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Prevalence of neurogenic heterotopic ossification in traumatic head and spinal injured patients admitted to a tertiary referral hospital in Australia.

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Conflict of Interest Statement:

The authors report no conflict of interest.
Abstract:

**Objective:** To investigate the prevalence of neurogenic heterotopic ossification (NHO) in patients with traumatic brain injury (TBI) or traumatic spinal cord injury (TSCI) admitted to non-specialised units.

**Subjects and Method:** Retrospective audit of patients, using the ICD-10-AM coding system, admitted to The Townsville Hospital (TTH) with TBI/TSCI between 1 July 2006 and 31 December 2012.

**Results:** 58 patients with length of stay (LOS) ≥60 days were admitted to TTH with TBI/TSCI over this period; mean age 60 years (range 31-87 years); (55 were TBI and 3 TSCI patients). 3114 TBI/TSCI patients with LOS <60 days and mean age of 43 years (range 18-93 years) were also identified (2903 were TBI and 211 TSCI patients). Overall, none were diagnosed with NHO; six patients, identified by the ICD-AM-10 codes, diagnosed with heterotopic ossification (HO) did not have an associated TBI/TSCI.

**Conclusion:** Findings of zero percent of NHO prevalence in TSCI/TBI patients admitted to the large tertiary referral hospital suggest that NHO may have been missed, possibly due to the TSCI/TBI ICD-10-AM codes, not being specifically designed for documentation of the TBI/TSCI complications. If NHO remains undiagnosed in non-specialised units due to the method of coding, it may increase functional limitation in already compromised individuals.

**Number of words in abstract:** 200

**Key words:** Brain Injury, Spinal Cord Injury, Traumatic, Neurogenic Heterotopic Ossification, ICD-10 coding
Introduction:

Heterotopic ossification (HO) is the atypical formation of mature lamellar bone within extraskeletal soft tissues where bone normally does not exist; neurogenic heterotopic ossification (NHO) is one particular form of HO, following traumatic spinal cord (TSCI) and traumatic brain (TBI) injuries (1, 2). NHO typically develops within four months post neurological insult with the peak incidence at approximately two months post-injury (3). It manifests itself clinically as severe pain, swelling, erythema, warmth and decreased range of movement (3, 4). Patients with NHO usually develop lesions around larger joints, the hip being the most common location, followed by the knees and elbows (5, 6). A single joint is affected in approximately 40% of patients; in another third, two joints are affected (5, 7). Following its initial clinical manifestation, NHO tends to increase in size over the next two to three months and is usually fully developed two years post neurological injury (1, 3, 8).

As the bone becomes mature it can be seen on radiographs and can result in a variety of complications, including nerve impingement, joint ankylosis, complex regional pain syndrome, and soft tissue infection (9). The associated decline in range of motion (ROM) may greatly limit activities of daily living, such as positioning, transferring and maintenance of hygiene, thereby adversely affecting quality of life (4, 10-14).

The prevalence of NHO in the TSCI and TBI patients admitted to specialised units is relatively well documented (1, 3-5, 16-18). Clinically significant NHO in TSCI patients has been previously determined to be between 10% and 53% (16); in the TBI population the prevalence of NHO has been reported as being between 10% and 20% (4, 9). No comparative epidemiological data of NHO prevalence, however, is available for health-care facilities that are not specialized in treating patients with neurological trauma. In order to address this deficiency of existing data, a retrospective audit over a six and a half year period was carried out at a large tertiary hospital in September 2013.
Materials and Methods:

The study was approved by the Human Ethics Committees at The Townsville Hospital (TTH) and James Cook University (JCU), Australia; the protocols conformed to the Declaration of Helsinki. TTH is the only tertiary hospital in North Queensland, although not considered to be a specialised unit for TSCI and TBI patients (15).

Identification of patients

Patients were identified using the Hospital Based Corporate Information System (HBCIS) and Transition II (TII) tools. At TTH, HBCIS is used to record inpatient and outpatient activity, including revenue and clinical coding. Data relating to emergency department attendances, radiology, pharmacy and pathology are not included in HBCIS. TII is used to record data relating to inpatient activity and clinical coding, costing and acuity. All data were extracted using Crystal Reports 2008, which is a SAP Business Objects (Australia) application and were exported to the Microsoft Excel 2003 spreadsheet.

