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A comparison of patients managed in specialist versus non-specialist inpatient rehabilitation units in Australia

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Abstract

Aim: To compare the rehabilitation of patients with brain and spinal cord injury in specialist rehabilitation units and non-specialist rehabilitation units in Australia over a 10-year period.

Method: A retrospective cohort study design was used. Epidemiological descriptive analysis was used to examine inpatient rehabilitation data held in the Australasian Rehabilitation Outcomes Centre Registry Database at four discrete time points: 2007, 2010, 2013 and 2016. Data sets included patient demographics, length of stay and the Functional Independence Measure. Data sets were examined for differences between specialist and non-specialist rehabilitation units.

Results: Over the 10-year study period, compared to patients admitted to non-specialist rehabilitation units patients admitted to specialist rehabilitation units: (1) were younger and more likely to be male; (2) had a longer time between onset of illness/injury and rehabilitation admission; (3) had a longer median rehabilitation length of stay; (4) had a higher burden of care on admission to rehabilitation; however (5) had a greater functional gain. Patients in specialist rehabilitation units had a lower relative functional efficiency per day of rehabilitation, but higher percentage of Functional Independence Measure gain. In 2016, 66% of brain injury and 51% of spinal cord injury patients were not rehabilitated in specialist rehabilitation units.

Conclusion: There are differences in the characteristics of patients admitted to specialist versus non-specialist rehabilitation units. Patients admitted to specialist rehabilitation units have greater functional gain. A noteworthy proportion of brain and spinal cord injury patients are not being rehabilitated in specialist rehabilitation units, particularly patients with non-traumatic injuries.

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Running head: Specialist and non-specialist rehabilitation

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Keywords: rehabilitation, specialist, non-specialist, outcomes

Introduction

The fundamental goal of rehabilitation is to optimise a patient's functional independence after injury or illness. For some diagnosis-related groups rehabilitation in specialist rehabilitation units (SRUs) is advocated for optimal outcomes. These include spinal cord injury (SCI) [1-5], stroke [6,7], traumatic brain injury (TBI) [8-11], and brain injury more generally.[12] Nonetheless, time to when intensive inpatient rehabilitation starts also appears to be a factor for rehabilitation efficiency [13-16] whereby delay may adversely affect outcomes.[2,4,9,17]

Brain injury and SCI are two injury types that can result in catastrophic and life-long impairment. The exact number of new brain injuries and SCIs in Australia each year is unknown. However, during 2014-15 378 new cases of SCI were reported to the Australian Spinal Cord Injury Register; 264 of these were a traumatic SCI.[18] Approximately 1 in 45 Australians had an activity limitation due to a disability following an acquired brain injury in 2003.[19] A 2009 study estimated the total economic costs in Australia for moderate to severe TBI at A$8.6 billion, it was A$2 billion for SCI.[20]

Access to SRUs for patients with a brain injury and SCI can be an issue. Small numbers of SRUs which are predominately located in metropolitan areas [21] and injury type [3,22] are three potential factors contributing to access to these units. For instance, in Australia 81% of rehabilitation care separations were for people living in metropolitan areas in 2016-17 [23], and less than 14% of stroke patients are rehabilitated in a specialist stroke unit [22]; this is due to there being very few SRUs for stroke.

Inpatient rehabilitation data submitted to the Australasian Rehabilitation Outcomes Centre for brain and spinal cord injury episodes of care are recorded as coming from SRUs and non-specialist rehabilitation units (NSRUs). The aim of this study was to compare the rehabilitation of patients with

brain and spinal cord injury in SRUs versus NSRUs in Australia over a 10-year period. This is the first population-based study to examine differences in patients admitted to these units in Australia over a 10-year period comparing four discrete years.

Methods

Study design and data collection

A retrospective cohort study design was used to examine aggregated and de-identified brain injury (excluding stroke) and SCI impairment group data held by the Australasian Rehabilitation Outcomes Centre over a 10-year period. This data is collected prospectively by participating rehabilitation services, and the data set comprises case episode, demographic and outcome items for 16 individual impairment groups.[24] Patient demographic data were used to examine patient age and sex; length of stay (LOS) and Functional Independence Measure (FIM™) data were used to examine patient dependency. FIM™ is an 18-item burden of care measure that is used in rehabilitation services worldwide. Data were examined for four discrete time points: 2007, 2010, 2013 and 2016.

