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Major trauma: the unseen financial burden to trauma centres, a descriptive multicentre analysis

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Abstract

Objective. This research examines the existing funding model for in-hospital trauma patient episodes in New South Wales (NSW), Australia and identifies factors that cause above-average treatment costs. Accurate information on the treatment costs of injury is needed to guide health-funding strategy and prevent inadvertent underfunding of specialist trauma centres, which treat a high trauma casemix.

Methods. Admitted trauma patient data provided by 12 trauma centres were linked with financial data for 2008–09. Actual costs incurred by each hospital were compared with state-wide Australian Refined Diagnostic Related Groups (AR-DRG) average costs. Patient episodes where actual cost was higher than AR-DRG cost allocation were examined.

Results. There were 16 693 patients at a total cost of AU$178.7 million. The total costs incurred by trauma centres were $14.7 million above the NSW peer-group average cost estimates. There were 10 AR-DRG where the total cost variance was greater than $500 000. The AR-DRG with the largest proportion of patients were the upper limb injury categories, many of whom had multiple body regions injured and/or a traumatic brain injury ($P < 0.001$).

Conclusions. AR-DRG classifications do not adequately describe the trauma patient episode and are not commensurate with the expense of trauma treatment. A revision of AR-DRG used for trauma is needed.

What is known about this topic? Severely injured trauma patients often have multiple injuries, in more than one body region and the determination of appropriate AR-DRG can be difficult. Pilot research suggests that the AR-DRG do not accurately represent the care that is required for these patients.

What does this paper add? This is the first multicentre analysis of treatment costs and coding variance for major trauma in Australia. This research identifies the limitations of the current AR-DRGS and those that are particularly problematic. The value of linking trauma registry and financial data within each trauma centre is demonstrated.

What are the implications for practitioners? Further work should be conducted between trauma services, clinical coding and finance departments to improve the accuracy of clinical coding, review funding models and ensure that AR-DRG allocation is commensurate with the expense of trauma treatment.

Additional keywords: cost, injury, health economics, health services.

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Background

Worldwide, traumatic injury accounts for 11% of mortality[1] and is increasing as a leading cause of death and disability.[2] Injury impacts society significantly on a physical, psychological and economic level.[3] In Australia, injuries are one of the most costly disease groups,[4] responsible for over half a million

hospitalisations, making it the second highest in-hospital cost after cardiovascular disease.[5] In 2008–09, New South Wales (NSW), the most populous state in Australia, received over one-third (34.3%, $n = 137\,088$) of all hospital admissions relating to injury.[6]

Trauma treatment represents a significant cost to the community and different funding models are used to resource the healthcare sector with varying degrees of accuracy.[7,8] In NSW, an episode-based funding model (also known as casemix-based funding) has been adopted for acute healthcare services[9] where a healthcare facility is allocated a predetermined financial payment for each type of patient episode, defined by an Australian Refined Diagnosis-Related Group (AR-DRG).[10]

For some health conditions, such as rehabilitation or palliative care, episode funding models and AR-DRG have not been found to be good indicators of the 'true' types of patient episodes.[11] Internationally, episode funding models are not commensurate with the cost of treating trauma and may leave trauma centres at a financial disadvantage.[12–14] The same has been suggested for the Australian episode funding model.[15] Severely injured trauma patients often have complex care needs as they can have multiple injuries, in more than one body region,[16] thus the determination of appropriate AR-DRG can be difficult.[10]

In an environment of increasing healthcare costs and competition for finite resources, economic data relating to the cost of injury and illness is integral to guiding health services policy. Therefore, it is important to have appropriately costed hospital treatment and service-utilisation funding models and subsequent resource allocation to avoid under-resourcing of the hospital sector. The present study aims to: determine whether AR-DRG adequately describe the in-hospital trauma patient episode; identify AR-DRG groupings where average AR-DRG costs are not commensurate with total actual cost; and identify factors, including demographics, specific treatment and circumstances of the injury event, that are associated with above-average treatment costs.

