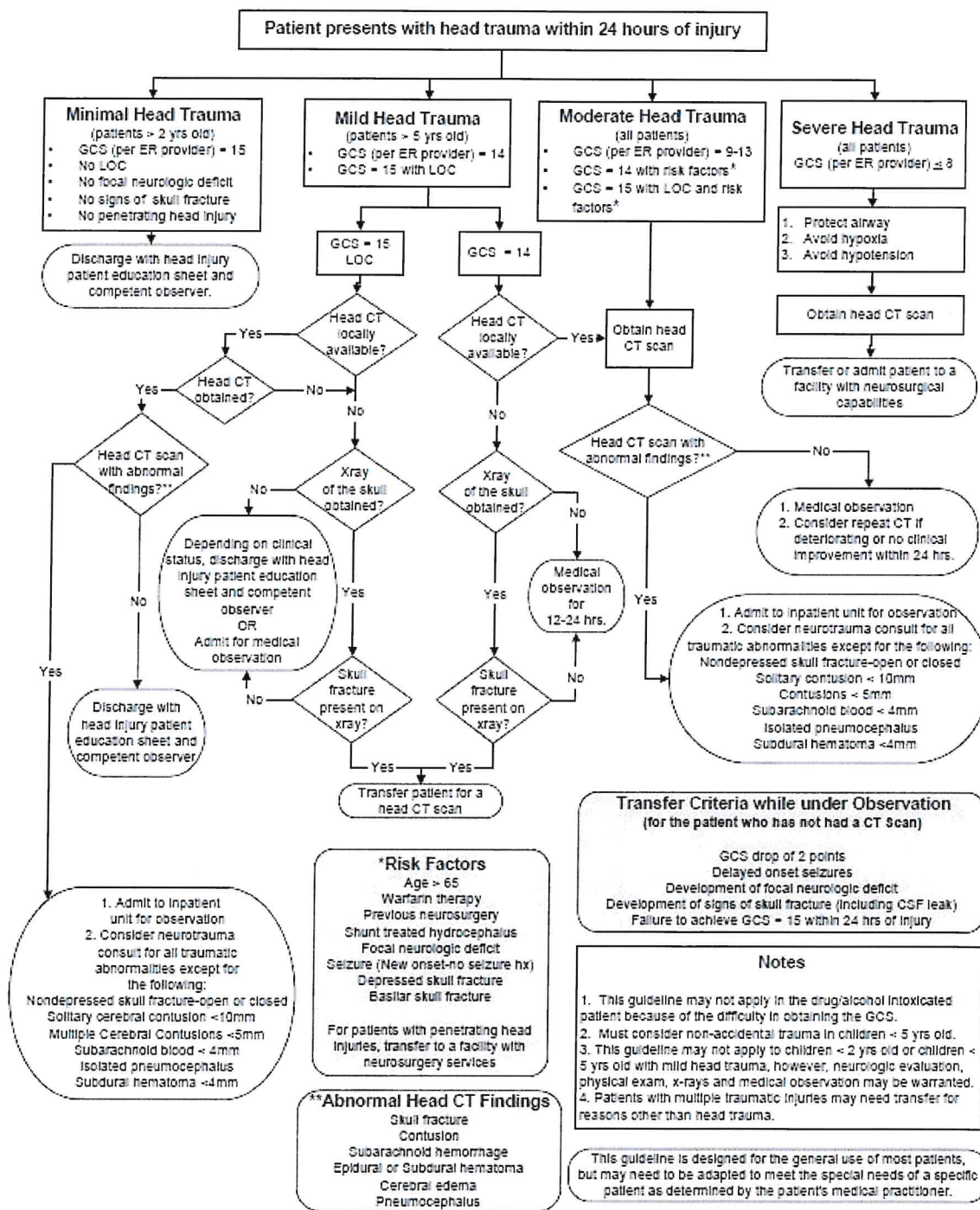
The Alaska guidelines were initially formed when the Alaska Trauma Systems Review Committee convened in 2003 to develop the recommendations. This group consisted of 18 physicians representing emergency medicine, trauma surgery, radiology, pediatrics, and neurosurgery. Each physician had many years of experience working in the unique environment provided within the state of Alaska. A literature review was done and distributed to the committee. Several previous studies were considered in the formation of

the final guidelines, including neurosurgical literature, the Canadian Computed Tomography (CT) Head Rules, the Scandinavian guidelines, and NEXUS II. A complete list of reviewed literature taken into account when formulating the guidelines can be seen in Table 1. These studies, along with the experiences and judgement of the committee members were taken into account when developing the Alaska guidelines. A detailed flowchart of the Alaska guidelines appears in Figure 1.<sup>4</sup>