All rehabilitation units that admitted brain and spinal cord injury patients and submitted data to the Australasian Rehabilitation Outcomes Centre over the 10-year study period were included in the study. All individual patient episodes within a service were used in the analysis. Only when a patient had a required data item missing or invalid were they excluded from that specific part of the analysis. The data includes all admissions to rehabilitation associated with the first rehabilitation episode of care. Subsequent readmissions following an interruption to the initial rehabilitation program are accounted for within the primary admission, however, subsequent readmissions not part of the primary admission were excluded.

The Australian National Subacute and Non-acute Patient Classification (version 4) system was used to control for variations between patients admitted to rehabilitation. This enabled casemix-adjusted relative means to be derived controlling for a patient's reason for rehabilitation admission (Australasian Rehabilitation Outcomes Centre impairment code), age and level of motor/cognitive functioning on admission to rehabilitation (based on admission FIM™ score). Ethical clearance for this study was covered by negligible risk ethical approval from the University of Wollongong Human Research Ethics Committee (HREC 2016/287).

Data analysis

Comparisons were made between patients admitted to SRUs and NSRUs using epidemiological descriptive analysis. Comparisons between traumatic and non-traumatic injury were also conducted because these two injury types are used to classify SCI and brain injury patients admitted to rehabilitation and differences between them may contribute to differences between SRUs and NSRUs. With high volume data, such as population data, statistical tests return significant results that are not necessarily clinically relevant. As this study focuses on trends overtime and their clinical relevance, statistical significance was intentionally not provided.

FIM™ scores were used to calculate four rehabilitation impact indices algorithms: (1) absolute functional gain (discharge total FIM – admission total FIM); (2) rehabilitation efficiency ([discharge total FIM – admission total FIM]/LOS) that measures mean FIM gain per day; (3) relative functional efficiency ([discharge total FIM – admission total FIM]/[(126 − admission total FIM) × LOS] x 100) that measures proportion of FIM gain per day and is expressed as a percentage; and (4) rehabilitation effectiveness (Relative Functional Gain) ([discharge total FIM – admission total FIM]/[126 − admission total FIM] × 100) that measures overall proportion of FIM™ gain that is also expressed as a percentage.[25]

Results

Table 1 shows episode of care and demographic results for patients rehabilitated in SRUs and NSRUs for the brain injury and SCI impairment groups. Over the 10-year study period, the reported total number of rehabilitation episodes per annum increased for both impairment groups in both SRUs and NSRUs; for brain injury the increase was 104% (SRU = 85%; NSRU = 115%) and for SCI it was 26% (SRU = 60%; NSRU = 4%). Rehabilitation episodes increased more for non-traumatic than traumatic injuries, with 212% and 42% increases for non-traumatic brain injury and non-traumatic SCI respectively. The increases for TBI and traumatic SCI were 48% and 5% respectively. Despite these increases, both impairment groups decreased as a proportion of all rehabilitation episodes (brain injury from 3% in 2007 to 2.8% in 2016; SCI from 1.6% in 2007 to 0.9% in 2016). However, this was not the case for non-traumatic brain injury which increased from 0.2 to 0.3% in SRUs and from 0.8 to 1.1% in NSRUs.

Overall, more patients were rehabilitated in NSRUs than SRUs over the 10-year study period (see Table 1). 2013 was the exception when all SCI episodes in SRUs outnumbered episodes in NSRUs. Within unit comparisons reveal that there was over three-times more non-traumatic brain injury than TBI rehabilitation episodes in NSRUs at each time point. This is associated with a downward trend in proportions of TBI episodes in both unit types. The proportion of traumatic SCI episodes in SRUs also declined. In contrast, the pattern for SCI in NSRUs has remained fairly constant over time with nearly three times more episodes for non-traumatic than traumatic SCI.

SRUs admitted proportionally more males and the average patient age was consistently lower compared to NSRUs for both impairment groups over the 10-year study period (see Table 1). Within each unit patients with a traumatic injury were younger and proportionally more were male than patients with a non-traumatic injury.

The onset from injury/illness to rehabilitation admission and rehabilitation LOS were consistently longer for patients in SRUs over the 10-year study period (see Table 2). Total hospital LOS was greater than 90 days (median 93 to 167 days) for patients with a SCI in SRUs; this is double that for such patients in NSRUs. Despite this, the total LOS of patients with a SCI in NSRUs increased while it decreased for such patients in SRUs over the 10-year study period. The inverse is observed for the brain injury impairment group (see Table 2). Patients with a traumatic injury mostly had a longer rehabilitation LOS in both unit types.

