

Don't Miss the Diagnosis!
**Delineating the Connection between Traumatic Brain Injuries and the Subsequent
Development of Chronic Central Endocrinopathies in the Pediatric Population**

A thesis submitted to the University of Arizona College of Medicine – Phoenix
in partial fulfillment of the requirements for the degree of Doctor of Medicine

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Dedication: I would like to dedicate this thesis to my parents, as well as my mentor,
Dr. Jonathan Lifshitz, who instilled in me the value of curiosity and lifelong learning

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Abstract:

Introduction: Traumatic brain injury (TBI) in children can result in cognitive, emotional and somatic neurological impairments. In adults, post-traumatic hypopituitarism can extend or exacerbate these impairments, likely due to mechanical damage to the pituitary and hypothalamus. The pituitary in the pediatric brain likely suffers similar mechanical damage, inducing endocrinopathies as in adults, but injury-induced endocrinopathies are infrequently reported in children. Unrecognized hypopituitarism may lead to elevated risks of metabolic syndrome, diabetes, delayed or absent puberty, short stature, and other endocrinopathies. However, screening for endocrine deficiencies in susceptible patients and initiating appropriate hormone replacement therapy may prevent these sequelae and improve the prospects for recovery.

Methodology: To address this issue, we identified patients who had experienced a TBI and subsequently developed a new-onset hypothalamically-regulated endocrine disorder. We hypothesized that pediatric patients who were diagnosed with a TBI were at a higher risk of being diagnosed with a central endocrinopathy than those without a prior diagnosis of TBI. We retrospectively analyzed patients from 2008-2016 at Phoenix Children's Hospital (PCH), a nationally-recognized level-1 Trauma Children's center and hospital serving the greater Phoenix, Arizona metropolitan area, and identified two patients who sustained TBIs in infancy and subsequently diagnosed and treated for central endocrinopathies at PCH. To expand these cases into an epidemiological assessment, we also identified 511 pediatric patients enrolled in the Arizona Health Cost Containment System (AHCCCS) from 2008-2014 who were diagnosed with one of 40 TBI ICD-9 codes and subsequently diagnosed with one of 14 central endocrinopathy codes. Additionally, by utilizing ICD-9 code data from over 650,000 Arizona pediatric patients, we are the first to successfully estimate the epidemiology, relative risk, odds ratio, and number needed to harm, of developing a central endocrinopathy after sustaining a TBI in Arizona Medicaid pediatric patients.

Results: We determined that TBI victims were 3.18-times higher risk of developing a central endocrinopathy compared with the general population (CI=0.264), pediatric AHCCCS patients with a central endocrinopathy had a 3.2-fold higher odds of a history with TBI than those without a central endocrinopathy (CI=0.266), of the central endocrinopathy in TBI victims is attributable to the TBI, and the number of patients who need to be exposed to a TBI for 1 patient to develop an endocrinopathy was 154.2 (CI=7.11). We also determined that more males than females presented with central endocrinopathies after TBI compared with the general population of TBI victims.

Conclusion: These biostatistical measures are the first, consortium-based, epidemiological study conducted to determine the risk of developing a central endocrinopathy after a TBI as a pediatric patient. Our results contribute to a body of knowledge advising physicians to consider a TBI etiology for idiopathic endocrine disorders, which can be screened through preventative therapy approaches. This work was made thanks to the generous support of the Valley Research Project P1 Grant.

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Introduction/Significance:

Background for the research question

Traumatic brain injuries (TBI) are a leading cause of childhood mortality and morbidity in industrialized countries, and are a major public health concern, if not an epidemic. TBI survivors are at risk for poor developmental and functional outcome, with increased risk for developing endocrine disorders. Mechanically, the forces of injury can selectively damage the hypothalamic-pituitary axis, an integral system in regulating neuronal with hormonal function. Despite increased understanding of both TBI and hypothalamic-pituitary dysfunction, few have bridged the fields of neurology and endocrinology to study the interaction on functional outcome; and when investigated, these reports focus on adult patients. Dissecting this connection between nervous and endocrine systems has the potential to advance diagnosis and open rapid treatment for children recovering from TBI.

The pituitary gland is a major endocrine gland in the brain that secretes a variety of hormones necessary for normal physiologic functioning: growth hormone (GH), thyroid stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), prolactin (PRL), luteinizing hormone (LH), follicle stimulating hormone (FSH), anti-diuretic hormone (ADH) and oxytocin. The pituitary gland is regulated by a centrally located collection of neurons, the hypothalamus. Injury to this axis due to TBI has therefore been shown to promote endocrine dysfunctions due to imbalance of any or all of these hormones. Such dysfunctions are a well-documented complication in adults following TBIs, and are less studied in children.

Prevalence in the adult literature:

In adults, the prevalence of hypopituitarism was unexpectedly high (23–69%) and the most common deficiency described was GH deficiency (2–66%) and gonadotropin deficiency (0–29%).^{12, 13, 21-27} A recent systematic review including 1203 adult patients with TBI reported a pooled prevalence of hypopituitarism of 27.8% and 6.2% of multiples deficiencies. The authors highlighted it has a relevant impact to public health worldwide.²⁸ Between 1977 and 2004, only a total of 20 paediatric cases of hypopituitarism after TBI were reported. Interestingly, in those reports, the cases had an interval episode between injury and diagnosis ranging from 1 to 42 years.²⁹ The prevalence in paediatric studies ranged from 5% to 57% (up to 86% in studies

including hyperprolactinaemia as abnormality). Previously published studies in children differed in the eligible population, inclusion criteria and methodological design, with differences in hormonal assessment including baseline profile and dynamic tests sometimes restricted to selected patients, and accordingly, sometimes reducing comparability.¹⁴⁻²⁴

After reviewing recent data in children, the first difference observed was the inclusion criteria; in all the studies except Salomón's, the inclusion criteria were defined by GCS, but some studies included only severe-to-moderate TBI while others such as Khadr et al¹¹ and Casano-Sancho et al³³ also included minor TBI with additional skull fracture. Heather et al¹⁸, Auble et al³⁵ and Salomón-Estébanez et al³⁴ restricted studies to those patients with structural abnormalities after TBI. Another difference was the rate of inclusion reported by different studies, ranging between 20% and 70%, which may obviously influence the estimation of the prevalence of hypopituitarism.¹⁴⁻²⁰ The protocol and methodology used to evaluate endocrine function is crucial when comparing studies. In retrospective studies, such as those performed by Poomthavorn et al³⁰, the authors restricted the hormonal assessment to those patients who had symptoms suggestive of possible hypopituitarism after they responded to a questionnaire. Other retrospective studies, such as the one published by Eunadi¹⁴, restricted the dynamic tests to patients with low growth velocity; Norwood et al³¹ and Khadr et al¹¹ carried out cross-sectional studies, showing a wide range of hypopituitarism from 48% to 25%. Prospective studies such as those by Kaulfers et al¹⁶, Niederland et al¹⁵, Casano-Sancho et al³³, and Personnier et al³² used functional hormonal testing irrespective of clinical symptoms and found a high prevalence of pituitary dysfunction.

A large number of studies have reported long-term hypopituitarism in up to 11-69% of TBI survivors.¹⁻⁷ In a systematic review in 2007, Schneider et al. analyzed 19 clinical studies involving 1137 patients reporting on pituitary function after TBI. In the chronic phase a 27.5% prevalence of pituitary dysfunction was found in general.² Again, these studies primarily focus on adult patients.

Prevalence in the pediatric literature:

Retrospective and prospective pediatric studies, however, reported highly variable rates of hypopituitarism after TBI.³⁻⁷ The reported 4-86% prevalence of endocrine dysfunction 6 months after TBI, and 10-38% at 1 year after TBI in children are not instructive. Variations in overall prevalence of pituitary dysfunction after TBI can result from different methods of endocrine testing, and patient selection from a small number of severe TBI cases. This indicates a lack of large epidemiological studies to evaluate endocrine dysfunction subsequent to pediatric TBI.

The majority of endocrine dysfunction post-TBI in pediatric patients are GH deficiencies, but children can also experience ACTH deficiency, diabetes insipidus, central hypothyroidism, and elevated prolactin reported between 6 months to a year after TBI.⁸ Several publications report endocrine dysfunctions up to 5 years after the initial TBI, suggesting the continuous need for monitoring of TBI survivors⁹. Elevated prolactin, abnormal thyroid function, short stature, and low GH peak were shown to be present in a study evaluating children with previous TBI⁴¹. Recovery of pituitary function can occur in up to 50% of patients with major hormonal deficiencies diagnosed at 3 months post-injury.¹⁰⁻¹² Risk factors of pituitary dysfunction after TBI are controversial. Some previous studies failed to show a definitive relationship between injury factors and hypopituitarism.¹³⁻¹⁹ On the other hand, according to Kelly et al., the severity of brain injury on acute CT is the strongest predictor of subsequent pituitary dysfunction ($p=0.02$).⁹ Overall, the “typical” symptomatology of these patients has shown to be acute and/or chronic changes in GH, ACTH, prolactin and TH levels. In addition, many of these and other acute and chronic endocrine sequelae have been reported in children post-TBI, though the data remain inconsistent and controversial. For this study, we have identified the ICD-9 diagnostic codes associated with these potential endocrine dysfunctions to develop inclusion criteria.