Audit protocol

Retrospective data were provided by the clinical information services of the Townsville Hospital and Health Service. These data included all patients with head or and spinal injuries, and/or heterotopic ossification (HO)/myositis ossificans (MO), aged 18 years or over at the time of admission and who were discharged from TTH between 1 July 2006 and 31 December 2012. The data were then searched for patients with ICD-10-AM codes indicating traumatic spinal cord injury (TSCI) or traumatic brain injury (TBI) with resultant injury to the nervous system. Demographic data relating to age, length of stay (LOS) and discharge destination were also noted.
Patient diagnoses for TSCI or TBI were further identified using the ICD-10AM codes for TSCI/TBI (S06, S09, S14, S24, S34, T09) and M61 for HO/MO.

The data were then filtered to identify patients with a length of stay (LOS) < 60 days and a LOS ≥60 days, and not currently recorded on Townsville HBCIS database as being deceased. The selection criterion of 60 days for LOS was chosen as NHO rarely becomes clinically relevant earlier than two months post trauma\(^1,3\).

Data were also extracted for any patients aged 18 years or over at the time of admission, with a diagnosis of HO or MO, using the data code M61 for HO/MO and who were discharged from TTH between 1 July 2006 and 31 December 2012.

ICD-10-AM (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification) refers to the Australian modification of the World Health organization (WHO) ICD-10 base classification system. This version of ICD has been modified to serve particular Australian needs and to support the national collection of data relevant to the Australian population's health. It is mandatory in all Australian hospitals and is purported to permit and support the systematic recording, analysis, interpretation and comparison of morbidity data. ICD-10-AM is used to translate diseases and other health problems from words into an alphanumeric code, allowing for easy storage, retrieval and analysis of the data. ICD-10-AM has been regularly reviewed and updated since its first release and implementation in 1998.

Clinical coding is undertaken by trained coders after the discharge of the patient from hospital. Coders apply international standards when coding diseases, injuries and procedures. They review the section of the patient’s medical record relating to the inpatient episode of care to determine all of the clinical codes relevant to the patient’s admission. Coders rely on the documentation in the patient chart; they can only code the documented diagnoses, and cannot diagnose from results in a chart.
Patients with a date of death were excluded from the data set. Queensland Health does not always receive notification regarding deaths, so not all death-related data can be assumed to be accurate, unless the patient died in hospital. The absence of a date of death in HBCIS does not necessarily mean that the patient is not deceased.

Statistical analysis

Nominal variables are presented as numbers, while continuous variables are presented as mean with ranges in brackets. Nominal and continuous variables were compared by the Fisher’s exact test and the Mann-Whitney U test, respectively. Statistical significance was defined at the conventional 5% level. All computations were performed using the StatsDirect version 2.7.9 statistical software (StatsDirect, Ltd.).

Results:

Using the HBCIS and TII tools, 3172 patients with ICD-10AM codes for TSCI/TBI were identified between July 2006 and December 2012 (Table 1). The mean age of the patients was 43 years (range 18-93 years) and the mean LOS was 14 days (range 1-1054 days; Table 1). The majority of TSCI/TBI patients were discharged home from the hospital, only 12% (388/3172) being discharged to another facility. The number of TSCI/TBI patients hospitalized per month increased from 25 in the period 2006-2007 to 64 in the period 2012-2013 (Figure 1).

For those TSCI/TBI patients with a LOS≥ 60days the results show that during the period 2011-2012 a minimum number of five patients with TSCI/TBI was recorded (mean LOS=257 days, range=67-905 days; Table 2), whilst a maximum number of 13 patients with TSCI/TBI was recorded during the period 2009-2010 (mean LOS=103 days, range=68-156 days; Table 2). The period 2012-2013 represented only six calendar months i.e. from July 1st to December 31st 2012 with only five long-stay patients with TSCI/TBI being recorded (mean LOS=92 days, range=63-123 days; Table 2). TSCI/TBI
patients with LOS<60 days had similar discharge destinations (discharged home 65% (2020/3114), discharged to another facility 12% (381/3114); (Table 3) as compared to TSCI/TBI patients with LOS ≥60 days (discharged home 66% (38/58), discharged to another facility 12% (7/58); (Table2) but were younger (mean age=43 years, range 18-93 years; Table 3) compared to TSCI/TBI patients with LOS ≥60 days (mean age=60 years, range 31-87 years; Table 2). The difference in age was statistically significant (P<0.05).