Table 3 shows mean admission and discharge FIM™ scores and absolute functional gain results. The mean admission FIM™ score was lower for patients in SRUs compared to those in NSRUs. There was a decrease in mean admission FIM™ score for all patient groups over the 10-year study period, except for patients with a non-traumatic SCI in SRUs where it increased from 73.6 in 2007 to 75.2 in 2016. Between 2010 and 2013 there was a 10-point decrease in mean admission FIM™ scores (83.9 to 73.9) for patients with a traumatic SCI in NSRUs; it increased to 79.2 in 2016.

Brain injury patients in SRUs consistently had a higher mean discharge FIM™ score than brain injury patients in NSRUs; the opposite is observed for SCI patients. Brain injury and SCI patients in SRUs consistently had a higher absolute functional gain compared to those in NSRUs over the 10-year study period. Within the two unit types, patients with a traumatic injury mostly had a lower mean admission FIM™ score and higher absolute function gain than those with a non-traumatic injury. Non-traumatic brain injury patients in SRUs were the only group that had a reduction in mean functional gain (1.5 FIM™ points) between 2007 and 2016.

Comparison of rehabilitation impact indices shows that over the 10-year study period patients in SRUs consistently had a lower FIM™ gain per day of rehabilitation than patients in NSRUs (see Table 4). This is evidenced by lower rehabilitation efficiency and relative functional efficiency results. These results are reflective of patients in SRUs having a longer rehabilitation LOS compared to those in

NSRUs (see Table 2). However, for rehabilitation effectiveness which measures the overall proportion of FIM™ gain and is not impacted by LOS, patients in SRUs consistently had a higher percentage of FIM™ gain. rain injury and SCI patients with a traumatic injury had a higher percentage of FIM™ gain than those with a non-traumatic injury within the two unit types. There was also an increase in rehabilitation effectiveness for all groups over the 10-year study period, except for patients with a non-traumatic brain injury in SRUs where it deceased from 63.4% in 2007 to 57.7% in 2016.

Insert table 1 about here
Insert table 2 about here
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Discussion

The main finding of this study is that over the 10-year study period there were consistent differences between patients admitted to SRUs versus NSRUs in Australia. These differences include patient demographics, dependency on admission to rehabilitation and functional gain at discharge. Compared to patients admitted to NSRUs, patients admitted to SRUs: (1) were younger and more likely to be male which in part, likely reflects the epidemiological distribution of traumatic injuries in Australia [26,27]; (2) had a longer time between onset of illness/injury and rehabilitation admission; (3) had a longer median rehabilitation LOS; (4) had a higher burden of care on admission to rehabilitation (as evidenced by total admission FIM™ score); however (5) had a greater functional gain (as evidenced by absolute functional gain and rehabilitation effectiveness). Regardless of unit type, these results are mainly evident in patients with traumatic injuries rather than those with non-traumatic injuries. Patients in SRUs had a lower relative functional efficiency per day of rehabilitation which is due to such patients having a longer median rehabilitation LOS. A noteworthy proportion of brain injury and SCI patients are not being rehabilitated in SRUs, particularly patients with non-traumatic injuries.

As a proportion of all rehabilitation episodes of care in Australia, there was a decrease in the proportion of rehabilitation episodes for brain injury and SCI over the 10-year study period. This is due to the increasing demand for rehabilitation care more generally in Australia [23] and specifically for reconditioning and orthopaedic conditions.[28] Nonetheless, the total number of rehabilitation episodes for both impairment groups increased. The marked increase in rehabilitation episodes of patients with a non-traumatic injury is the main contributor to this.

A noteworthy proportion of brain injury and SCI patients were not rehabilitated in a SRU over the 10-year study period. The proportion was higher for patients with non-traumatic than traumatic injuries. This raises issues about access to SRUs more generally and inequitable access to SRUs for patients with non-traumatic injuries.[3,29,30] Factors that may impact on SRU access include: (1) patient awareness of SRUs; (2) selective admission criteria based on patient age and injury characteristics [9,11,31]; (3) it may be a matter of capacity as there is a relatively small number of SRUs in Australia; resulting in (4) prioritising which patients are referred to a SRU based on injury severity; and (5) location where SRUs are mainly located in metropolitan areas. Patients in remote areas are particularly impacted by this last point.[9,23] It should be noted for individuals in remote areas there is a balance between spending many months in a SRU away from social supports versus undertaking rehabilitation closer to such supports.[29] Social isolation may impact active patient participant in rehabilitation, so this is a particularly important consideration. Nonetheless, it is not sustainable to have SRUs in remote locations due to relatively small demand for such services given the small population. For these locations telehealth, specialist rural clinics and specialist community outreach rehabilitation services may be helpful.[21,29] However, inequitable access to such specialist services may remain an issue.[9]