**Table 1- Literature considered in the formation of the Alaska guidelines**

Committee on Trauma, American College of Surgeons. <i>Advanced Trauma Life Support for Doctors</i> . Chapter 6. "Head Trauma" 6th edition. 1997
Committee on Quality Improvement, Am. Academy of Pediatrics, Commission on Clinical Policies and Research, Am Academy of Family Physicians. The management of minor closed head injury in children. <i>Pediatrics</i> 1999 104(6) 1407-15.
Cushman JG, Agarwal N, Fabian T, et al, Practice management guidelines for the management of mild traumatic brain injury: The EAST practice management guidelines workgroup. <i>Eastern Association for the Surgery of Trauma</i> 2001
Ingebrigtsen T, Romner B, Kock-Jensen C. Scandinavian guidelines for initial management of minimal mild and moderate head injuries. <i>Journal of Trauma</i> 2000; 48:760-766.
Mower WR, Hoffman JR, Herbert M. et al. Developing a clinical decision instrument to rule out intracranial injuries in patients with minor head trauma: methodology of the NEXUS II investigation. <i>Ann Emerg Med</i> . 2002;40:505-514.
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Figure 1 - Flowchart of Alaska Traumatic Brain Injury Guidelines



The Alaska guidelines define a *rural* facility as one with medical providers and a CT scanner, but no neurosurgeons, and a *remote* facility as one that has medical providers, but no CT scanner or neurosurgeons. Effectively, all medical facilities in Alaska outside of Anchorage are either rural or remote. This emphasizes how rural most of Alaska is. The largest city in the state, Anchorage, has a population of approximately 300,000. The next two largest cities, Fairbanks and Juneau each have a population slightly greater than 30,000.

Patients with minimal head trauma (see Table 2) do not need imaging. They can be discharged with head injury instructions in the care of a competent observer and do not require transfer. The guidelines for patients with mild and moderate head trauma are much more complicated and depend on Glasgow Coma Scale (GCS), level of consciousness (LOC), the availability of CT, specific CT findings, x-ray findings, neurosurgery teleradiology consultant availability and recommendations, and individual patient's symptom progression during emergency department (ED) observation (see Figure 1). All patients with severe head trauma require head CT and should be managed facilities in with neurosurgical specialist care.

The 2002 American College of Emergency Physicians (ACEP) Clinical Policy regarding neuroimaging and disposition decision-making in adult mild TBI in the acute setting was not cited in the Alaska guidelines.<sup>5</sup> The ACEP Clinical Policy does not recommend skull film radiographs in the evaluation of mild TBI. The ACEP Clinical Policy recommends a head CT scan in patients with loss of consciousness or posttraumatic amnesia *only* if one or more of the following is present: headache, vomiting, age greater than 60 years, drug or alcohol intoxication, deficits in short term memory, physical evidence of trauma above the clavicle, posttraumatic seizure, GCS score less than 15, focal neurologic deficit, or coagulopathy. Lastly, the ACEP Clinical Policy recommends that patients with no history of coagulopathy or prior neurosurgical procedures who have a negative head CT scan result are at minimal risk for developing an intracranial lesion and therefore may be safely discharged from the ED. The Alaska guidelines differ from the ACEP Clinical Policy in that they apply to all TBI, not just mild TBI. Furthermore, the Alaska guidelines account for situations in which CT scanners may not be readily available by using x-ray. Lastly, the Alaska guidelines are much less conservative allowing for observation of a range of patients, including those with

**Table 2 - Alaska guidelines categorization of head trauma**

<b>Minimal</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
GCS 15, no LOC, no focal neurological deficit, no signs of skull fracture, no penetrating head injury	GCS 14 or GCS 15 with LOC	GCS 9-13 or GCS 14 with risk factors* or GCS 15 with LOC and risk factors*	GCS ≤ 8
*Risk factors: age > 65, warfarin therapy, previous neurosurgery, shunt treated hydrocephalus, focal neurologic deficit, new onset seizure, depressed skull fracture, basilar skull fracture			

abnormal head CT findings. The Alaska guidelines for moderate head trauma also differs from the American College of Surgeons (ACS) Committee on Trauma Field Triage Decision Scheme to identify which patients require transport to a trauma center. The ACS recommends that all patients with GCS less than or equal to 13 be transported to the highest available trauma center.<sup>6</sup> A summary of the major differences between the Alaska guidelines and the ACEP and ACS guidelines can be seen in Table 3.