In addition, six patients were identified with M61 code (HO/MO) during the period of interest between July 2006 and December 2012. Medical records of those six patients with HO/MO were hand searched and none were associated with TSCI or TBI. Three patients with HO/MO had motor vehicle accidents without TSCI or TBI; one was the case of HO/MO following a burns injury; and two cases of HO/MO were diagnosed in patients with carcinoma of the testes and renal cell carcinoma (Table 4).

Discussion:

The prevalence of clinically significant NHO in TSCI patients has been previously determined to be between 10% and 53% (16). In the TBI population the prevalence of NHO has been reported as being between 10% and 20% (4, 9), though a very recent audit by Reznik, et al., (2014) at a specialised unit in Australia, describes lower figures of approximately 4% and 11% for TBI and TSCI patients, respectively (5). Over a six and a half year period more than 3,000 patients with TSCI or TBI were admitted to TTH, the tertiary referral hospital providing health-care services for the North Queensland population, and none were diagnosed with NHO associated with TSCI/TBI. The finding is surprising in regard to the large number of patients identified and the fact that the number of TSCI/TBI patients hospitalized per month in TTH more than doubled during the audited period between July 2006 and December 2013. There are a number of factors that might contribute to our finding of zero percent of NHO prevalence in TSCI/TBI patients admitted to TTH. NHO is usually
Prevalence of NHO in non-specialised units

diagnosed when it becomes clinically significant, i.e. causes pain, interferes with movement and/or restricts function \(^{1, 3, 5}\). The TSCI/TBI patients were identified using the ICD-10-AM coding system; however, some important complications of NHO such as pain and decreased mobility are also associated with TSCI/TBI itself, suggesting that NHO might remain overlooked due to these overlaps with the TSCI/TBI as a primary cause of admission. Furthermore, NHO typically becomes apparent at two month post-injury \(^{1, 3}\). Only a very small percentage of TTH patients with TSCI/TBI were hospitalised for \(\geq 60\) days (\(\sim 2\%\)), suggesting that the vast majority of TSCI/TBI patients at discharge (\(\sim 98\%\)) were, in fact, below the post-injury time-point of the NHO peak manifestation. The highest incidence of TSCI/TBI has been reported as being in the 15-25 year old age group \(^{19, 20}\) however our data showed that TSCI/TBI patients admitted to TTH were approximately twice as old as typical TSCI/TBI patients. NHO has also been reported to be primarily diagnosed within this younger age group \(^{2, 5, 16-18}\) and thus the age-related differences in the NHO incidence cannot be excluded as a biasing factor in our results. Finally, our data also show that the majority of TSCI/TBI patients admitted to TTH during the audit period were discharged home, with only a small percentage being discharged to another health-care facility. It is not known if any of these patients were subsequently diagnosed with NHO.

In a recent study undertaken at specialised units, Reznik, et al., (2014)\(^5\) suggested deep vein thrombosis to be the only common risk factor in the development of NHO in both the TSCI and TBI populations. Additional risk factors in the TBI population were the length of time the patient was intubated, the level of spasticity and the number of associated injuries. In the TSCI population the additional risk factors included the completeness of the lesion or the presence of multiple pressure ulcers \(^5\), thought to be the major complication of prolonged hospitalization \(^{21}\). Since the ICD-10-AM system does not allow for coding of those additional clinical characteristics, the system may be considered fundamentally ineffective as a registering tool for the severe complications associated with TSCI/TBI such as NHO.
In conclusion, NHO is a relatively common complication of neurological trauma. Taking this fact into consideration, our findings of zero percent of NHO prevalence in a large group of TSCI/TBI patients admitted to the large tertiary referral hospital suggest that NHO may have been missed; possibly due to the TSCI/TBI ICD-10-AM codes not being primarily designed for documentation of the TBI/TSCI complications. Recommendations forthcoming from this study include regular screening for NHO, if the TSCI/TBI ICD-10-AM codes are being recorded, especially in those patients with prolonged hospitalization. If NHO remains undiagnosed it may later prove to be an extremely debilitating condition in an already functionally compromised individual.
References:


APPENDIX 1

Definitions:

Medical Record Number: Unique identifying 6-digit number allocated to each patient.