International Classification of Diseases, Ninth Revision (ICD-9):

ICD-9 Diagnostic and Current Procedural Terminology (CPT) Billing codes for reimbursement is a vital part of health-care operations.²⁰ Codes are specific to the particular disease, syndrome, and diagnosis of each patient, and are entered for every patient visit, regardless of acuity. For example, a patient at her 11th office visit for growth hormone deficiency will have the relevant

diagnostic code entered, despite it being the 11th visit for this chronic condition. The physician will also submit a billing code along with the diagnostic code for growth hormone deficiency. Billing codes are coupled with diagnostic codes to help health insurance companies determine the reason for the visit as well as the appropriate reimbursement rate. ICD-9 codes have inherent flaws both with the level of detail and selection of codes by the physician. These shortcomings inherent in any large database are recognized and assumed to be equal among age, sex, and race.

Significance and rationale for the research question

Despite the wide-ranging reports on pediatric TBIs affecting endocrine dysfunction, there is little published epidemiological data analyzing large cohorts of patients to identify correlations with location, sex, race, and age, nor is it commonly considered in a clinician's differential diagnosis for a patient presenting to the office after TBI, nor is a history of TBI routinely asked for in a patient presenting with fatigue, weight gain, obesity, delayed puberty, and growth stunting. Such studies provide the basis for developing predictive screening needs and measures. It is also clear that predictive measures are needed in order to better determine which children should undergo further examination for endocrine dysfunction after TBI, and for how long. Predictive methods remain one of the greatest unanswered questions in the field and one of the most needed answers to further care for these patients.

Hypothesis/Research Question

Pediatric patients who were diagnosed with a TBI were at a higher risk of being diagnosed with a central endocrinopathy than those without a prior diagnosis of TBI.

Goals for this study

Results from this project can contribute to a screening tool for children who sustain a TBI that guides physicians to the awareness and potential testing of endocrine disorders. The second objective for this thesis is to increase awareness among pediatricians, pediatric endocrinologists, pediatric neurologists, and other clinicians treating children with TBIs, of the incidence, risks, and presenting symptoms, of hypopituitarism among TBI survivors.

Research Methods and Materials:

We conducted a preparatory to research query with ASU's ChiR program and PCH to evaluate feasibility of the approach. The AHCCCS patient records query included data beginning in 2007 until December 2014, and identified more than 9,000 patients diagnosed with an ICD-9 TBI diagnosis (appendix 1) followed by the diagnosis of an ICD-9 endocrine diagnosis (appendix 2) at least 6 months after initial TBI diagnosis, whereas the PCH study included over 200 patients. The number of patients found in these records was sufficient to conduct an epidemiological study to determine the relationships between age, race, sex, and income of patients diagnosed with a TBI and patients subsequently diagnosed with an endocrine disorder.

Refined inclusion/exclusion criteria for the research study identified cases of TBI followed by an endocrine diagnosis at least 6 months later, all before the age of 18. In addition, we included only patients who have been continuously enrolled in AHCCCS for a specific period of time (determined by empirical evaluation by CHiR).

Inclusion Criteria

- Age range ≤ 18
- Geography = AZ
- Years of data = 2007 – 2014 (calendar year)
- Diagnosis of TBI (Please see ICD-9 codes in Appendix 1)
- Diagnosis of endocrine disorder (Please see ICD-9 codes in Appendix 2)
- Diagnosis of an endocrine dysfunction ≥ 6 months after a TBI diagnosis (or multiple TBI diagnoses), all diagnoses prior to the age of 18
- Patients diagnosed with a TBI prior to 18 years old, without an endocrine disorder
- Patients diagnosed with an endocrine disorder prior to 18 years old, without a TBI
- Continuous enrollment in AHCCCS (no more than 30 days not enrolled per year)

Exclusion Criteria

- Patients diagnosed with an endocrine disorder or TBI > 18 years of age
- Diagnosis of an endocrine dysfunction prior to a TBI

For the research study, two queries were required to evaluate the development versus risk of endocrine dysfunction after TBI. The first query extracted a limited data set regarding individual ICD-9 diagnosis and billing codes, in order to follow individual cases for the development of specific endocrine disorders after TBI. The second query extracted population data for four groups: (1) only TBI, (2) only endocrine disorders, (3) both TBI and endocrine disorders, and (4) neither TBI nor Endocrine diagnoses. The second query provides data to analyze the prevalence stratified by age, gender, and race, relative risk, odds ratio, attributable risk, and number needed to harm, of endocrine disorders subsequent to a TBI.

$$\textit{Prevalence} = \textit{cohort a/cohort b}$$

$$\textit{Relative risk (RR)} = [a/(a + b)]/[c/(c + d)]$$

$$\textit{Odds ratio (OR)} = (ad)/(bc)$$

$$\textit{Attributable risk (AR)} = [a/(a + b)] - [c/(c + d)]$$

$$\textit{Number needed to harm} = 1/AR$$

We discerned these results by grouping our ASU study patients into 4 cohorts: a, b, c, and d, based on the contingency table seen in table 1.

2x2 contingency table	Endo +	Endo -
TBI +	Cohort a	Cohort b
TBI -	Cohort c	Cohort d

Table 1: 2x2 contingency table utilized to analyze ASU cohort data.

Results:

ASU cohort:

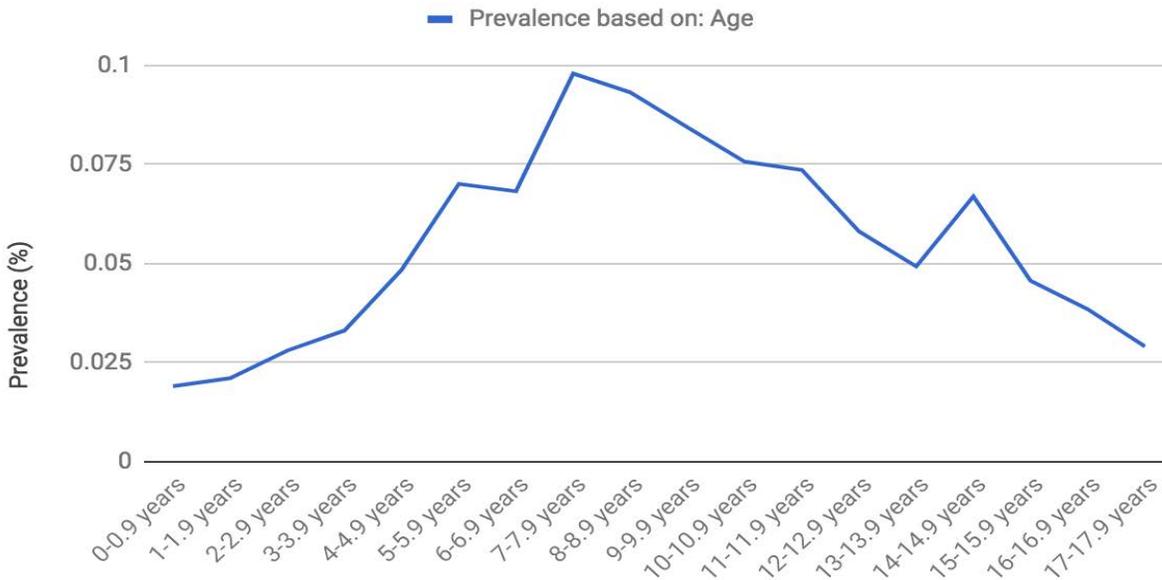
2x2 contingency table	Endo +	Endo -
TBI +	Cohort A (n=511)	Cohort B (n=145,413)
TBI -	Cohort C (n=13,355)	Cohort D (n=656,680)

Table 2: Patient cohorts and number of patients and each cohort

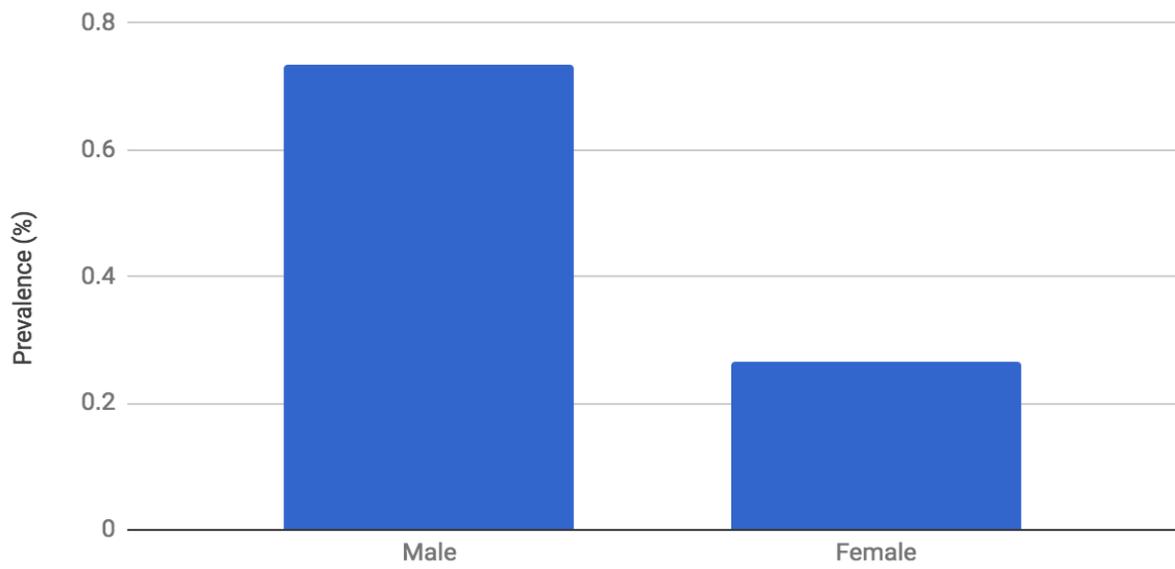
	Relative risk	Odds ratio	Attributable risk	NNH
Value (95% CI)	3.21 (0.26)	3.31(0.27)	0.016 (0.0003)	154.2 (7.11)