The 16 and 25% respective increases in patients with a non-traumatic brain injury or non-traumatic SCI rehabilitated in a SRU suggests a trend towards more equitable access over the 10-year study period. Despite this improvement, when considering the proportion of patients with a non-traumatic injury to those with a traumatic injury the results are not so favourable. In 2016 non-traumatic SCI accounted for 64% of all SCI rehabilitation episodes of care but only 55% of the episodes were in SRUs. Non-traumatic brain injury accounted for 53% of all brain injury rehabilitation episodes of care but only 34% of the episodes were in SRUs. Nonetheless, over half of the patients with a TBI in this study were not rehabilitated in a SRU. Regardless of unit type, however, patients with a traumatic injury had a lower mean admission FIM™ score than those with a non-traumatic injury. Further research is required to determine if this difference in burden of care contributed to proportionately more patients with a traumatic injury being rehabilitated in a SRU.

An alternative to SRUs is specialist multidisciplinary rehabilitation teams involved in the rehabilitation of patients in NSRUs. The benefit of this approach may be outweighed by the benefits of an impairment specific patient milieu as the context of multidisciplinary rehabilitation can influence outcomes.[12] Compared to SRUs, NSRUs may have inadequate resources, context-specific assessments, assistive technologies, targeted therapies and equipment.[30,32,33] Similarly, they may not provide a milieu-oriented rehabilitation model that fosters a specific therapeutic environment involving a peer group of patients.[12] For instance, environmental factors including noise, overcrowding, restrictions and interactions can contribute to incidents of agitation [34] and aggression in patients with a brain injury.[35,36] Managing environmental stimuli through unit design, staff training and involvement of specialist clinicians (such as, neuro and clinical psychologists) to mitigate such behaviours is core business for specialist neuro-rehabilitation units. Resources, patient environment and infrastructure are important considerations when rehabilitating particular patient populations, such as brain injury and SCI.

Patients in SRUs had a higher burden of care on admission than those in NSRUs. In part, this may reflect selective referral practices in acute care whereby patients with higher complex care needs are prioritized for admission to SRUs over NSRUs [1,9,37-40] or conversely, selection bias of less complex patients by NSRUs.[3,11] NSRUs may also refer patients with higher complex care needs to SRUs [37,41] due to: the need for complex multifaceted care including equipment prescription and/or a requirement for major home modifications.[9,42] Selective referral of patients with higher complex care needs for admission to a SRU may inadvertently impact on the rehabilitation of less dependent patients.

Patients in SRUs had a longer median LOS than those in NSRUs. Lower functional status on admission to rehabilitation and an associated increased risk for complications during rehabilitation (i.e., patient deterioration) in patients with SCI and brain injury may contribute to this.[43-45] For instance, in a study by Wu *et al.*[11] TBI patients in SRUs had significantly lower admission FIM™ scores, more rehabilitation interruptions and longer rehabilitation LOS than patients in NSRUs. The longer rehabilitation LOS in this study resulted in patients in SRUs having a lower rehabilitation efficiency per day of rehabilitation, however, they had higher relative functional gain (rehabilitation effectiveness), the calculation of which is not influenced by LOS. There appears to be a cost (relating to rehabilitation LOS) versus functional benefit ratio here. Introduction of the FIM + FAM into the Australasian Rehabilitation Outcomes Centre data set would be useful for examining the cost versus functional outcomes in the brain injury rehabilitation population.[11,46] This is because the FAM adds an additional 12 items to FIM that focuses on cognitive and psychosocial function. Of the 18 items in FIM alone only five capture such information.

For optimal patient outcomes following SCI and brain injury there are two factors to consider with regards to rehabilitation. Firstly, the sooner rehabilitation services are introduced the better. This

includes specialist rehabilitation while in acute care [1,4,6,10,13,47] and time to when intensive inpatient rehabilitation starts in general.[2,4,9,17] The second consideration is that brain injury [12] and SCI patients [3] should be rehabilitated in SRUs. In this study, patients in a SRU had a greater functional gain than those in NSRUs which supports the second point. However, patients in SRUs had a lower total admission FIM™ score resulting in a higher possible absolute functional gain and longer rehabilitation LOS. These factors need to be considered when interpreting these results. Additional research is needed to examine patient outcomes, while controlling for injury severity [48], to better understand the long-term benefits of being rehabilitated in SRUs compared to NSRUs.