Admit Number: Combination of the patient’s Medical Record Number and the number of their inpatient episode, for example 123456-5, where 123456 is the Medical Record Number, and the episode is the fifth inpatient episode at the nominated facility for that patient.

Age: Age of the patient at the time of admission.

Birth date: Patient’s date of birth as recorded in HBCIS.

Admit Date: Date of admission to hospital for the current inpatient episode of care.

Discharge Date: Date of discharge from hospital for current inpatient episode of care.

Also includes statistical discharges (change in care type, for example from Acute to Maintenance or Rehabilitation).

Discharge Disposition: Describes how the inpatient episode of care was terminated, for example discharged to home or usual residence, episode change, died in hospital, transfer to another facility.

Admit Unit: Doctor Unit under which the patient was admitted to hospital.

Admit Ward: Hospital Ward to which the patient was admitted.

Admit Source: Describes how the patient was admitted to hospital, for example Emergency Department, outpatient appointment, transfer from another facility, or episode change from another inpatient episode of care, for example Acute Care to Rehabilitation.

Admit Status: Shows whether the patient was admitted as an emergency admission, an elective admission, or may not be assigned if the admission is as a result of an episode change.

Admit Type: Indicates the type of care for which the patient has been admitted, for example, acute, maintenance, rehabilitation.

Discharge Unit: Doctor Unit under which the patient is discharged.

Discharge Ward: Hospital Ward from which the patient is discharged.
Days ICU: Number of days spent in the Intensive Care Unit.

Length Of Stay (LOS): Number of days spent in hospital. Excludes leave days.

Diagnosis Code: ICD-10-AM code relevant to the patient’s inpatient episode of care.

Diagnosis Type: Shows whether the diagnosis is:

• the principal reason for the patient’s admission to hospital, and present on admission (P),
• was present upon admission but was not the principal reason for admission (A),
• was not present on admission, and developed during the inpatient episode of care (C), or unable to be determined from the patient’s medical record (U).

Diagnosis description: Description associated with the ICD-10-AM code.
Table 1: Number of patients admitted to a tertiary referral hospital between 2006 and 2013 identified by the ICD-10-AM codes for TSCI/TBI.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Period</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients</td>
<td>298</td>
<td>370</td>
</tr>
<tr>
<td>Age in years (range)</td>
<td>38 (18-85)</td>
<td>42 (18-86)</td>
</tr>
<tr>
<td>Length of stay in days (range)</td>
<td>13 (1-87)</td>
<td>14 (1-263)</td>
</tr>
<tr>
<td>Discharge destination</td>
<td>Home</td>
<td>182 (61%)</td>
</tr>
<tr>
<td></td>
<td>Another facility</td>
<td>54 (18%)</td>
</tr>
</tbody>
</table>