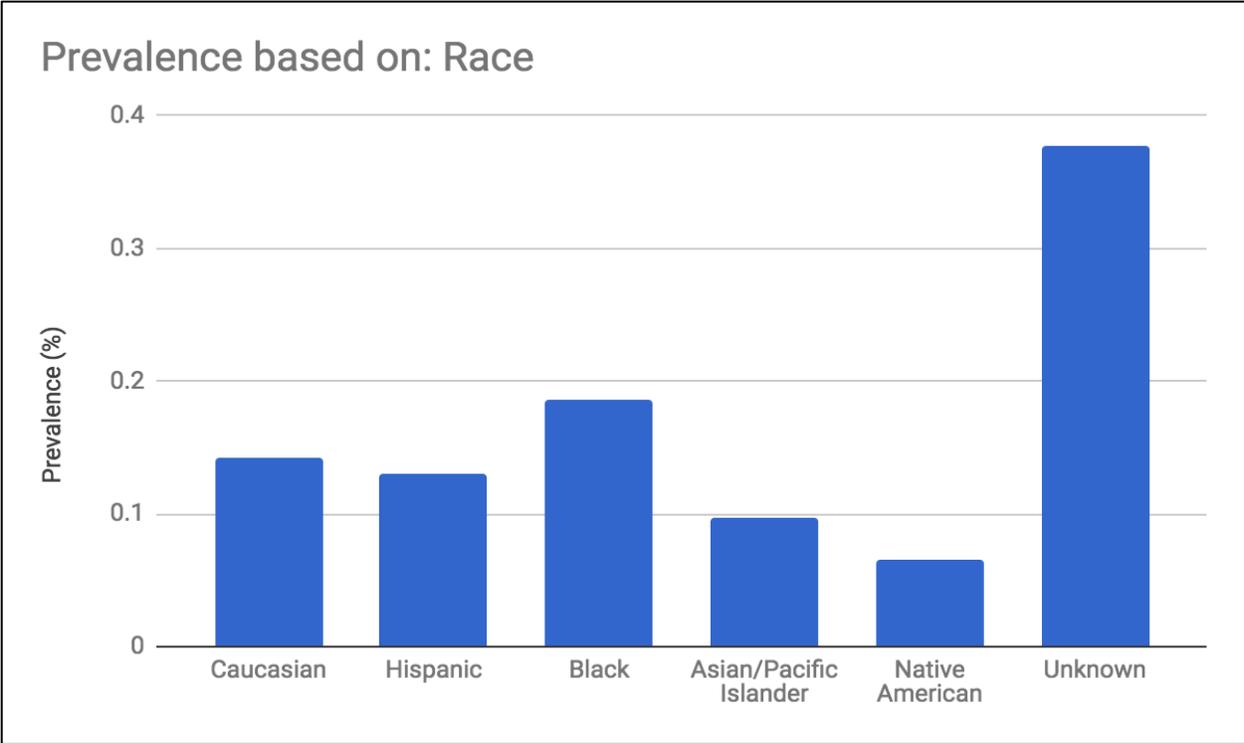
Table 3: Epidemiological biostatistics comparing cohorts A, B, C, D. TBI victims were 3.2-fold (CI=0.264) higher risk of developing a central endocrinopathy compared with the general population, pediatric AHCCCS patients with a central endocrinopathy had a 3-fold (CI=0.266) higher odds of a history with TBI than those without a central endocrinopathy, 1.6% (CI=0.000299) of the central endocrinopathy in TBI victims is attributable to the TBI, and the number of patients who need to be exposed to a TBI for 1 patient to develop an endocrinopathy was 154.2 (CI=7.11).

Prevalence of an endocrine disorder after TBI stratified by Age

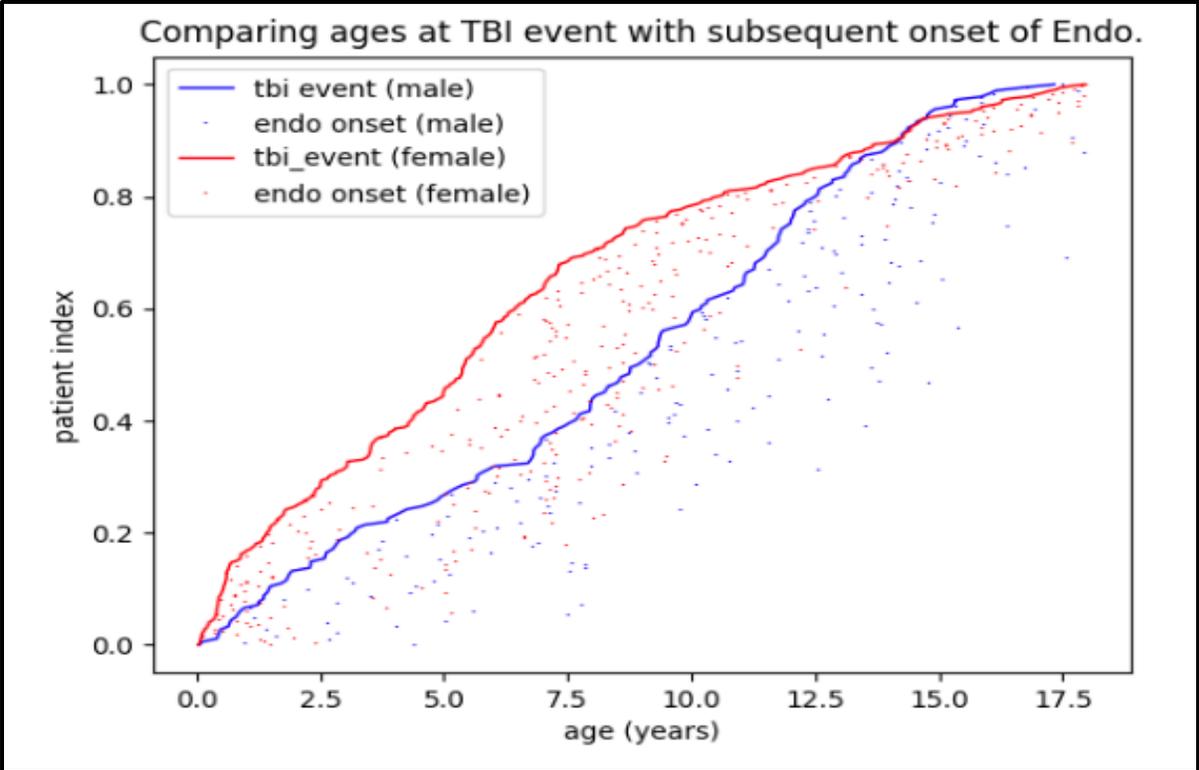


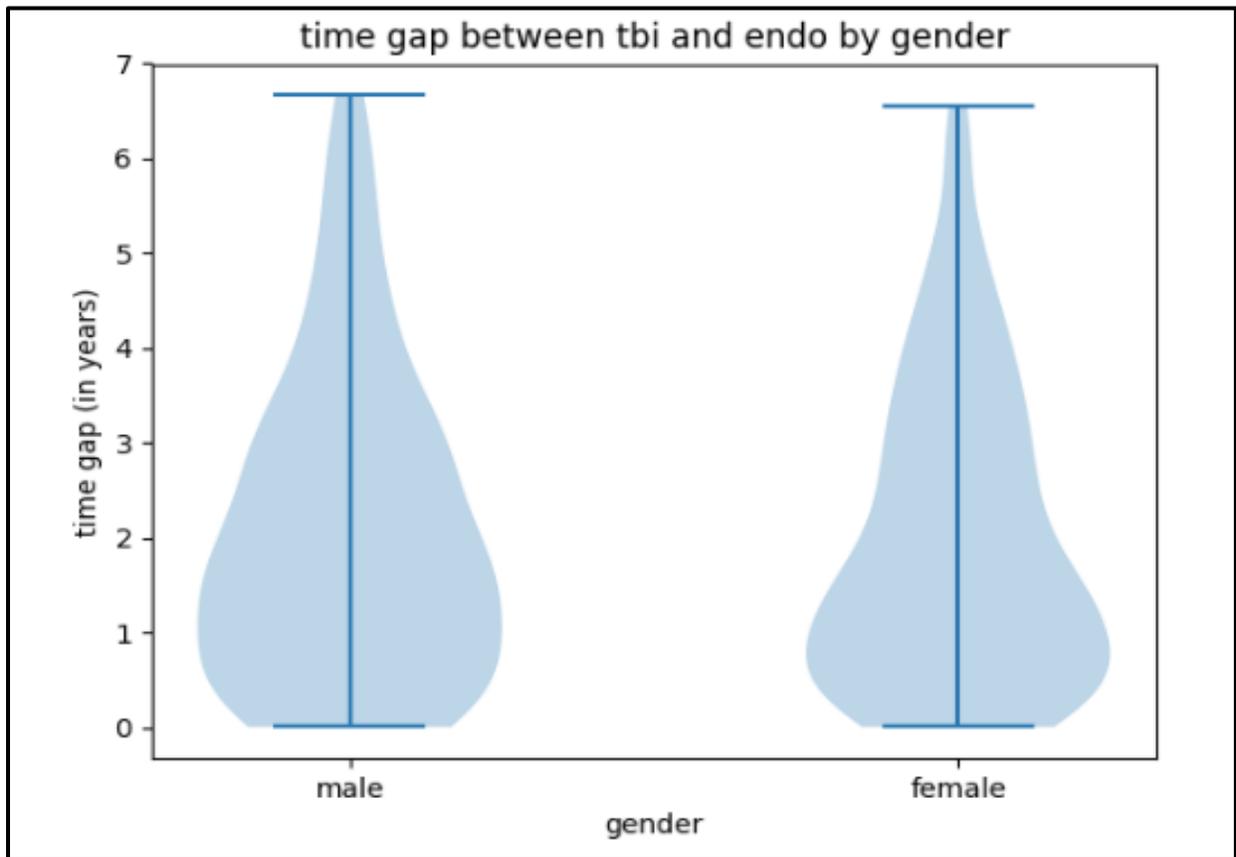
Prevalence of an endocrine disorder after TBI stratified by gender