Methods

Data capture, costing methods and linkage

All 12 hospitals designated Level I trauma centres by the NSW Ministry of Health[17] at the time of the study provided both trauma and health service cost data. Each trauma centre has a trauma registry. As a minimum, data are collected on every major trauma admission (that is, an injury severity score greater than 12), although most centres collect data on all patients with a significant injury mechanism, regardless of injury severity, such as high-speed motor vehicle collision, stabbing, fall from greater than 3 m or assault. Each trauma centre provided demographic, injury and treatment-related data on all trauma patients admitted between 1 July 2008 and 30 June 2009. Due to the variance in data classifications for some site trauma centre registries, the codes for each data variable required manual review and recoding. Further, medical record numbers and admission dates from the trauma data were provided to the casemix or performance units at each health service or hospital to obtain health service cost data. The trauma and financial cost data were linked using medical record number, date of birth and admission date. Any discrepancies were individually resolved using a manual review.

The costing tool used by the NSW Ministry of Health at the time of the study was the Power Performance Management Reporting System,[18] which employs both clinical costing and cost-modelling methods in the cost-allocation process. The system has two main components: financial and clinical. Financial information is extracted from the hospital's general ledger at cost centre and account code level. Indirect costs are allocated to patient care cost centres, during the costing process, using appropriate allocation statistics (e.g. human resources using staffing head count, cleaning expense using floor space). The clinical information is based on patient data from the hospital patient administration system, which is accessed via an interface with the Health Information Exchange. The Health Information Exchange is the NSW Ministry of Health's corporate data warehouse and acts as a repository for several data collections. Patient-level resource use from both state and local information systems, such as diagnostic, theatre, pharmacy allied health and imaging, is linked to the patient administration system data facilitating patient-level costing. Episode costs are reported broken down into 10 cost buckets, including clinical (e.g. medical wages), operating room, pathology, imaging, ward, emergency department, Intensive Care Unit (ICU), allied health, pharmacy and prostheses. All patient costing was conducted in accordance with 2008–09 NSW Program and Product Data Collection.[19]

Each inpatient episode was grouped to an AR-DRG according to diagnoses and interventions coded after hospital discharge. The 2008–09 state-wide average costs for the AR-DRG were obtained from the NSW Ministry of Health Inter-Government and Funding Strategies Branch.[20] All costs are presented in Australian dollars for 2008–09. The 2008–09 average exchange rates for the US dollar and British pound were 76 cents and 47 cents (Australian), respectively.[21] Ethics approval was received from each site.

Injury severity

Injury severity was categorised using the Injury Severity Score (ISS), an anatomic diagnosis system derived from the Abbreviated Injury Scale (AIS).[22] ISS range from 0 to 75, with a score of less than 9 considered minor, 9–15 major and greater than 15 severe.[23,24] Further development of the AIS system has led to an ISS greater than 12 being considered reflective of severe injury in NSW.[25] Traumatic brain injury was calculated using an AIS greater than 2 (definition of serious traumatic brain injury[26]) and polytrauma the presence of more than two body regions injured.

Data management and analysis

Data were analysed using SPSS 20.0.[27] The direct cost and AR-DRG estimated cost of treating trauma patients are described for the 2008–09 financial year. There were 837 trauma patients where no AR-DRG code was allocated and these cases were excluded from cost analyses.

Descriptive analyses were conducted. The actual cost of treating the trauma patient was compared with peer-group hospitals (i.e. the reported AR-DRG average costs of NSW hospitals of similar size and resources) to determine any variance between the actual costs incurred by the trauma patient and the average costs of all patients with the same AR-DRG.

For the 10 AR-DRG with the most variance between actual and peer-group average total costs, non-parametric univariate analyses (Mann–Whitney Test) were performed to investigate

variables that were associated with large cost variance. These variables included demographics, specific treatment and mechanism of injury.

Results

There were 16 693 trauma patients who had AR-DRG assigned and costing information available. The average trauma patient cost was $10 705 (median $4698, quartile range (QR): $2222–$10 231) and the average length of stay (LOS) was 6.5 days. The average cost for males was higher than for females ($11 111 and $10 060, respectively). Patients aged 65 years and older had the highest average cost at $12 732. Patients who did not survive their injuries cost $8 432 more than those who survived. Patients with an injury mechanism of other transport ($47 664), drowning/submersion ($26 506) and road trauma ($14 232) had the highest average costs of trauma care, although both other transport and drowning/submersion accounted for only a relatively small number of patients (Table 1).