They reported no in-hospital deaths and all patients were discharged with unchanged or improving head CTs and good neurologic condition.

#### *Objectives*

The Alaska head trauma guidelines have been available since 2004, but anecdotal evidence suggests that they have been applied inconsistently. The primary aim of this study is to estimate how well the transfer guidelines are being followed. The secondary aim is to report descriptive

**Table 3 - Summary of the major differences between the Alaska, ACEP, and ACS guidelines**

	<b>GCS 14-15</b>	<b>GCS 9-13</b>
<b>Alaska</b>	Consider skull xray if head CT not available	Consider inpatient observation even with abnormal CT findings
<b>ACEP</b>	Doesn't recommend skull xray	
<b>Trauma Field Triage</b>		Transfer to highest available trauma center

Our literature review suggests that the Alaska guidelines intention to avoid excessive transfers is a problem faced by many rural facilities. A 2013 study by Sorensen et al looked at the rates of secondary overtriage in a rural trauma system and reported that 56% of overtriaged transferred patients had head and neck injuries.<sup>7</sup> These patients were likely transferred because of the lack of neurosurgical specialty care. Sorensen et al. recommend improved collaboration, including teleradiology, between neurosurgeons at level I trauma centers and their referring rural hospitals. In addition, Alaska is not unique in starting a non-transfer protocol for patients with head trauma and abnormal CT scans. A 2008 study by Fabbri et al reviewed 6 month outcomes for patients with abnormal post-TBI head CT's that did not require immediate neurosurgical intervention.<sup>8</sup> These patient's scans were discussed with a neurosurgeon via a teleradiology consultation before deciding if they would be transferred to a higher level of care. Their research demonstrated that patients with mild to moderate TBI who were observed in a peripheral hospital and could be transferred to a higher level of care within 30-60 minutes were not exposed to extra risks. A 2013 study by Levy et al studied in hospital outcomes of non-transferred patients with small intracranial hemorrhages in a rural trauma center without neurosurgical capabilities.<sup>9</sup>

characteristics of patients with isolated head trauma in Alaska. Results might be useful for hospitals in Alaska and elsewhere, to improve their transfer protocols. Improved transfer protocols might improve outcomes and decrease unnecessary transfers. Unnecessary transfers not only waste limited resources, especially money and personnel, but also carry risks for EMS providers, including flight crews, and patients.

#### **Methods**

Alaska Trauma Registry (ATR) data from 2004-2010 was obtained. The ATR collects information from all 24 of Alaska's acute care hospitals. In order for a patient to be included in the ATR, the patient must be admitted to a hospital in Alaska, either as an inpatient or under observation, transferred to another acute care hospital, or declared dead in the ED within 30 days of an injury.<sup>10</sup> Patients discharged home from the ED were not included in the study since they were not in the ATR. This is a significant limitation in the evaluation of minimal head trauma and is further addressed in the limitations section.

We identified head trauma cases based on ICD-9 codes and described demographics of patients with head trauma. We then categorized these cases retrospectively, using the Alaska guidelines, into minimal, mild, moderate, or severe

head trauma. In order to eliminate the effects of other injuries on transfer decisions, we further evaluated only patients with isolated head trauma. In the final analysis, we included only patients with minimal and severe head trauma, the two categories for which the Alaska guidelines make clear-cut recommendations. Patients with minimal head trauma should not be transferred, whereas all patients with severe head trauma seen at hospitals outside of Anchorage should be transferred for neurosurgical care. We compared survival among patients who were and were not transferred. We could not study adherence to the guidelines for patients in the mild and moderate categories because imaging results affecting transfer decisions were not available in the registry. We simplified dispositions from the ED into either “admit” or “transfer.” A single

researcher (KA) compiled all the data in a Microsoft Excel Spreadsheet. Statistical significance of changes was evaluated using two-tailed p-values, which were calculated using OpenEpi software.