Figures 1a-c. Prevalence of patients in cohort A based on age (A), gender (B), and race (C). The Y axis represents the prevalence measure of patients diagnosed with a central endocrinopathy after a TBI.





Figures 2a-b: Female TBI victims are more likely to be diagnosed with central endocrinopathies at an earlier age than males with TBIs. **(A)** Patients on Y-axis, age (years) on x-axis, solid lines in red (female) and blue (male) representing age at TBI diagnosis depicting age at each central endocrinopathy diagnosis. **(B)** Quantity of patients on the x-axis for males and females.

PCH Cohort:

	Age at TBI	TBI diagnosis	Age at endocrine referral (year, month)	Endocrine diagnosis(es)	Intervention(s)	Outcome
Patient 1	3 months and 27 days	Non-accidental trauma resulting in R>L frontal white matter encephalomalacia, skull fracture, subdural hematomas.	4 months and 1 day	Diabetes Insipidus	DDAVP supplementation	Likely life-long diabetes insipidus requiring daily DDAVP supplementation and frequent sodium monitoring
Patient 2	2 years	Fell from kitchen table resulting in non-depressed left parietal skull fx w/underlying small, less than 4mm subdural hematoma w/o mass effect	Unknown	Central hypothyroidism, growth hormone insufficiency	Levothyroxine and growth hormone supplementation	Unknown
Patient 3	3 months	Non-accidental trauma involving the frontal lobe --> pending outside record retrieval	14 years and 3 months	Low prolactin, central hypothyroidism, low testosterone, morbid obesity	Levothyroxine supplementation	Weight loss, improved attention, more engaged in sports and school
Patient 4	5 months, 30 days	Non-accidental trauma resulting in large accumulating right frontoparietal mixed densities subdural hematoma with midline shift	1 year, 3 months	Hypogonadism, failure to thrive, central hypothyroidism, low growth hormone	Levothyroxine and Growth Hormone supplementation	Normalized growth velocity, stature and weight. Improved attention, developmental milestones

Table 4: Representation of PCH patients that were found to have a TBI and subsequently diagnosed with a central endocrinopathy that did not meet any exclusion criteria. Pertinent information revealed in this table includes age at TBI, TBI diagnosis, Age at referral to a PCH endocrinologist, each patient’s endocrine diagnoses, Intervention(s), and outcome.

Discussion:

Significance, ASU Study:

TBI is a leading cause of childhood morbidity and mortality in industrialized countries, and establish a major public health concern, if not an epidemic. Mechanically, the forces of injury can selectively damage the hypothalamic-pituitary axis, an integral system in regulating hormonal influence on neuronal function. Despite increased understanding of both TBI and hypothalamic-pituitary dysfunction, few have bridged the fields of neurology and endocrinology to study the interaction on functional outcome; and when investigated, these reports focus on adult patients. Dissecting this connection between nervous and endocrine systems has the potential to advance diagnosis and open rapid treatment for children recovering from TBI. Our data represent the first large epidemiological study to evaluate endocrine disorder onset subsequent to pediatric TBI. As such, we are the first to determine that patients can present with central, new-onset endocrinopathies days to years after a TBI. Therefore, physicians must be aware of endocrine symptoms years after a TBI and, most importantly, add TBI-induced central endocrinopathies to their differential diagnosis when treating a patient with a history of a TBI. For now, central endocrinopathies can be diagnosed up to 6 or 7 years after TBI diagnosis. Which can represent (1) a half-dozen year delay in endocrinopathy onset, (2) an early onset endocrinopathy that has a delayed diagnosis, or (3) procedural issues with patients entering and exiting the AHCCCS system when earlier diagnosis occurred. These initial results provide a basis for developing predictive screening needs and measures in the vulnerable pediatric population. For example, discrete predictive measures can identify children who would benefit from further endocrine function testing at specific times after TBI. Predictive methods remain one of the greatest unanswered questions in the field and one of the most needed answers to further care for these patients.

Significance, PCH Study:

Our PCH study identified 4 patients who were treated for both their TBI and subsequent endocrinopathies. These 4 patients did not have any past medical history that could have otherwise explain the development of their endocrinopathies. These 4 patients further demonstrate that unrecognized hypopituitarism in TBI survivors in may lead to elevated risks of

metabolic syndrome, diabetes, delayed or absent puberty, short stature, and other endocrinopathies. However, screening for these deficiencies in susceptible patients and initiating appropriate hormone replacement therapy (HRT) may prevent these sequelae, and enhance the prospects for rehabilitation, as in our patients.

Affected patients may experience deficits for many years. It is also associated with significant acute and chronic health care costs. However, pediatric central endocrinopathy due to TBI remains underrecognized by caregivers and health care providers due to subtle and nonspecific presentation.

Differential Diagnosis:

Patients can present with a variety of chief complaints depending on the extent of their endocrine derangement. The differential diagnosis for failure to thrive in an toddler include insufficient supply/nutrition, insufficient absorption, or excess energy expenditure. Patient number 4 (table 4) underwent endocrine testing as a result of his microphallus in addition to his failure to thrive on physical exam, as well as past medical history of TBI.

Though our patients presented with signs and symptoms suspicious of hormone deficiency, derangements of hypopituitarism can be subtle, or can mimic the sequelae of post-concussive syndrome, and must be regarded with a high index of suspicion in TBI survivors.

Management:

High indices of suspicion for life threatening endocrine deficiencies should be maintained during acute care immediately after TBI. There are currently no screening guidelines for children for non-life threatening deficiencies that are managed primarily in the outpatient setting, after stabilization from their injury. However, it has been suggested by multiple pediatric studies to extrapolate from existing adult screening guidelines that apply all survivors of moderate-to-severe TBI (Moderate defined as GCS of 9-12, severe defined as GCS of 3-9).⁹⁻¹¹ Proposed screening guidelines include performing a baseline hormonal profile with fT4/ TSH and 08:00 cortisol between 3 and 6 months after TBI, considering the effect of thyroxine and hydrocortisone in patient recovery and functional outcome.¹⁰ Supplementation with sex hormones in hypogonadal patients should be considered in pubertal patients to optimise pubertal growth, and in symptomatic postpubertal patients, but the effects on cognitive

outcome are unclear. The evaluation of GH could be delayed till 1 year after TBI, after growth velocity monitoring.⁹

In addition to screening guidelines, post-TBI hypopituitarism should remain in a clinician's differential diagnosis in every TBI survivor, regardless of age of the patient, or length of time after the injury. This is because the onset and resolution of post-TBI endocrinopathies are extremely variable. The time of onset of an endocrinopathy after a moderate to severe TBI has been found to be approximately 15% within a month, 75% between 1 to 6 months, and 29% between 6 and 12 months after injury.^{8,11,12} The incidence of any endocrinopathy in children who had moderate to severe head injury has been shown to be 15% at 1 month after injury, 75% at 6 months, and 29% at 12 months after TBI. Interestingly, many of the endocrine abnormalities found in the first few months after injury resolved by 1 year.¹³ Thus, children should have continued close endocrine surveillance until at least 1 year after TBI. However, suspicion of central endocrinopathies in TBI survivors cannot be extinguished 1 year after their injury. Multiple studies have reported onset of these deficiencies many years after TBI, even into adulthood.^{4,6,7,14} Therefore, it is imperative to keep post-TBI endocrinopathies on the differential diagnosis of any patients with a history of head trauma, regardless of age of injury. No risk factors for post-TBI endocrinopathy have yet to be identified in the literature, such as TBI severity, GCS, presence or absence of cranial fractures, or intracranial hematomas.⁸ If identified, hypopituitarism can be readily treated with the appropriate HRT.

Future Directions:

We have completed the cost expenditures for the Valley Research Project Grant (2017) and presentation at the National Neurotrauma Symposium in July 2016. In the near term, we will stratify the data based on income level, similar to the approach regarding race. Additionally, data for patients diagnosed with TBI without endocrinopathy will permit a risk analysis in developing an endocrinopathy after TBI for pediatric patients, compared to the general population. These findings will be incorporated in a manuscript for peer-review within the next year. Finally, following the submission of our manuscript, we will be pursuing additional funding next year by developing a prospective trial further delineating the link between pediatric TBIs and the subsequent development of central endocrinopathies. Regarding our PCH study, we are currently pursuing publication in the American Academy of Pediatrics Journal under the *Index of Suspicion* section.