There were 386 AR-DRG groupings identified for the trauma patients. Comparison of the actual trauma costs for trauma patients with the peer-group hospital average found that there were 267 (69.2%) instances where the trauma patient cost was above average, totalling $19 993 525. There were 119 (30.8%) instances where the trauma patient costs were below average, equivalent to $3 724 009. Overall, trauma patient costs were $14 668 097 above average (Table 2).

For the AR-DRG allocated to trauma patients the actual treatment costs versus NSW peer-group average costs of all patients with the same AR-DRG were examined. There were 10 AR-DRG that had total variance greater than $500 000. The largest cost variances by AR-DRG classification were for treatments that required 'tracheostomy or ventilation >95 h' (A06Z), 'injury to the forearm, wrist, hand or foot for patients aged <75 years without complications of care' (I74C), 'hand procedures' (I30Z) and 'humerus, tibia, fibula and ankle procedures for patients age <60 years without catastrophic or severe complications of care' (I13C). The AR-DRG with the most patients was 'injuries, age <65 years' (X60C). Mean LOS did not differ significantly between the trauma centres in the study and the NSW peer-group hospital, except for 'other knee procedures' (I18Z) (Table 3).

On closer examination of these 10 high-variance AR-DRG, 84% ($n = 3963$) of patients had minor injuries (ISS <9). The average treatment cost of patients increased exponentially with the number of body regions injured (from $7598 for patients with an isolated injury to $64 652 for patients with four or more regions injured), although patients with four or more body regions injured represented only 2% of patients. The median cost for patients with a traumatic brain injury was significantly higher than for patients without a traumatic brain injury ($P < 0.001$). Falls, road trauma and violence were the most predominant injury mechanisms, although patients who fell from a height greater than 5 m had a higher median cost than those that fell less than 5 m ($P < 0.001$). Similarly, motorcycle crashes and pedestrians had higher median costs than those injured in a motor vehicle collision ($P = 0.035$ and $P = 0.01$, respectively) (Table 4).

As the hospital LOS was not significantly different in the high-variance AR-DRG group, the cost components where hospital

Table 1. Characteristics of trauma patients admitted to 12 trauma centres in NSW, 2008–09 ($n = 16\,693$)
LOS, length of stay

		No. of patients	Patient actual cost ($)			Episode LOS (days)		
			Mean	Median	Total	Mean	Median	Total
Overall		16 693	10 705	4698	178 700 851	6.45	3.00	107 700.00
Sex[A]	Male	10 264	11 111	4449	114 045 235	6.07	2.00	62 343.00
	Female	6417	10 060	5100	64 556 044	7.06	3.00	45 290.00
Age group (years)	<16	3489	5768	2367	20 124 682	2.80	1.00	9785.00
	16–34	4080	10 863	4519	44 322 608	5.40	2.00	22 032.00
	35–64	4467	12 304	5423	54 962 959	6.84	3.00	30 551.00
	65 and over	4657	12 732	7371	59 290 603	9.73	6.00	45 332.00
Outcome	Alive	16 354	10 534	4680	172 271 267	6.44	3.00	105 318.00
	Dead	339	18 966	6192	6 429 584	7.03	2.00	2382.00
Mechanism of injury[B]	Falls	6503	11 185	5538	72 735 141	7.31	3.00	47 537.00
	Road trauma	3479	14 232	5273	49 513 704	7.98	3.00	27 770.00
	Violence	2039	8391	3809	17 108 985	3.83	2.00	7809.00
	Burns	342	11 541	1684	3 947 151	5.25	1.00	1795.00
	Sport and recreation	455	8321	4144	3 786 079	4.17	2.00	1896.00
	Industrial/machinery	153	13 710	5260	2 097 652	6.87	3.00	1051.00
	Animal-related	226	8089	3310	1 828 213	4.74	2.00	1071.00
	Struck by or crushed by object	374	4279	2290	1 600 316	2.24	1.00	836.00
	Drowning/submersion	46	26 506	4071	1 219 271	6.54	2.00	301.00
	Penetrating or cutting injury	100	3919	2987	391 899	1.86	1.00	186.00
	Other transport (e.g. aircraft, train)	7	47 664	14 436	333 648	23.29	8.00	163.00
	Poisoning	43	6827	1857	293 555	3.70	1.00	159.00
	Unspecified	862	8140	4512	7 016 947	4.26	2.00	3674.00

[A]12 records without sex, thus not included.
[B]2032 records with no mechanism of injury.