Study limitations and strengths

As the first population-based study to examine differences in patients admitted to SRUs versus NSRUs in Australia over a 10-year period using four discrete years the study has strengths. Firstly, it highlights trends over time. Examination of such trends can better assist in health service planning than examining data from a single year. Secondly, the data set was obtained from an organization (Australasian Rehabilitation Outcomes Centre) dedicated to national benchmarking, research and improvement of clinical rehabilitation outcomes.[49]

Not all rehabilitation episodes of care in Australia are included because it is not mandatory for rehabilitation services to submit data to the Australasian Rehabilitation Outcomes Centre; this is a limitation of the study. However, almost 100% of rehabilitation services submitted data to the Australasian Rehabilitation Outcomes Centre in the 2017/18 financial year. The use of large nationwide data sets such as this: (1) can have information bias as accuracy of information is unknown [3]; (2) can restrict researchers to examining predefined variables; and (3) the meaningfulness of results with regards to effect size and small differences is a consideration.[50] Nonetheless, such data sets allow for inclusion of a nationally representative sample assisting in generalisability of results.[51] Nonetheless, caution is required when considering generalisability of these results to other countries. Caution is also required if considering international comparisons due to differences in the model of rehabilitation, funding and selection criteria for referral to a SRU.[11]

Conclusion

Results from this study show that over the 10-year study period there were consistent differences in patient demographics, dependency on admission and functional gain for brain injury and SCI patients admitted to SRUs versus NSRUs. A noteworthy proportion of patients with a brain injury and SCI are not being rehabilitated in a SRU, particularly patients with non-traumatic injuries. This is despite increases in the number of non-traumatic brain injury and non-traumatic SCI patients being rehabilitated in such units. Consideration is needed on how to increase patient access to specialist rehabilitation expertise.

This study supports international literature in demonstrating that patients rehabilitated in a SRU have a greater function gain than those in a NSRU. There are, however, two contributing factors for this greater function gain: a lower mean admission FIM™ score and longer median rehabilitation LOS. Research is needed regarding the predictors for patients admitted to a SRU versus a NSRU, and what is the relationship between these predictors and rehabilitation outcomes. Examination of changes in these predictors and their association with rehabilitation outcomes over time is also needed.

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Table 1. Inpatient rehabilitation episodes of care and patient demographics for brain and spinal cord dysfunction between 2007 and 2016

	Episodes, No. (%)				Age (year), mean (SD)				Sex (male), %			
	2007	**2010**	**2013**	**2016**	**2007**	**2010**	**2013**	**2016**	**2007**	**2010**	**2013**	**2016**
Brain dysfunction, all	1642	2338	2917	3352	54.8 (21.5)	58.9 (20.9)	60.2 (20.2)	60.9 (19.8)	62.2	57.2	60.3	60.0
Specialist unit	614 (37)	851 (36)	997 (34)	1137 (34)								
Traumatic	501 (82)	622 (73)	708 (71)	746 (66)	39.3 (17.9)	41.1 (18.2)	42.1 (18)	44.1 (19.3)	75.0	77.5	77.4	75.3
Non-traumatic	113 (18)	229 (27)	289 (29)	391 (34)	56.7 (18.7)	51 (15.1)	52.7 (16.8)	53.7 (16.9)	50.4	47.6	54.7	59.8
Non-specialist unit	1028 (63)	1487 (64)	1920 (66)	2215 (66)								
Traumatic	576 (56)	632 (43)	741 (39)	846 (38)	53.9 (23.2)	63.4 (22.6)	63.2 (22.5)	64.2 (21.8)	68.1	53.0	61.7	65.1
Non-traumatic	452 (44)	855 (57)	1179 (61)	1369 (62)	64.4 (16.8)	65.8 (16.5)	65.5 (16.5)	65.1 (16.7)	47.8	50.6	53.4	52.7
Spinal cord dysfunction, all	856	808	972	1078	58 (19.8)	55.9 (19.9)	55 (19.6)	57.7 (18.1)	56.5	63.6	69.1	64.4
Specialist unit	334 (39)	312 (39)	548 (56)	533 (49)								
Traumatic	234 (70)	146 (47)	261 (48)	238 (45)	42.1 (18.2)	43.5 (18.5)	45.8 (19.5)	52.2 (18.6)	80.3	84.9	76.2	77.7
Non-traumatic	100 (30)	166 (53)	287 (52)	295 (55)	55.5 (15.8)	47.6 (19.3)	50.7 (18.6)	54.5 (18)	58.0	69.3	68.3	56.9
Non-specialist unit	522 (61)	496 (61)	424 (44)	545 (51)								
Traumatic	138 (26)	117 (24)	123 (29)	152 (28)	56.6 (20.4)	57.9 (20.6)	56.7 (20.1)	58 (19.4)	47.1	65.0	67.5	73.7
Non-traumatic	384 (74)	379 (76)	301 (71)	393 (72)	67.6 (14.6)	63.1 (17)	64 (16.4)	62.3 (16.1)	43.8	52.0	64.8	61.5