Conclusions:

This study is the first to determine the epidemiology of new-onset central endocrinopathies after TBI in the pediatric population in the Arizona Medicaid System from 2007-2014. We determined that TBI victims were 3.18-times higher risk of developing a central endocrinopathy compared with the general population (CI=0.264), pediatric AHCCCS patients with a central endocrinopathy had a 3.2-fold higher odds of a history with TBI than those without a central endocrinopathy (CI=0.266), and that the number of patients who need to be exposed to a TBI for 1 patient to develop an endocrinopathy was 154.2 (CI=7.11). This data also helped illustrate that patients can present with central, new-onset endocrinopathies days to years after TBI; physicians must be aware of endocrine symptoms after TBI and add TBI-induced central endocrinopathies to their differential diagnosis when treating a patient with a history of TBI. We also identified 4 patients treated at PCH for both their TBI and central endocrinopathies, patients will help further solidify the relationship between TBI and central endocrine disorders. Further prospective studies are needed to better determine correlation between TBI severity and endocrinopathies.

References

1. Langlois JA, Rutland-Brown W, Thomas KE. Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths. Atlanta (GA): *Centers for Disease Control and Prevention, National Center for Injury Prevention and Control*; 2004.
2. Keenan HT, Runyan DK, Marshall SW, Nocera MA, Merten DF. A population-based comparison of clinical and outcome characteristics of young children with serious inflicted and noninflicted traumatic brain injury. *Pediatrics*. 2004 Sep;114(3):633-9.
3. World Health Organization, editor 2006 Neurological disorders: public health challenges. Geneva, Switzerland: *WHO Press*
4. Parslow C, Morris KP, Tasker RC, Forsyth RJ, Hawley CA, on behalf of the UK Paediatric Traumatic Brain Injury Study Steering Group and the Paediatric Intensive Care Society Study Group. Epidemiology of traumatic brain injury in children receiving intensive care in the UK. *Arch Dis Child*. 2005;90:1182–1187.
5. Faul M, Xu L, Wald MM, Coronado VG. 2010 Traumatic brain injury in the United States: emergency department visits, hospitalizations and deaths 2002–2006. Atlanta (GA):*Centers for Disease Control and Prevention, National Center for Injury Prevention and Control*
6. McKinlay A, Grace RC, Horwood LJ, Fergusson DM, Ridder EM, MacFarlane MR. Prevalence of traumatic brain injury among children, adolescents and young adults: prospective evidence from a birth cohort. *Brain injury*. 2008;22:175–181.
7. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet*. 1974;2:81– 84.
8. Keenan HT, Bratton SL. Epidemiology and outcomes of pediatric traumatic brain injury. *Dev Neurosci*. 2006;28:256 –263.
9. Michaud LJ, Rivara FP, Grady MS, Reay DT. Predictors of survival and severity of disability after severe brain injury in children. *Neurosurgery*. 1992;31:254 –264.
10. McCarthy ML, MacKenzie EJ, Durbin DR, Aitken ME, Jaffe KM, Paidas CN, Slomine BS, Dorsch AM, Christensen JR, Ding R, Children’s Health After Trauma Study Group. Health-related quality of life during the first year after traumatic brain injury. *Arch Pediatr*

Adolesc Med. 2006;160:252–260.

11. Ghigo E, Masel B, Aimaretti G, León-Carrión J, Casanueva F F, Domonguez-Morales MR, Elovic E, Perrone K, Stalla G, Thompson C, Urban R. Consensus guidelines on screening for hypopituitarism following traumatic brain injury. *Brain Injury.* 2005;19: 711–724.
12. Aimaretti G, Ambrosio MR, Di Somma C, Fusco A, Cannavò S, Gasperi M, Scaroni C, De Marinis L, Benvenga S, degli Uberti EC, Lombardi G, Mantero F, Martino E, Giordano G, Ghigo E. Traumatic brain injury and subarachnoid haemorrhage are conditions at high risk for hypopituitarism: screening study at 3 months after the brain injury. *Clin Endocrinol (Oxf).* 2004;61:320–326.
13. Einaudi S, Matarazzo P, Peretta P, Grossetti R, Giodarno F, Altare F, Bondone C, Andreo M, Ivani G, Genitori L, de Sanctis C. Hypothalamo-hypophysial dysfunction after traumatic brain injury in children and adolescents: a preliminary retrospective and prospective study. *J Pediatr Endocrinol Metab.* 2006;19:691–703.
14. Niederland T, Makovi H, Gal V, Andreka B, Abraham CS, Kovacs J. Abnormalities of pituitary function after traumatic brain injury in children. *J Neurotrauma.* 2007;24:119 – 127.
15. Phoomtavorn P, Maixner W, Zacharin M. Pituitary function in paediatric survivors of severe traumatic brain injury. *Arch Dis Child.* 2008;93:133–137.
16. Kaulfers AM, Backeljauw PF, Reifschneider K, Blum S, Michaud L, Weiss M, Rose SR. Endocrine dysfunction following traumatic brain injury in children. *J Pediatr* 2010;157:894 – 899.
17. Moon RJ, Wilson P, Kirkham FJ, Davies JH. Growth monitoring following traumatic brain injury. *Arch Dis Child.* 2009;94:699 –701.
18. Khadr SN, Crofton PM, Jones PA, Wardhaugh B, Roach J, Drake AJ, Minns RA, Kelnar CJH. Evaluation of pituitary function after traumatic brain injury in Childhood. *Clin Endocrinol (Oxf).* 2010; 73: 637– 644.
19. Heather NL, Jefferies C, Hofman PL, Derraik JGB, Brennan C, Kelly P, Hamill JKM, Jones RG, Rowe DL, Cutfield WS. Permanent hypopituitarism is rare after structural traumatic brain injury in early childhood. *J Clin Endocrinol Metab.* 2012;97:599 – 604.

20. Crompton MR, 1971 Hypothalamic lesions following closed head injury. *Brain* 94: 165-172.
21. Popovic V, Pekic S, Pavlovic D, et al. Hypopituitarism as a consequence of traumatic brain injury (TBI) and its possible relation with cognitive disabilities and mental distress. *J Endocrinol Invest.* 2004; 27: 1048-1054
22. Kelly DF, Gonzalo IT, Cohan P, Berman N, Swerdloff Post-traumatic hypopituitarism R, Wang C. Hypopituitarism following traumatic brain injury and aneurysmal subarachnoid hemorrhage: a preliminary report. *J Neurosurg.* 2000; 93: 743-752.
23. Agha A, Rogers B, Sherlock M, et al. Anterior pituitary dysfunction in survivors of traumatic brain injury. *J Clin Endocrinol Metab.* 2004;89:4929–36.
24. Kokshoorn NE, Wassenaar MJ, Biermasz NR, et al. Hypopituitarism following traumatic brain injury: prevalence is affected by the use of different dynamic tests and different normal values. *Eur J Endocrinol.* 2010;162:11–18.
25. Wachter D, Gündling K, Oertel MF, et al. Pituitary insufficiency after traumatic brain injury. *J Clin Neurosci.* 2009;16:202–8.
26. Krahulik D, Zapletalova J, Frysak Z, et al. Dysfunction of hypothalamic-hypophyseal axis after traumatic brain injury in adults. *J Neurosurg.* 2010;113:581–4.
27. Agha A, Thompson CJ. Anterior pituitary dysfunction following traumatic brain injury (TBI). *Clin Endocrinol.* 2006;64(5):481–8.
28. Leal-Cerro A, Flores JM, Rincon M, et al. Prevalence of hypopituitarism and growth hormone deficiency in adults long-term after severe traumatic brain injury. *Clin Endocrinol.* 2005;62:525–32.
29. Lieberman SA, Oberoi AL, Gilkison CR, et al. Prevalence of neuroendocrine dysfunction in patients recovering from traumatic brain injury. *J Clin Endocrinol Metab.* 2001;86:2752–6.
30. Tanriverdi F, Schneider HJ, Aimaretti G, et al. Pituitary dysfunction after traumatic brain injury: a clinical and pathophysiological approach. *Endocr Rev.* 2015;36:305–42.
31. Acerini CL, Tasker RC. Endocrine sequelae of traumatic brain injury in childhood. *Horm Res.* 2007;68(Suppl 5):14–17.
32. Poomthavorn P, Maixner W, Zacharin M. Pituitary function in paediatric survivors of severe traumatic brain injury. *Arch Dis Child.* 2008;93:133–7.

33. Norwood KW, Deboer MD, Gurka MJ, et al. Traumatic brain injury in children and adolescents: surveillance for pituitary dysfunction. *Clin Pediatr (Phila)*. 2010;49:1044–9.
34. Personnier C, Crosnier H, Meyer P, et al. Prevalence of pituitary dysfunction after severe traumatic brain injury in children and adolescents: a large prospective study. *J Clin Endocrinol Metab*. 2014;99:2052–60.
35. Casano-Sancho P, Suárez L, Ibáñez L, et al. Pituitary dysfunction after traumatic brain injury in children: is there a need for ongoing endocrine assessment? *Clin Endocrinol* 2013;79:853–8.
36. Salomón-Estébanez MA, Grau G, Vela A, et al. Is routine endocrine evaluation necessary after paediatric traumatic brain injury? *J Endocrinol Invest*. 2014;37:143–8.
37. Auble BA, Bollepalli S, Makoroff K, et al. Hypopituitarism in pediatric survivors of inflicted traumatic brain injury. *J Neurotrauma*. 2014;31:321–6.