LOS was not the main cost driver were compared. Patients in the high-variance group had higher ICU, operating room, prosthesis and pharmacy costs compared with those who were not in the high-variance AR-DRG group (Table 5).

The AR-DRG that had both a high cost variance compared with the NSW peer-group average and the largest proportion of patients were those from the upper limb injury or 'I' category (i.e. I74C, I13C, I30Z and I19Z). When examining the injury characteristics of patients allocated the 'I' AR-DRG, patients were predominantly aged less than 60 years, and a large proportion of patients in each 'I' category had multiple body regions injured and/or a traumatic brain injury (Table 6). For example, in AR-DRG I74C, a 57-year-old who fell from 1–5 m had a fractured (#) radius, panfacial fractures, cheek degloving and a concussion. A 64-year-old pedestrian had a # radius, # ulna, arm degloving and a concussion, a 42-year-old who fell from a horse had bilateral ulna fractures, a radius fracture and multiple rib fractures. In other instances there were likely incorrect AR-DRG allocations, for example in I19Z a 30-year-old motorcycle rider had a severe head injury (diffuse axonal injury), cerebral contusions, facial laceration and a fractured radius.

The mechanisms with the highest proportions of patients in the high-variance AR-DRG were sport (50%), fall from unspecified height (44%), violence, and motorcycle and pedal cycle crashes (36%). Large proportions of each of these injury-mechanism groups were allocated the AR-DRG I74C and I13C.

Table 2. Sum of difference between actual costs and peer group average Australian Refined Diagnostic Related Group (AR-DRG) costs, 2008–09 (*n* = 16 693)

LOS, length of stay

Item	Actual cost and LOS	AR-DRG peer group average	Total variance
Cost	178 700 851	164 032 753	14 668 097
LOS (days)	107 700	104 719	2981
Average LOS (days)	6.45	6.27	0.18

Discussion

This multicentre study describes the trauma casemix treated at major trauma centres and demonstrates that traumatic injury cost NSW trauma centres AU$178.7 million in 2008–09. Average per patient costs for severely injured patients in this study were less than those reported internationally[7] and locally.[28] In comparing costs, it is necessary to collect data across multiple sites so that discrepancies caused by variations in efficiency across centres are offset. The high financial cost of treating trauma highlights the need to ensure that injury-prevention interventions remain a priority in Australia.

When severely injured individuals are treated at specialist trauma centres, their chances of surviving their injury are greatly improved.[26,29–31] Trauma centres are major teaching hospitals that provide services for the full spectrum of illness, as well as major trauma. The present study highlighted that AR-DRG classifications used as the basis for funding are not commensurate with the trauma patient episode of care. Within the AR-DRG examined in this study, trauma patients are only one patient group. It is expected that there is a range of patient illnesses and associated individual comorbidities. The mean cost for reimbursement assumes that within a hospital, some patients fall below the average cost and others fall above. However, the findings of this study demonstrate that hospitals with a high trauma casemix are likely to have a higher proportion of AR-DRG where patient costs are above average.

The allocation of AR-DRG for trauma patients can be complicated, as trauma patients often have multiple injuries[32] that are not easily defined by a single AR-DRG classification. This was demonstrated by the examination of a series of cases that were allocated to the problematic upper-limb injury AR-DRG. This could be a result of inaccurate coding or the inadequacy of AR-DRG in describing the trauma patient episode. Further work should be undertaken between trauma services, clinical coders and health-strategy services to review funding models and ensure that AR-DRG allocation is commensurate with the expense of trauma treatment, as has been suggested previously.[15,33,34]

Table 3. Top 10 Australian Refined Diagnostic Related Group (AR-DRG) classifications with the highest sum variance for trauma patients admitted to 12 trauma centres in NSW, 2008–09 compared with peer-group hospital costs (*n* = 5520)