## Results

### Demographics

From 2004 to 2010, there were 33,515 patients with trauma of whom 4,685 (14%) had head trauma (see Table 4). There were 943 patients with minimal head trauma, 1073 mild, 1939 moderate and 730 severe. Of the head trauma patients, 3059 (65%) had isolated head trauma. There were 597 patients with minimal isolated head trauma and 432 patients with severe isolated head trauma.

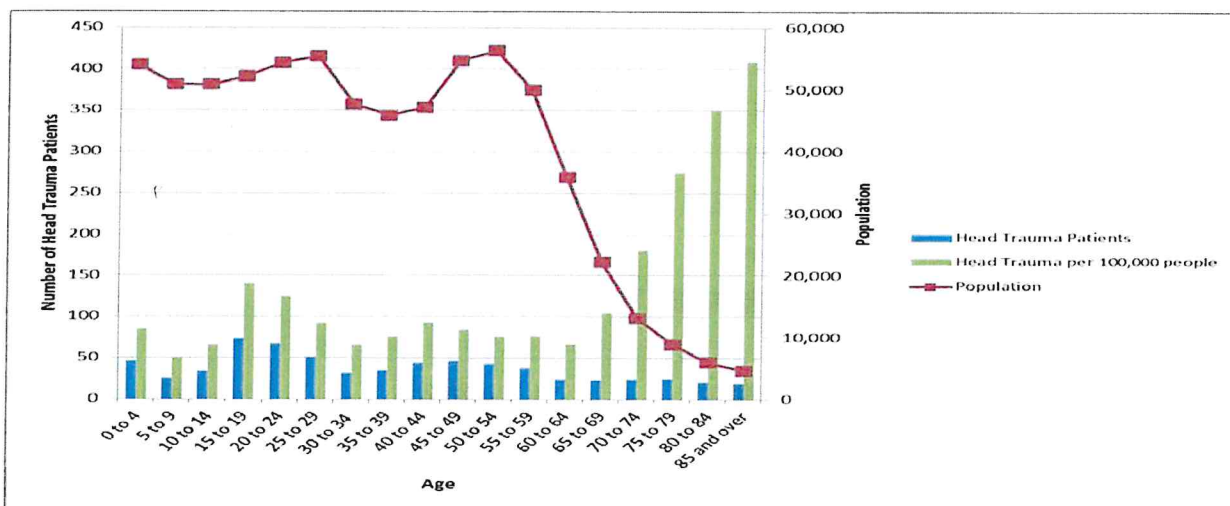
**Table 4- Head Trauma Demographic Data**

	Total	Average/Year	Percentage of Total Trauma
<b>Trauma</b>	33515	4787.9	100
<b>Male</b>	19151	2735.9	57
<b>Female</b>	14357	2051.0	43
<b>Non-Native</b>	21911	3130.1	65
<b>Native</b>	11604	1657.7	35
	Total	Average/Year	Percentage of Total TBI
<b>TBI</b>	4685	669.3	100
<b>Males</b>	3201	457.3	68
<b>Females</b>	1483	211.9	32
<b>Non-Native</b>	3202	457.4	68
<b>Native</b>	1483	211.9	32
TBI by Age	Total	Average/Year	Percentage of Total TBI
<b>0 to 4</b>	321	46	7
<b>5 to 9</b>	177	25	4
<b>10 to 14</b>	235	34	5
<b>15 to 19</b>	512	73	11
<b>20 to 24</b>	475	68	10
<b>25 to 29</b>	358	51	8
<b>30 to 34</b>	221	32	5
<b>35 to 39</b>	242	35	5
<b>40 to 44</b>	306	44	7
<b>45 to 49</b>	321	46	7
<b>50 to 54</b>	299	43	6
<b>55 to 59</b>	267	38	6
<b>60 to 64</b>	168	24	4
<b>65 to 69</b>	163	23	3
<b>70 to 74</b>	166	24	4
<b>75 to 79</b>	171	24	4
<b>80 to 84</b>	147	21	3
<b>85 and over</b>	135	19	3

The age distribution of patients with head trauma is shown in Figure 2. There is a bimodal distribution of head trauma. The 15-29 year old age range experiences the greatest percentage of all head trauma; however, the greater than 65 year old population has the highest rate of head trauma per capita.