Appendix 1: Traumatic Brain Injury ICD-9 Codes

800	Fracture of vault of skull
800.01	Closed fracture of vault of skull without mention of intracranial injury; with no loss of consciousness
800.02	Closed fracture of vault of skull without mention of intracranial injury; with brief [less than one hour] loss of consciousness
800.03	Closed fracture of vault of skull without mention of intracranial injury; with moderate [1-24 hours] loss of consciousness
800.05	Closed fracture of vault of skull without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.06	Closed fracture of vault of skull without mention of intracranial injury; with loss of consciousness of unspecified duration
800.09	Closed fracture of vault of skull without mention of intracranial injury; with concussion; unspecified
800.1	Closed fracture of vault of skull with cerebral laceration and contusion; unspecified state of consciousness
800.11	Closed fracture of vault of skull with cerebral laceration and contusion; with no loss of consciousness
800.12	Closed fracture of vault of skull with cerebral laceration and contusion; with brief [less than one hour] loss of consciousness
800.13	Closed fracture of vault of skull with cerebral laceration and contusion; with moderate [1-24 hours] loss of consciousness
800.14	Closed fracture of vault of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
800.15	Closed fracture of vault of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.16	Closed fracture of vault of skull with cerebral laceration and contusion; with loss of consciousness of unspecified duration
800.19	Closed fracture of vault of skull with cerebral laceration and contusion; with concussion; unspecified
800.2	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
800.21	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness

800.22	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
800.23	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with moderate [1-24 hours] loss of consciousness
800.24	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
800.25	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.26	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
800.29	Closed fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with concussion; unspecified
800.3	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; unspecified state of consciousness
800.31	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; with no loss of consciousness
800.32	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; with brief [less than one hour] loss of consciousness
800.35	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.36	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
800.39	Closed fracture of vault of skull with other and unspecified intracranial hemorrhage; with concussion; unspecified
800.4	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; unspecified state of consciousness
800.41	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; with no loss of consciousness
800.42	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; with brief [less than one hour] loss of consciousness
800.45	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.46	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration

800.49	Closed fracture of vault of skull with intracranial injury of other and unspecified nature; with concussion; unspecified
800.5	Open fracture of vault of skull without mention of intracranial injury; unspecified state of consciousness
800.51	Open fracture of vault of skull without mention of intracranial injury; with no loss of consciousness
800.52	Open fracture of vault of skull without mention of intracranial injury; with brief [less than one hour] loss of consciousness
800.53	Open fracture of vault of skull without mention of intracranial injury; with moderate [1-24 hours] loss of consciousness
800.54	Open fracture of vault of skull without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
800.56	Open fracture of vault of skull without mention of intracranial injury; with loss of consciousness of unspecified duration
800.59	Open fracture of vault of skull without mention of intracranial injury; with concussion; unspecified
800.6	Open fracture of vault of skull with cerebral laceration and contusion; unspecified state of consciousness
800.61	Open fracture of vault of skull with cerebral laceration and contusion; with no loss of consciousness
800.62	Open fracture of vault of skull with cerebral laceration and contusion; with brief [less than one hour] loss of consciousness
800.65	Open fracture of vault of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.66	Open fracture of vault of skull with cerebral laceration and contusion; with loss of consciousness of unspecified duration
800.7	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
800.71	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
800.72	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
800.74	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level

800.75	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.76	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
800.79	Open fracture of vault of skull with subarachnoid; subdural; and extradural hemorrhage; with concussion; unspecified
800.8	Open fracture of vault of skull with other and unspecified intracranial hemorrhage; unspecified state of consciousness
800.81	Open fracture of vault of skull with other and unspecified intracranial hemorrhage; with no loss of consciousness
800.84	Open fracture of vault of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
800.85	Open fracture of vault of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.86	Open fracture of vault of skull with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
800.9	Open fracture of vault of skull with intracranial injury of other and unspecified nature; unspecified state of consciousness
800.91	Open fracture of vault of skull with intracranial injury of other and unspecified nature; with no loss of consciousness
800.93	Open fracture of vault of skull with intracranial injury of other and unspecified nature; with moderate [1-24 hours] loss of consciousness
800.95	Open fracture of vault of skull with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
800.99	Open fracture of vault of skull with intracranial injury of other and unspecified nature; with concussion; unspecified
801	Fracture of base of skull
801.01	Closed fracture of base of skull without mention of intra cranial injury; with no loss of consciousness
801.02	Closed fracture of base of skull without mention of intra cranial injury; with brief [less than one hour] loss of consciousness
801.03	Closed fracture of base of skull without mention of intra cranial injury; with moderate [1-24 hours] loss of consciousness

801.05	Closed fracture of base of skull without mention of intra cranial injury; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.06	Closed fracture of base of skull without mention of intra cranial injury; with loss of consciousness of unspecified duration
801.09	Closed fracture of base of skull without mention of intra cranial injury; with concussion; unspecified
801.1	Closed fracture of base of skull with cerebral laceration and contusion; unspecified state of consciousness
801.11	Closed fracture of base of skull with cerebral laceration and contusion; with no loss of consciousness
801.12	Closed fracture of base of skull with cerebral laceration and contusion; with brief [less than one hour] loss of consciousness
801.13	Closed fracture of base of skull with cerebral laceration and contusion; with moderate [1-24 hours] loss of consciousness
801.14	Closed fracture of base of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
801.15	Closed fracture of base of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.16	Closed fracture of base of skull with cerebral laceration and contusion; with loss of consciousness of unspecified duration
801.19	Closed fracture of base of skull with cerebral laceration and contusion; with concussion; unspecified
801.2	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
801.21	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
801.22	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
801.23	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with moderate [1-24 hours] loss of consciousness
801.24	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level

801.25	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.26	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
801.29	Closed fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with concussion; unspecified
801.3	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; unspecified state of consciousness
801.31	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with no loss of consciousness
801.32	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with brief [less than one hour] loss of consciousness
801.33	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with moderate [1-24 hours] loss of consciousness
801.34	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
801.35	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.36	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
801.39	Closed fracture of base of skull with other and unspecified intracranial hemorrhage; with concussion; unspecified
801.4	Closed fracture of base of skull with intracranial injury of other and unspecified nature; unspecified state of consciousness
801.41	Closed fracture of base of skull with intracranial injury of other and unspecified nature; with no loss of consciousness
801.42	Closed fracture of base of skull with intracranial injury of other and unspecified nature; with brief [less than one hour] loss of consciousness
801.45	Closed fracture of base of skull with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.46	Closed fracture of base of skull with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
801.49	Closed fracture of base of skull with intracranial injury of other and unspecified nature; with concussion; unspecified

801.5	Open fracture of base of skull without mention of intracranial injury; unspecified state of consciousness
801.51	Open fracture of base of skull without mention of intracranial injury; with no loss of consciousness
801.52	Open fracture of base of skull without mention of intracranial injury; with brief [less than one hour] loss of consciousness
801.56	Open fracture of base of skull without mention of intracranial injury; with loss of consciousness of unspecified duration
801.59	Open fracture of base of skull without mention of intracranial injury; with concussion; unspecified
801.6	Open fracture of base of skull with cerebral laceration and contusion; unspecified state of consciousness
801.61	Open fracture of base of skull with cerebral laceration and contusion; with no loss of consciousness
801.62	Open fracture of base of skull with cerebral laceration and contusion; with brief [less than one hour] loss of consciousness
801.64	Open fracture of base of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
801.65	Open fracture of base of skull with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.66	Open fracture of base of skull with cerebral laceration and contusion; with loss of consciousness of unspecified duration
801.7	Open fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
801.71	Open fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
801.74	Open fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
801.75	Open fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.76	Open fracture of base of skull with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
801.8	Open fracture of base of skull with other and unspecified intracranial hemorrhage; unspecified state of consciousness

801.81	Open fracture of base of skull with other and unspecified intracranial hemorrhage; with no loss of consciousness
801.84	Open fracture of base of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
801.85	Open fracture of base of skull with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.86	Open fracture of base of skull with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
801.9	Open fracture of base of skull with intracranial injury of other and unspecified nature; unspecified state of consciousness
801.91	Open fracture of base of skull with intracranial injury of other and unspecified nature; with no loss of consciousness
801.92	Open fracture of base of skull with intracranial injury of other and unspecified nature; with brief [less than one hour] loss of consciousness
801.95	Open fracture of base of skull with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
801.96	Open fracture of base of skull with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
802	Fracture of face bones
802.1	Open fracture of nasal bones
802.2	Closed fracture of mandible; unspecified site
802.21	Closed fracture of mandible; condylar process
802.22	Closed fracture of mandible; subcondylar
802.23	Closed fracture of mandible; coronoid process
802.24	Closed fracture of mandible; ramus; unspecified
802.25	Closed fracture of mandible; angle of jaw
802.26	Closed fracture of mandible; symphysis of body
802.27	Closed fracture of mandible; alveolar border of body
802.28	Closed fracture of mandible; body; other and unspecified
802.29	Closed fracture of mandible; multiple sites
802.3	Open fracture of mandible; unspecified site
802.31	Open fracture of mandible; condylar process
802.32	Open fracture of mandible; subcondylar