ALOS, average length of stay; LOS, length of stay; A06Z,tracheostomy or ventilation > 95 h; I30Z, hand procedures; I08A, other hip and femur procedures with catastrophic or severe complications of care; I74C, injury to forearm, wrist, hand or foot, age <75 years without complications of care; I13C, humerus, tibia, fibula and ankle procedures, age <60 years without catastrophic or severe complications of care; I75C, injury to shoulder, arm, elbow, knee, leg or ankle, age <65 years without complications of care; I18Z, other knee procedures; J65B, trauma to the skin, subcutaneous tissue and breast, age <70 years; I19Z, other elbow or forearm procedures; X60C, injuries, age <65 years

AR-DRG version 5.1	*n*	Patient direct cost		Peer-group hospitals		Variance		Episode LOS	Peer-group ALOS
		Mean	Sum	Mean	Sum	Mean	Sum	Mean	Mean
A06Z	214	118 920.66	25 449 020.56	109 831.90	23 504 026.60	9088.76	1 944 993.96	33.71	34.10
I08A	418	21 766.42	9 098 361.89	20 172.87	8 432 259.66	1593.55	666 102.23	18.24	17.80
I13C	800	8838.19	7 070 548.23	7831.83	6 265 464.00	1006.36	805 084.23	4.76	4.00
I18Z	66	11 836.22	781 190.56	3792.65	250 314.90	8043.57	530 875.66	6.73	2.10
I19Z	712	7615.19	5 422 014.66	6589.95	4 692 044.40	1025.24	729 970.26	3.43	2.90
I30Z	630	5161.21	3 251 560.08	3826.71	2 410 827.30	1334.50	840 732.78	2.06	1.40
I74C	838	2669.07	2 236 684.63	1593.41	1 335 277.58	1075.66	901 407.05	1.26	1.20
I75C	470	3657.82	1 719 175.46	1957.06	919 818.20	1700.76	799 357.26	2.10	1.90
J65B	463	3188.74	1 476 384.58	1968.88	911 591.44	1219.86	564 793.14	1.77	1.70
X60C	909	2924.44	2 658 312.45	2218.78	2 016 871.02	705.66	641 441.43	1.97	1.80

Table 4. Injury and cost characteristics for trauma patients for the 10 Australian Refined Diagnostic Related Groups (AR-DRG) with the highest cost variance admitted to 12 trauma centres in NSW, 2008–09 ($n = 5520$)

		No. of patients	% of patients	Patient actual cost ($)		
				Mean	Median	Total
Sex[A]	Male	3507	63.6	11 081	3429	38 860 871
	Female	2010	36.4	10 096	4253	20 293 621
Age group (years)	<16	1512	27.4	4857	2296	7 344 505
	16–34	1630	29.5	9186	3557	14 973 696
	35–64	1714	31.1	12 238	4598	20 975 812
	>64	664	12.0	23 899	12 263	15 869 240
Count of body regions injured[B]	One	3455	73.3	7598	3580	26 252 155
	Two	940	19.9	11 614	3968	10 917 055
	Three	221	4.7	30 177	6792	6 669 160
	Four+	100	2.1	64 652	25 460	6 465 155
Traumatic brain injury	No	4256	90.2	8269	3796	35 192 237
	Yes	460	9.8	32 851	4178	15 111 287
Mechanism of injury[C]	Falls					
	All falls	2288	45.4	11 991	4431	27 434 691
	Falls <1 m	1611	32.0	11 436	4763	18 423 677
	Falls 1–5 m	449	8.9	12 731	4210	5 716 199
	Falls >5 m	130	2.6	16 738	3308	2 175 981
	Falls, unspecified height	98	1.9	11 417	3169	1 118 834
	Road trauma					
	All road trauma	1217	24.2	11 912	3411	14 497 023
	Motor vehicle crash	481	9.5	12 521	3095	6 022 738
	Motor bike crash	350	6.9	10 179	4000	3 562 545
	Pedestrian	205	4.1	12 762	4013	2 616 276
	Pedal cyclist	168	3.3	13 312	3268	2 236 453
	Other vehicle crash	13	0.3	4539	3488	59 012
	Violence	747	14.8	8750	2980	6 536 587
	Sport and recreation	236	4.7	8143	3506	1 921 853
	Others[D]	276	5.5	12 454	2527	3 437 363
	Unspecified	274	5.4	5581	4032	1 529 065

[A]Sex was not provided for three patients.
[B]804 records with no Abbreviated Injury Scale or Injury Severity Score information provided.
[C]482 records with no mechanism of injury information.
[D]Others include struck by or crushed by object, burns, industrial/machinery, animal, penetrating or cutting injury, drowning/submersion and poisoning.