Episodes with valid age only, Excludes episodes where sex is unknown or indeterminate.

Table 2. Length of stay for brain and spinal cord dysfunction between 2007 and 2016

	Onset to rehabilitation admission				Rehabilitation LOS				Total LOS			
	2007	2010	2013	2016	2007	2010	2013	2016	2007	2010	2013	2016
Brain dysfunction, all												
Mean (SD)	21.3 (19.6)	21.9 (18.8)	22.8 (19.9)	22 (19.2)	30.9 (40.3)	31.6 (38.7)	30.1 (35.8)	27.7 (35.1)	50 (43.8)	52.8 (47.3)	49.7 (45.4)	47.3 (43.3)
Median (IQR)	15 (8-28)	16 (9-29)	16 (9-30)	16 (8-29)	20 (12-34)	20 (13-34)	20 (12-34)	18 (11-32)	39 (25-59)	39 (26-65)	38 (25-62)	37 (24-60)
Specialist unit												
Traumatic, mean (SD)	20.9 (20.7)	21.9 (18.3)	31.2 (22.1)	29.2 (18.6)	44.5 (58.1)	47.3 (58.9)	45.7 (51.7)	47.8 (66.7)	59.7 (56.9)	66.1 (61.6)	71.6 (61.6)	71.3 (71.2)
Median (IQR)	15 (8-26)	17 (9-31)	27 (13-45)	25 (14-39)	25 (14-49)	25 (15-54)	27 (16-52)	26 (15-52)	40 (25-71)	46 (28-81)	54 (31-92)	56 (36-96)
Non-traumatic, mean (SD)	18.8 (19.1)	27.7 (19.5)	33.9 (21.4)	35.6 (23.6)	34.1 (35.6)	42.3 (51.2)	41.2 (47.3)	35.3 (38)	49.5 (41.9)	64.7 (62.9)	69.8 (60.8)	63.9 (53.3)
Median (IQR)	12 (6-31)	23 (13-38)	30 (19-43)	29 (17-50)	22 (15-41)	23 (14-44)	22 (14-54)	24 (14-41)	38 (23-66)	45 (29-73)	64 (41-103)	61 (40-101)
Non-specialist unit												
Traumatic, mean (SD)	17.2 (14.1)	19.9 (20)	19.7 (18.1)	19.3 (17.6)	32.9 (40.6)	28.8 (31.8)	28 (31.8)	25.8 (23.3)	44.8 (36.4)	46.9 (40.1)	44.3 (35.9)	43.9 (31.9)
Median (IQR)	14 (7-25)	13 (7-25)	14 (8-25)	14 (8-25)	21 (13-38)	20 (12-33)	19 (12-30)	19 (13-32)	39 (24-55)	38 (24-60)	36 (24-54)	36 (24-54)
Non-traumatic, mean (SD)	22.1 (19.6)	20.7 (17.3)	19.5 (18)	19.2 (17.8)	25.2 (22)	25.5 (23)	26 (27.1)	23 (21)	47.7 (30)	45.5 (30.2)	43.1 (35)	40.2 (29.4)