More trauma patients were male: 19,151 (57%) than female: 14,357 (43%) (see Table 4). For head trauma, the ratio was more skewed: 3,201 (68%) male and 1,483 (32%) female. According to the 2010 US census, 15% of the population are Alaska natives; but 1,483 (32%) of all head trauma patients were Alaska natives.<sup>11</sup>

Figure 2 - Head Trauma incidence per 100,000 people by age

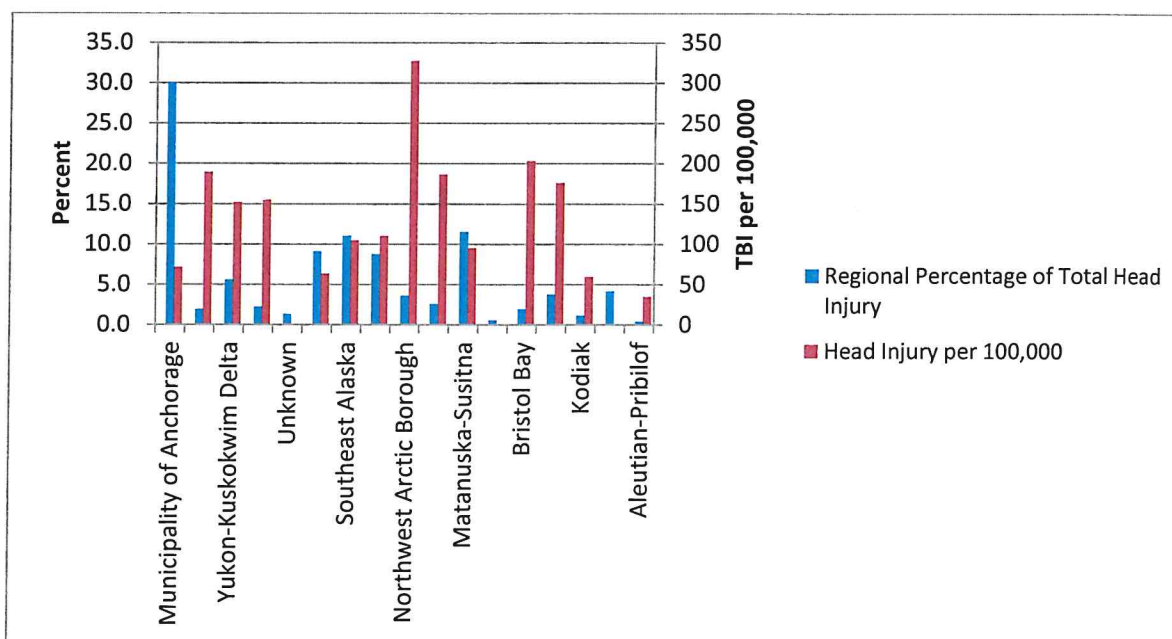


Region

The Municipality of Anchorage makes up 41% of the population of Alaska, but only 30% of Alaska’s head injuries occurred within this region (see Figure 3). The incidence of head injury within Anchorage was 72/100,000 people. This trend of lower incidence of head injury can be

seen in all of the larger population centers within the state including Fairbanks, Southeast Alaska, Kenai, and the Mat-Su Borough. Additionally, the highest incidences of head injury were seen in the rural communities across the state, with the highest incidence occurring in the Northwest Arctic Borough at 327/100,000 people.

Figure 3 - Regional percentage of total head injury and head injury per 100,000 people



*Disposition*

From 2004 to 2010, of 343 patients with minimal isolated head trauma outside Anchorage, 101 (29%) were transferred and 242 (71%) were not transferred. Of 227 patients with severe isolated head trauma, 81 (36%) were transferred and 146 (64%) were not transferred. Transferred versus not transferred data can be seen in Table 5. Details of the remaining ED dispositions of patients with head trauma are shown in Table 6. The final in-hospital disposition of all patients from the hospital can be seen in Table 7. For both severe and minimal head trauma patient transfer status had no statistical significance on patient mortality.