802.34	Open fracture of mandible; ramus; unspecified
802.35	Open fracture of mandible; angle of jaw
802.36	Open fracture of mandible; symphysis of body
802.37	Open fracture of mandible; alveolar border of body
802.38	Open fracture of mandible; body; other and unspecified
802.39	Open fracture of mandible; multiple sites
802.4	Closed fracture of malar and maxillary bones
802.5	Open fracture of malar and maxillary bones
802.6	Closed fracture of orbital floor (blow-out)
802.7	Open fracture of orbital floor (blow-out)
802.8	Closed fracture of other facial bones
802.9	Open fracture of other facial bones
803	Other and unqualified skull fractures
803.01	Other closed skull fracture without mention of intracranial injury; with no loss of consciousness
803.02	Other closed skull fracture without mention of intracranial injury; with brief [less than one hour] loss of consciousness
803.03	Other closed skull fracture without mention of intracranial injury; with moderate [1-24 hours] loss of consciousness
803.04	Other closed skull fracture without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.05	Other closed skull fracture without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.06	Other closed skull fracture without mention of intracranial injury; with loss of consciousness of unspecified duration
803.09	Other closed skull fracture without mention of intracranial injury; with concussion; unspecified
803.1	Other closed skull fracture with cerebral laceration and contusion; unspecified state of consciousness
803.11	Other closed skull fracture with cerebral laceration and contusion; with no loss of consciousness
803.12	Other closed skull fracture with cerebral laceration and contusion; with brief [less than one hour] loss of consciousness

803.13	Other closed skull fracture with cerebral laceration and contusion; with moderate [1-24 hours] loss of consciousness
803.14	Other closed skull fracture with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.15	Other closed skull fracture with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.16	Other closed skull fracture with cerebral laceration and contusion; with loss of consciousness of unspecified duration
803.19	Other closed skull fracture with cerebral laceration and contusion; with concussion; unspecified
803.2	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
803.21	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
803.22	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
803.23	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with moderate [1-24 hours] loss of consciousness
803.24	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.25	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.26	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
803.29	Other closed skull fracture with subarachnoid; subdural; and extradural hemorrhage; with concussion; unspecified
803.3	Other closed skull fracture with other and unspecified intracranial hemorrhage; unspecified state of unconsciousness
803.31	Other closed skull fracture with other and unspecified intracranial hemorrhage; with no loss of consciousness
803.32	Other closed skull fracture with other and unspecified intracranial hemorrhage; with brief [less than one hour] loss of consciousness
803.33	Other closed skull fracture with other and unspecified intracranial hemorrhage; with moderate [1-24 hours] loss of consciousness

803.34	Other closed skull fracture with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.35	Other closed skull fracture with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.36	Other closed skull fracture with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
803.39	Other closed skull fracture with other and unspecified intracranial hemorrhage; with concussion; unspecified
803.4	Other closed skull fracture with intracranial injury of other and unspecified nature; unspecified state of consciousness
803.41	Other closed skull fracture with intracranial injury of other and unspecified nature; with no loss of consciousness
803.42	Other closed skull fracture with intracranial injury of other and unspecified nature; with brief [less than one hour] loss of consciousness
803.43	Other closed skull fracture with intracranial injury of other and unspecified nature; with moderate [1-24 hours] loss of consciousness
803.44	Other closed skull fracture with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.45	Other closed skull fracture with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.46	Other closed skull fracture with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
803.49	Other closed skull fracture with intracranial injury of other and unspecified nature; with concussion; unspecified
803.5	Other open skull fracture without mention of injury; unspecified state of consciousness
803.51	Other open skull fracture without mention of intracranial injury; with no loss of consciousness
803.52	Other open skull fracture without mention of intracranial injury; with brief [less than one hour] loss of consciousness
803.55	Other open skull fracture without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level

803.56	Other open skull fracture without mention of intracranial injury; with loss of consciousness of unspecified duration
803.59	Other open skull fracture without mention of intracranial injury; with concussion; unspecified
803.6	Other open skull fracture with cerebral laceration and contusion; unspecified state of consciousness
803.61	Other open skull fracture with cerebral laceration and contusion; with no loss of consciousness
803.65	Other open skull fracture with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.66	Other open skull fracture with cerebral laceration and contusion; with loss of consciousness of unspecified duration
803.69	Other open skull fracture with cerebral laceration and contusion; with concussion; unspecified
803.7	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
803.71	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
803.72	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
803.74	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
803.75	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.76	Other open skull fracture with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
803.8	Other open skull fracture with other and unspecified intracranial hemorrhage; unspecified state of consciousness
803.82	Other open skull fracture with other and unspecified intracranial hemorrhage; with brief [less than one hour] loss of consciousness
803.85	Other open skull fracture with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.86	Other open skull fracture with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration

803.9	Other open skull fracture with intracranial injury of other and unspecified nature; unspecified state of consciousness
803.91	Other open skull fracture with intracranial injury of other and unspecified nature; with no loss of consciousness
803.95	Other open skull fracture with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
803.96	Other open skull fracture with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
803.99	Other open skull fracture with intracranial injury of other and unspecified nature; with concussion; unspecified
804	Multiple fractures involving skull or face with other bones
804.01	Closed fractures involving skull or face with other bones; without mention of intracranial injury; with no loss of consciousness
804.02	Closed fractures involving skull or face with other bones; without mention of intracranial injury; with brief [less than one hour] loss of consciousness
804.04	Closed fractures involving skull or face with other bones; without mention or intracranial injury; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
804.05	Closed fractures involving skull of face with other bones; without mention of intracranial injury; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
804.06	Closed fractures involving skull of face with other bones; without mention of intracranial injury; with loss of consciousness of unspecified duration
804.09	Closed fractures involving skull of face with other bones; without mention of intracranial injury; with concussion; unspecified
804.1	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; unspecified state of consciousness
804.11	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; with no loss of consciousness
804.13	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; with moderate [1-24 hours] loss of consciousness
804.14	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
804.16	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; with loss of consciousness of unspecified duration

804.19	Closed fractures involving skull or face with other bones; with cerebral laceration and contusion; with concussion; unspecified
804.2	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
804.21	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
804.22	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with brief [less than one hour] loss of consciousness
804.23	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with moderate [1-24 hours] loss of consciousness
804.24	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
804.25	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
804.26	Closed fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
804.3	Closed fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; unspecified state of consciousness
804.31	Closed fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with no loss of consciousness
804.34	Closed fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
804.36	Closed fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with loss of consciousness of unspecified duration
804.39	Closed fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with concussion; unspecified
804.4	Closed fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; unspecified state of consciousness
804.41	Closed fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; with no loss of consciousness

804.45	Closed fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; with prolonged [more than 24 hours] loss of consciousness; without return to pre-existing conscious level
804.46	Closed fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
804.5	Open fractures involving skull or face with other bones; without mention of intracranial injury; unspecified state of consciousness
804.52	Open fractures involving skull or face with other bones; without mention of intracranial injury; with brief [less than one hour] loss of consciousness
804.6	Open fractures involving skull or face with other bones; with cerebral laceration and contusion; unspecified state of consciousness
804.61	Open fractures involving skull or face with other bones; with cerebral laceration and contusion; with no loss of consciousness
804.7	Open fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; unspecified state of consciousness
804.71	Open fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with no loss of consciousness
804.74	Open fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
804.76	Open fractures involving skull or face with other bones with subarachnoid; subdural; and extradural hemorrhage; with loss of consciousness of unspecified duration
804.8	Open fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; unspecified state of consciousness
804.82	Open fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with brief [less than one hour] loss of consciousness
804.89	Open fractures involving skull or face with other bones; with other and unspecified intracranial hemorrhage; with concussion; unspecified
804.9	Open fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; unspecified state of consciousness
804.96	Open fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; with loss of consciousness of unspecified duration
804.99	Open fractures involving skull or face with other bones; with intracranial injury of other and unspecified nature; with concussion; unspecified

850	Concussion with no loss of consciousness
850.1	Concussion; with brief loss of consciousness
850.11	Concussion; with loss of consciousness of 30 minutes or less
850.12	Concussion; with loss of consciousness from 31 to 59 minutes
850.2	Concussion with moderate loss of consciousness
850.3	Concussion with prolonged loss of consciousness and return to pre-existing conscious level
850.4	Concussion with prolonged loss of consciousness; without return to pre-existing conscious level
850.5	Concussion with loss of consciousness of unspecified duration
850.9	Concussion; unspecified
851	Cerebral laceration and contusion
851.01	Cortex (cerebral) contusion without mention of open intracranial wound; with no loss of consciousness
851.02	Cortex (cerebral) contusion without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
851.03	Cortex (cerebral) contusion without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
851.04	Cortex (cerebral) contusion without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
851.05	Cortex (cerebral) contusion without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.06	Cortex (cerebral) contusion without mention of open intracranial wound; with loss of consciousness of unspecified duration
851.09	Cortex (cerebral) contusion without mention of open intracranial wound; with concussion; unspecified
851.1	Cortex (cerebral) contusion with open intracranial wound; unspecified state of consciousness
851.11	Cortex (cerebral) contusion with open intracranial wound; with no loss of consciousness
851.13	Cortex (cerebral) contusion with open intracranial wound; with moderate [1-24 hours] loss of consciousness
851.16	Cortex (cerebral) contusion with open intracranial wound; with loss of consciousness of unspecified duration