Median (IQR)	18 (9-26)	16 (9-26)	14 (8-25)	14 (7-25)	20 (12-31)	20 (12-30)	19 (11-31)	16 (10-28)	40 (29-61)	37 (25-58)	34 (23-53)	32 (22-52)
Spinal cord dysfunction, all												
Mean (SD)	24.5 (23.6)	26.7 (25.5)	29.1 (23.7)	27.9 (25.9)	47.6 (55.3)	61.1 (67.8)	63.3 (64.8)	58.5 (60)	82.1 (71.8)	97.8 (92.7)	90.1 (72.5)	88.7 (76)
Median (IQR)	18 (8-33)	18 (8-38)	22 (11-42)	18 (10-38)	26 (14-60)	34 (16-87)	40 (20-87)	38 (19-77)	65 (32-118)	60 (30-145)	74 (38-137)	73 (40-138)
Specialist unit												
Traumatic, mean (SD)	32.8 (22.7)	43.9 (29.7)	38.4 (25.7)	32.9 (28.5)	85.8 (70.8)	108.8 (80.3)	94.2 (71)	100.6 (80.2)	137 (71.7)	180.6 (102.3)	130.8 (80.3)	134.9 (93.1)
Median (IQR)	26 (18-41)	42 (19-61)	35 (17-53)	23 (15-44)	67 (31-127)	96 (45-155)	81 (42-133)	79 (42-130)	122 (88-190)	157 (129-240)	131 (78-175)	136 (73-190)
Non-traumatic, mean (SD)	36.2 (31.9)	39.5 (23.2)	33.5 (25)	33.7 (26.6)	77.3 (57.7)	114.1 (86.6)	87.5 (76)	63.5 (54.8)	121.8 (84.5)	176.9 (98.7)	114.9 (78.5)	100 (73.2)
Median (IQR)	27 (14-54)	36 (25-54)	28 (14-50)	29 (12-47)	57 (39-100)	94 (48-156)	66 (34-119)	45 (23-90)	117 (65-169)	167 (108-227)	108 (66-159)	93 (50-146)
Non-specialist unit												
Traumatic, mean (SD)	19.6 (16.7)	20.8 (25.2)	23.4 (19.8)	22.7 (27)	32.9 (44.3)	31.1 (28.7)	37 (43.5)	30.4 (31.2)	46.4 (31.3)	46 (34.3)	53 (32.8)	53.2 (47.6)
Median (IQR)	15 (8-27)	12 (7-21)	17 (9-32)	13 (8-24)	19 (13-34)	22 (13-41)	24 (11-43)	22 (11-39)	39 (28-54)	39 (23-59)	50 (26-70)	39 (24-69)
Non-traumatic, mean (SD)	17.5 (21.3)	18.2 (21)	19.7 (17.6)	20.1 (19)	26.3 (31.4)	32.8 (30)	31 (28.3)	35.8 (31.3)	45.4 (41.7)	51.7 (40.2)	47.2 (30.3)	55.7 (41.2)
Median (IQR)	10 (6-21)	11 (7-20)	13 (9-26)	14 (8-22)	16 (11-30)	22 (14-40)	25 (14-37)	26 (15-47)	34 (22-62)	39 (24-62)	43 (30-62)	48 (27-77)