Age is defined as the chronological age of the patient in years at the date of admission. Period is defined as the time between 1st July and 30th June of the two consecutive calendar years. Period 2012-2013 represents only six calendar months, i.e. from 1st July to 31st December 2012. Nominal variables are presented as numbers, while continuous variables are presented as mean (range).
Table 2: Characteristics of patients with TSCI/TBI hospitalized for ≥ 60 days.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>58</td>
</tr>
<tr>
<td>Patients with TBI</td>
<td>6 (100%)</td>
<td>7 (100%)</td>
<td>10 (100%)</td>
<td>11 (85%)</td>
<td>12 (100%)</td>
<td>4 (80%)</td>
<td>5 (100%)</td>
<td>55 (95%)</td>
</tr>
<tr>
<td>Patients with TSCI</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (15%)</td>
<td>0 (0%)</td>
<td>1 (20%)</td>
<td>0 (0%)</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>Age in years (range)</td>
<td>39 (31-49)</td>
<td>60 (36-82)</td>
<td>64 (47-87)</td>
<td>65 (35-82)</td>
<td>61 (37-85)</td>
<td>67 (39-86)</td>
<td>57 (50-72)</td>
<td>60 (31-87)</td>
</tr>
<tr>
<td>Length of stay in days (range)</td>
<td>68 (60-87)</td>
<td>139 (80-263)</td>
<td>191 (61-1054)</td>
<td>103 (68-156)</td>
<td>120 (61-183)</td>
<td>257 (67-905)</td>
<td>92 (63-123)</td>
<td>135 (60-1054)</td>
</tr>
<tr>
<td>Discharge destination</td>
<td>Home</td>
<td>4 (67%)</td>
<td>5 (71%)</td>
<td>4 (40%)</td>
<td>8 (62%)</td>
<td>9 (75%)</td>
<td>4 (80%)</td>
<td>4 (80%)</td>
</tr>
<tr>
<td></td>
<td>Another facility</td>
<td>0 (0%)</td>
<td>1 (14%)</td>
<td>3 (30%)</td>
<td>1 (8%)</td>
<td>1 (8%)</td>
<td>1 (20%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Age is defined as the chronological age of the patient in years at the date of admission. Period is defined as the time between 1st July and 30th June of the two consecutive calendar years. Period 2012-2013 represents only six calendar months, i.e. from 1st July to 31st December 2012. Nominal variables are presented as numbers, while continuous variables are presented as mean (range).
Table 3: Characteristics of patients with TSCI/TBI hospitalized for <60 days.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Period</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients</td>
<td>292</td>
<td>363</td>
</tr>
<tr>
<td>Patients with TBI</td>
<td>274 (94%)</td>
<td>316 (87%)</td>
</tr>
<tr>
<td>Patients with TSCI</td>
<td>18 (6%)</td>
<td>47 (13%)</td>
</tr>
<tr>
<td>Age in years (range)</td>
<td>38 (18-85)</td>
<td>*42 (18-86)</td>
</tr>
<tr>
<td>Length of stay in days (range)</td>
<td>11 (1-56)</td>
<td>11 (1-53)</td>
</tr>
<tr>
<td>Discharge destination</td>
<td>Home</td>
<td>178 (61%)</td>
</tr>
<tr>
<td></td>
<td>Another facility</td>
<td>54 (18%)</td>
</tr>
</tbody>
</table>

Age is defined as the chronological age of the patient in years at the date of admission. Period is defined as the time between 1st July and 30th June of the two consecutive calendar years. Period 2012-2013 represents only six calendar months, i.e. from 1st July to 31st December 2012. Nominal variables are presented as numbers, while continuous variables are presented as mean (range). Nominal variables such as discharge destinations and continuous variable such as age were compared to those of patients with LOS\(\geq60\) days (Table 2) using the Fisher's exact test and the Mann-Whitney U test, respectively. Statistically significant differences are marked by the asterisk (*).
Table 4: Patients with Heterotopic Ossification/Myositis Ossificans

<table>
<thead>
<tr>
<th>Patient</th>
<th>Clinical characteristics</th>
<th>Applicable to TSCI/TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chronic LBP, old MVA 20 years ago with fracture of pelvis</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>MVA with multiple fractures but no TBI or TSCI</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>HO following burns</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Minor TBI, testicular Ca possible cause of HO</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>MVA with multiple injuries but no TBI or TSCI</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Soft tissue calcification possibly due to renal cell Ca</td>
<td>No</td>
</tr>
</tbody>
</table>

LBP, low back pain; MVA, motor vehicle accident; TBI, traumatic brain injury; TSCI, traumatic spinal cord injury; HO, heterotopic ossification; Ca, cancer.
Figure 1: Number of TSCI/TBI patients admitted per month to a tertiary referral hospital between 2006 and 2013. Period is defined as the time between 1st July and 30th June of the two consecutive calendar years. Period 2012-2013 represents only six calendar months, i.e. from 1st July to 31st December 2012.
Prevalence of NHO in non-specialised units