**Table 5 - Minimal and Severe Head Trauma outside Anchorage Transfer Data**

Not transferred vs transferred			
	Not transferred	Transferred	Total
<b>2004-2010</b>			
<b>Minimal</b>	242 (71%)	101 (29%)	343 (100%)
<b>Severe</b>	146 (64%)	81 (36%)	227 (100%)

**Table 6 - Alaska Isolated Head Trauma Emergency Department Discharge by Category and Region**

Head Trauma ED Discharge											
		Observation	AMA	Non-critical inpatient unit	Stepdown Unit	ICU	OR	Died	Transfer	N/A	Total
<b>Alaska Isolated Head Trauma</b>											
	<b>Minimal</b>	88 (19%)	3 (1%)	175 (39%)	20 (4%)	49 (11%)	9 (2%)	0 (0%)	106 (23%)	5 (1%)	455 (100%)
	<b>Severe</b>	5 (2%)	1 (0%)	19 (6%)	5 (2%)	128 (39%)	36 (11%)	50 (15%)	85 (26%)	0 (0%)	329 (100%)
<b>Anchorage Isolated Head Trauma</b>											
	<b>Minimal</b>	13 (12%)	0 (0%)	52 (46%)	9 (8%)	29 (26%)	3 (3%)	0 (0%)	5 (5%)	1 (1%)	112 (100%)
	<b>Severe</b>	0 (0%)	0 (0%)	8 (8%)	4 (4%)	51 (50%)	17 (17%)	18 (18%)	4 (4%)	0 (0%)	102 (100%)
<b>Remainder of State Isolated Head Trauma</b>											
	<b>Minimal</b>	75 (22%)	3 (1%)	123 (36%)	11 (3%)	20 (6%)	6 (2%)	0 (0%)	101 (29%)	4 (1%)	343 (100%)
	<b>Severe</b>	5 (2%)	1 (0%)	11 (5%)	1 (0%)	77 (34%)	19 (8%)	32 (14%)	81 (36%)	0 (0%)	227 (100%)

**Table 7 – Final In-Hospital Dispositions**

Outside Anchorage Isolated TBI Transfer Final Discharge														
	Home, No Assistance	Home, Health Care	Home, Rehab Outpt	Skilled Nursing	Intermediate Care	Inpatient Rehabilitation	Acute Care Hospital	Expired	Other	Jail/Prison	AMA	Burn Center	Mental Health	N/A
<b>Minimal</b>	38 (38%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	2 (2%)	57 (57%)	2 (2%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
<b>Severe</b>	12 (15%)	0 (0%)	0 (0%)	2 (2%)	0 (0%)	8 (10%)	37 (46%)	20 (25%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)

Outside Anchorage Isolated TBI Stay Final Discharge														
	Home, No Assistance	Home, Health Care	Home, Rehab Outpt	Skilled Nursing	Intermediate Care	Inpatient Rehabilitation	Acute Care Hospital	Expired	Other	Jail/Prison	AMA	Burn Center	Mental Health	N/A
<b>Minimal</b>	222 (92%)	0 (0%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)	10 (4%)	0 (0%)	2 (1%)	2 (1%)	5 (2%)	0 (0%)	0 (0%)	0 (0%)
<b>Severe</b>	45 (31%)	0 (0%)	5 (3%)	7 (5%)	1 (1%)	15 (10%)	10 (7%)	56 (38%)	3 (2%)	2 (1%)	2 (1%)	0 (0%)	0 (0%)	0 (0%)

**Discussion**

Head trauma is a major problem for Alaskans. 94/100,000 people are reported to the ATR each year with head trauma, meaning they were either admitted to a hospital in Alaska, transferred to another acute care hospital, or declared dead in the ED within 30 days of an injury. This is slightly higher than the nationwide rate of head trauma hospitalizations of 91.7/100,000.<sup>12</sup> The actual number of patients with TBI, especially those associated with minimal head trauma, is likely much greater. Many patients with head trauma are evaluated and released from the ED or do not present at all and are therefore not included in the ATR. The difference in rates of head trauma among regions can be attributed to several factors. For examples, work, transportation access, and

recreation differ between rural and urban areas. Use of alcohol and drugs is also higher in rural areas.<sup>13</sup>

The Alaska guidelines recommend that patients with isolated minimal head trauma be discharged to a competent observer with head injury instructions rather than being transferred to another hospital.<sup>4</sup> However from 2004 to 2010, 29% of patients with isolated minimal head trauma were transferred. The number of patients seen in Alaskan EDs with minimal head trauma is likely much larger than the number recorded in the ATR since many would be discharged from the ED without ever being admitted or meeting criteria to be included in the ATR. This would greatly increase the true denominator of patients with minimal head trauma, and decrease the percentage of patients with minimal head trauma that were transferred.