Data in days, LOS = length of stay, IQR = interquartile range, Episodes = completed first admission episodes with valid length of stay only, Onset = illness/injury onset date to rehabilitation admission date (+/- acute care), Total LOS = onset plus rehabilitation (if onset available) otherwise acute length of stay plus rehabilitation.

Table 3. Functional Independence Measure™ results for brain and spinal cord dysfunction between 2007 and 2016

	Admission FIM				Discharge FIM				Absolute Functional Gain			
	2007	2010	2013	2016	2007	2010	2013	2016	2007	2010	2013	2016
Brain dysfunction, all	83.8 (27.3)	81.7 (27)	82.7 (26.8)	80.5 (26.5)	106 (21.7)	105.7 (21.7)	105.4 (22)	104.8 (21.2)	22.2 (21)	23.9 (19.8)	22.7 (19.1)	24.4 (19.5)
Specialist unit												
Traumatic	79.3 (30.6)	80.6 (29.6)	78.4 (30.4)	73.7 (31.6)	110.7 (19.4)	112 (17.3)	111 (19.1)	109.1 (19.3)	31.3 (25.9)	31.3 (25.2)	32.7 (25.8)	35.4 (27.1)
Non-traumatic	80.9 (23.9)	82.6 (31.3)	84.1 (29.4)	79.8 (28.7)	107.8 (20.1)	107.9 (21)	110.5 (20)	105.2 (22.2)	26.9 (19.6)	25.3 (22.3)	26.4 (22)	25.4 (20.4)
Non-specialist unit												
Traumatic	81.5 (28)	79.3 (25.3)	82.9 (25.2)	79.2 (23.8)	106.6 (20.9)	103.2 (21.9)	106.3 (20)	105.3 (20)	25.2 (23)	23.9 (18.3)	23.4 (18.7)	26.1 (18.4)
Non-traumatic	82.4 (25.2)	81.4 (24.9)	81.5 (25.5)	80.7 (25)	102.3 (21.7)	103.3 (22.9)	101.7 (23.2)	103.3 (21.5)	19.9 (17.8)	21.9 (16.8)	20.3 (16.3)	22.6 (17.2)
Spinal cord dysfunction, all	82.1 (22.2)	78.9 (23)	76 (22.5)	73.5 (22.6)	100.8 (21.9)	101.6 (22.5)	99.6 (23.8)	98.4 (23.5)	18.7 (16.6)	22.8 (17.7)	23.6 (19.1)	24.9 (19.2)
Specialist unit												
Traumatic	71.3 (21.8)	68.6 (20.7)	68.2 (22.4)	63 (21.7)	96.1 (23.3)	96.8 (25.9)	97.4 (26.2)	95.3 (25.3)	24.8 (20.3)	28.2 (20.8)	29.2 (21.7)	32.3 (21.4)
Non-traumatic	73.6 (18.6)	68.9 (22)	74 (22.5)	75.2 (23.5)	96.2 (21.7)	95.3 (25.6)	100.5 (23)	99.3 (24.5)	22.5 (17.8)	26.4 (19.5)	26.5 (20.5)	24.1 (19.7)
Non-specialist unit												
Traumatic	85.3 (23.8)	83.9 (25.6)	73.9 (25.6)	79.2 (20.8)	102.2 (23.9)	102.5 (26.6)	91.7 (28.6)	102.8 (20.1)	16.9 (15.5)	18.7 (15.9)	17.9 (17.5)	23.6 (18)
Non-traumatic	89 (20.1)	83.6 (21.6)	83.8 (19.8)	76.8 (21.1)	105.1 (18.8)	104.1 (19.7)	103.6 (20.2)	98.6 (22.1)	16.2 (13.7)	20.5 (15.9)	19.8 (14.6)	21.8 (16.6)

Data are mean (SD), Completed episodes with valid FIM and length of stay only, FIM = Functional Independence Measure.

Table 4. Rehabilitation impact indices for brain and spinal cord dysfunction between 2007 and 2016

	Rehabilitation Efficiency (per day), mean (SD)				Relative Functional Efficiency (per day), %				Rehabilitation Effectiveness, %			
	2007	2010	2013	2016	2007	2010	2013	2016	2007	2010	2013	2016
Brain dysfunction, all	1 (1.4)	1.1 (1.1)	1.1 (1.2)	1.3 (1.1)	3.6	3.4	3.6	3.8	54.3	55.7	55	55.5
Specialist unit												
Traumatic	1.1 (0.8)	1 (1)	1.1 (1)	1.2 (1)	3.5	3.1	3.1	3.3	65.5	66.5	66.6	66
Non-traumatic	1.2 (1.2)	0.9 (0.8)	1.1 (1.6)	1.1 (0.9)	3.6	3.1	3.8	3.2	63.4	57.8	64.9	57.7
Non-specialist unit												
Traumatic	1.1 (1.1)	1.2 (1.1)	1.2 (1.1)	1.4 (1.2)	3.5	3.5	3.7	3.8	56.5	53.6	55.3	56.8
Non-traumatic	1.1 (2.2)	1.2 (1.1)	1.1 (1.1)	1.4 (1.1)	3.5	3.4	3.4	4	49	52.8	49.6	53.1
Spinal cord dysfunction, all	0.8 (1)	0.8 (1)	0.7 (0.8)	0.8 (1)	2.5	2.3	2	2.2	44.9	50.9	49.8	50.8
Specialist unit												
Traumatic	0.5 (0.7)	0.5 (0.6)	0.5 (0.6)	0.6 (0.7)	1	1.2	1.1	1.3	45.8	52.7	51.7	54.2
Non-traumatic	0.4 (0.5)	0.3 (0.3)	0.5 (0.7)	0.7 (1.2)	1	0.6	1.3	2.3	44.5	48.7	51.7	52.4
Non-specialist unit												
Traumatic	0.9 (0.9)	1 (1.5)	0.9 (1)	1.2 (1.1)	3.2	3.2	2.7	3.2	45.6	50.3	40.2	51.2
Non-traumatic	1 (1.2)	0.9 (1.1)	1 (1)	0.9 (0.9)	3.4	2.9	2.9	2.5	45.7	50.6	51.2	47.8

Completed episodes with valid FIM and length of stay only, FIM = Functional Independence Measure.