851.19	Cortex (cerebral) contusion with open intracranial wound; with concussion; unspecified
851.2	Cortex (cerebral) laceration without mention of open intracranial wound; unspecified state of consciousness
851.21	Cortex (cerebral) laceration without mention of open intracranial wound; with no loss of consciousness
851.22	Cortex (cerebral) laceration without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
851.24	Cortex (cerebral) laceration without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
851.26	Cortex (cerebral) laceration without mention of open intracranial wound; with loss of consciousness of unspecified duration
851.3	Cortex (cerebral) laceration with open intracranial wound; unspecified state of consciousness
851.31	Cortex (cerebral) laceration with open intracranial wound; with no loss of consciousness
851.32	Cortex (cerebral) laceration with open intracranial wound; with brief [less than one hour] loss of consciousness
851.35	Cortex (cerebral) laceration with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.36	Cortex (cerebral) laceration with open intracranial wound; with loss of consciousness of unspecified duration
851.4	Cerebellar or brain stem contusion without mention of open intracranial wound; unspecified state of consciousness
851.41	Cerebellar or brain stem contusion without mention of open intracranial wound; with no loss of consciousness
851.42	Cerebellar or brain stem contusion without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
851.44	Cerebellar or brain stem contusion without mention of open intracranial wound; with prolonged [more than 24 hours] loss consciousness and return to pre-existing conscious level
851.45	Cerebellar or brain stem contusion without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.46	Cerebellar or brain stem contusion without mention of open intracranial wound; with loss of consciousness of unspecified duration

851.49	Cerebellar or brain stem contusion without mention of open intracranial wound; with concussion; unspecified
851.5	Cerebellar or brain stem contusion with open intracranial wound; unspecified state of consciousness
851.55	Cerebellar or brain stem contusion with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.6	Cerebellar or brain stem laceration without mention of open intracranial wound; unspecified state of consciousness
851.65	Cerebellar or brain stem laceration without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.66	Cerebellar or brain stem laceration without mention of open intracranial wound; with loss of consciousness of unspecified duration
851.7	Cerebellar or brain stem laceration with open intracranial wound; unspecified state of consciousness
851.71	Cerebellar or brain stem laceration with open intracranial wound; with no loss of consciousness
851.75	Cerebellar or brain stem laceration with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.8	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; unspecified state of consciousness
851.81	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with no loss of consciousness
851.82	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
851.83	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
851.84	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
851.85	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.86	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with loss of consciousness of unspecified duration

851.89	Other and unspecified cerebral laceration and contusion; without mention of open intracranial wound; with concussion; unspecified
851.9	Other and unspecified cerebral laceration and contusion; with open intracranial wound; unspecified state of consciousness
851.91	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with no loss of consciousness
851.92	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with brief [less than one hour] loss of consciousness
851.94	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
851.95	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
851.96	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with loss of consciousness of unspecified duration
851.99	Other and unspecified cerebral laceration and contusion; with open intracranial wound; with concussion; unspecified
852	Subarachnoid; subdural; and extradural hemorrhage; following injury
852.01	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with no loss of consciousness
852.02	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
852.03	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
852.04	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
852.05	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
852.06	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with loss of consciousness of unspecified duration
852.09	Subarachnoid hemorrhage following injury without mention of open intracranial wound; with concussion; unspecified
852.1	Subarachnoid hemorrhage following injury with open intracranial wound; unspecified state of consciousness

852.11	Subarachnoid hemorrhage following injury with open intracranial wound; with no loss of consciousness
852.13	Subarachnoid hemorrhage following injury with open intracranial wound; with moderate [1-24 hours] loss of consciousness
852.15	Subarachnoid hemorrhage following injury with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
852.16	Subarachnoid hemorrhage following injury with open intracranial wound; with loss of consciousness of unspecified duration
852.19	Subarachnoid hemorrhage following injury with open intracranial wound; with concussion; unspecified
852.2	Subdural hemorrhage following injury without mention of open intracranial wound; unspecified state of consciousness
852.21	Subdural hemorrhage following injury without mention of open intracranial wound; with no loss of consciousness
852.22	Subdural hemorrhage following injury without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
852.23	Subdural hemorrhage following injury without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
852.24	Subdural hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
852.25	Subdural hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
852.26	Subdural hemorrhage following injury without mention of open intracranial wound; with loss of consciousness of unspecified duration
852.29	Subdural hemorrhage following injury without mention of open intracranial wound; with concussion; unspecified
852.3	Subdural hemorrhage following injury with open intracranial wound; unspecified state of consciousness
852.31	Subdural hemorrhage following injury with open intracranial wound; with no loss of consciousness
852.32	Subdural hemorrhage following injury with open intracranial wound; with brief [less than one hour] loss of consciousness
852.33	Subdural hemorrhage following injury with open intracranial wound; with moderate [1-24 hours] loss of consciousness

852.35	Subdural hemorrhage following injury with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
852.36	Subdural hemorrhage following injury with open intracranial wound; with loss of consciousness of unspecified duration
852.39	Subdural hemorrhage following injury with open intracranial wound; with concussion; unspecified
852.4	Extradural hemorrhage following injury without mention of open intracranial wound; unspecified state of consciousness
852.41	Extradural hemorrhage following injury without mention of open intracranial wound; with no loss of consciousness
852.42	Extradural hemorrhage following injury without mention of open intracranial wound; with brief [less than 1 hour] loss of consciousness
852.43	Extradural hemorrhage following injury without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
852.44	Extradural hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
852.45	Extradural hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
852.46	Extradural hemorrhage following injury without mention of open intracranial wound; with loss of consciousness of unspecified duration
852.49	Extradural hemorrhage following injury without mention of open intracranial wound; with concussion; unspecified
852.5	Extradural hemorrhage following injury with open intracranial wound; unspecified state of consciousness
852.51	Extradural hemorrhage following injury with open intracranial wound; with no loss of consciousness
852.52	Extradural hemorrhage following injury with open intracranial wound; with brief [less than one hour] loss of consciousness
852.56	Extradural hemorrhage following injury with open intracranial wound; with loss of consciousness of unspecified duration
852.59	Extradural hemorrhage following injury with open intracranial wound; with concussion; unspecified
853	Other and unspecified intracranial hemorrhage following injury
853.01	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with no loss of consciousness

853.02	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
853.03	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness
853.04	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre- existing conscious level
853.05	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
853.06	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with loss of consciousness of unspecified duration
853.09	Other and unspecified intracranial hemorrhage following injury without mention of open intracranial wound; with concussion; unspecified
853.1	Other and unspecified intracranial hemorrhage following injury with open intracranial wound; unspecified state of consciousness
853.14	Other and unspecified intracranial hemorrhage following injury with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
853.15	Other and unspecified intracranial hemorrhage following injury with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
853.16	Other and unspecified intracranial hemorrhage following injury with open intracranial wound; with loss of consciousness of unspecified duration
853.19	Other and unspecified intracranial hemorrhage following injury with open intracranial wound; with concussion; unspecified
854	Intracranial injury of other and unspecified nature without mention of open intracranial wound; unspecified state of consciousness
854.01	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with no loss of consciousness
854.02	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with brief [less than one hour] loss of consciousness
854.03	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with moderate [1-24 hours] loss of consciousness

854.04	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
854.05	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
854.06	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with loss of consciousness of unspecified duration
854.09	Intracranial injury of other and unspecified nature without mention of open intracranial wound; with concussion; unspecified
854.1	Intracranial injury of other and unspecified nature with open intracranial wound; unspecified state of consciousness
854.11	Intracranial injury of other and unspecified nature with open intracranial wound; with no loss of consciousness
854.12	Intracranial injury of other and unspecified nature with open intracranial wound; with brief [less than one hour] loss of consciousness
854.13	Intracranial injury of other and unspecified nature with open intracranial wound; with moderate [1-24 hours] loss of consciousness
854.14	Intracranial injury of other and unspecified nature with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness and return to pre-existing conscious level
854.15	Intracranial injury of other and unspecified nature with open intracranial wound; with prolonged [more than 24 hours] loss of consciousness without return to pre-existing conscious level
854.16	Intracranial injury of other and unspecified nature with open intracranial wound; with loss of consciousness of unspecified duration
854.19	Intracranial injury of other and unspecified nature with open intracranial wound; with concussion; unspecified
925.1	Crushing injury of face and scalp
953	Injury to cervical nerve root
959.01	Head injury; unspecified
995.55	Shaken baby syndrome

Appendix 2: Endocrine ICD-9 Codes

253.1	Other and unspecified anterior pituitary hyperfunction
253.2	Panhypopituitarism
253.3	Pituitary dwarfism
253.4	Other anterior pituitary disorders
253.5	Diabetes insipidus
253.6	Other disorders of neurohypophysis
253.7	Iatrogenic pituitary disorders
253.8	Other disorders of the pituitary and other syndromes of diencephalohypophyseal origin
253.9	Unspecified disorder of the pituitary gland and its hypothalamic control
256.31	Premature menopause
256.39	Other ovarian failure
259	Delay in sexual development and puberty; not elsewhere classified
259.1	Precocious sexual development and puberty; not elsewhere classified
628.1	Infertility; female; of pituitary-hypothalamic origin