Furthermore, even though these patients presented with isolated head trauma, the fact that they were either admitted or transferred shows that there was something about the patient that made the treating physician uncomfortable about the patient's disposition.

The guidelines also recommend transfer to neurosurgical care for all patients with severe head trauma, but from 2004 to 2010 only 36% of patients outside of Anchorage with severe isolated head trauma were transferred. 56 (38%) of the patients with severe isolated head trauma who were not transferred died; however, 32 of these patients died before leaving the ED. When those patients are removed from the calculation, 24 (21%) died before their final disposition from the hospital. 20 (25%) of the patients with severe isolated head trauma who were transferred died before their final disposition from the hospital. These differences were statistically insignificant. The Alaska guidelines have a clause that states the guidelines "may need to be adapted to meet the special needs of a specific patient as determined by the patient's medical practitioner."<sup>14</sup> It is impossible to know from the available data whether the non-transferred patients who died were in a futile state, or if they would have benefited from a higher level of care. Providers may choose to not transfer patients they expect to die or those in whom they anticipate severe permanent brain damage even with treatment.

One key lesson learned from this data is the difficulty in implementation of new guidelines. Passive dissemination, the main route of distribution of the Alaska guidelines, is generally ineffective.<sup>14</sup> In order to change physician practice behavior, other techniques have seen greater success, including computerized decision support systems and interactive educational outreach visits. Using some of these techniques would likely increase adherence to the Alaska guidelines.

#### *Limitations*

This was a retrospective study. The ATR does not include patients with head trauma who were not admitted or transferred to a hospital, and therefore underestimates the number of patients with head trauma, especially minimal head trauma, by an unknown amount.

Adherence to the Alaska guidelines for patients with minimal head trauma is likely better than this data suggests.

The database, although compiled by trained trauma reviewers, may contain errors that would affect classification of head trauma, especially since it was not designed to capture the classification of head trauma. Specifically, transfer recommendations for mild and moderate head trauma may require results of CT or x-ray imaging, but these results were not available in the database. Several of the risk factors used to categorize the severity of head trauma were also not documented. These include previous neurosurgery, anticoagulant usage, and shunt-treated hydrocephalus. The lack of relevant data may have resulted in over-reporting of minimal and mild head trauma and underreporting of moderate head trauma. This would tend to skew the study towards the conclusion that minimal head trauma patients are excessively transferred, when some of these transfers may be appropriate.

We were not able to study the factors leading to the transfer of patients with isolated minimal head trauma or the reasons that many patients with isolated severe head trauma were not transferred. Patients with minimal head trauma may have had underlying medical conditions, such as syncope or seizure, that led to transfer and that may have caused the head trauma, even though the head trauma was minor. This would increase the number of apparently unnecessary transfers of patients with minimal head trauma. We also were not able to study outcomes other than death because the ATR does not collect follow-up morbidity information. This would be helpful in future studies because even mild head trauma can cause disability.

#### *Conclusion*

Based on our analysis of data from 2004–2010 in the ATR, it does not appear that medical providers were adhering to the Alaska guidelines for transfer of head trauma patients. Although patients with isolated minimal head trauma do not require urgent specialty care, 29% were transferred. All patients with severe head trauma require transfer according to the Alaska head trauma guidelines, but 64% of patients with isolated severe head trauma were not transferred.

Vast distances and limited resources will continue to provide challenges in the care of head trauma patients in Alaska. A literature review shows there are effective and safe ways to integrate imaging, observation, and neurosurgical teleradiology consultation to safely treat patients with head trauma in a rural setting.<sup>7,8,9</sup> Outreach to Alaskan providers at rural and remote healthcare facilities to understand their current practice patterns, their awareness of existing guidelines, and reasons for adherence or non-adherence to the Alaska guidelines will be essential reduce unnecessary transfers to a higher level of care for patients with head trauma.

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