Table 5. Comparisons of care characteristics between patients with the 10 Australian Refined Diagnostic Related Groups with the highest cost variance ($n = 5520$) and patients with other AR-DRG ($n = 11\,173$)

	AR-DRG with high cost variance Patient actual cost ($)				Other AR-DRG Patient actual cost ($)			
	Mean	Median	Total	% of total costs	Mean	Median	Total	% of total costs
Clinical	918	234	5 069 212	9.5	1412	495	15 771 313	14.6
Operating room	1710	991	9 431 723	17.6	1498	0	16 725 962	15.4
Specialist procedure Suites	46	–	235 346	0.4	55	0	571 055	0.5
Pathology	369	9	1 900 941	3.6	430	118	4 629 357	4.3
Imaging	458	124	2 497 117	4.7	590	233	6 401 829	5.9
Ward	1872	594	10 333 815	19.3	2780	1187	31 059 779	28.7
Emergency department	589	491	3 244 628	6.1	678	551	7 554 855	7.0
Intensive care unit	2787	–	14 153 994	26.4	1071	0	11 250 169	10.4
Allied health	317	27	1 749 381	3.3	470	119	5 243 816	4.8
Pharmacy	457	94	2 521 920	4.7	399	131	4 457 024	4.1
Prosthesis	436	170	2 406 127	4.5	419	11	4 685 003	4.3

Table 6. Injury characteristics of patients with the 10 Australian Refined Diagnostic Related Groups (AR-DRG) with the highest cost variance ($n = 5520$)

TBI, traumatic brain injury; A06Z,tracheostomy or ventilation > 95 h; I30Z, hand procedures; I08A, other hip and femur procedures with catastrophic or severe complications of care; I74C, injury to forearm, wrist, hand or foot, age <75 years without complications of care; I13C, humerus, tibia, fibula and ankle procedures, age <60 years without catastrophic or severe complications of care; I75C, injury to shoulder, arm, elbow, knee, leg or ankle, age <65 years without complications of care; I18Z, other knee procedures; J65B, trauma to the skin, subcutaneous tissue and breast, age <70 years; I19Z, other elbow or forearm procedures; X60C, injuries, age <65 years

AR-DRG	Count	%	Age		Count of body regions injured										Patients with TBI	
			Mean	Standard deviation	Isolated region		Two		Three		Four+		Total		Count	%
					Count	%	Count	%	Count	%	Count	%	Count	%		
A06Z	214	3.9	46	23.08	38	1.1	48	5.1	37	16.7	44	44.0	167	3.5	115	25.0
I08A	418	7.6	77	18.24	288	8.3	54	5.7	18	8.1	13	13.0	373	7.9	9	2.0
I13C	800	14.5	29	16.57	546	15.8	90	9.6	15	6.8	6	6.0	657	13.9	13	2.8
I18Z	66	1.2	45	19.51	42	1.2	12	1.3	4	1.8	1	1.0	59	1.3	2	.4
I19Z	712	12.9	47	23.37	467	13.5	100	10.6	37	16.7	12	12.0	616	13.1	38	8.3
I30Z	630	11.4	33	17.96	359	10.4	221	23.5	12	5.4	0	.0	592	12.6	3	.7
I74C	838	15.2	18	16.33	573	16.6	77	8.2	18	8.1	3	3.0	671	14.2	13	2.8
I75C	470	8.5	26	18.53	305	8.8	67	7.1	17	7.7	4	4.0	393	8.3	24	5.2
J65B	463	8.4	27	18.52	267	7.7	106	11.3	18	8.1	3	3.0	394	8.4	88	19.1
X60C	909	16.5	27	16.51	570	16.5	165	17.6	45	20.4	14	14.0	794	16.8	155	33.7
Total	5520	100.0	34	23.83	3455	100.0	940	100.0	221	100.0	100	100.0	4716	100.0	460	100.0

The most recent AR-DRG classification and International Classification of Diseases (ICD)-10-AM were implemented in Australia on 1 July 2013. Previous research and our findings should be taken into account when these systems are refined by the National Centre for Classification in Health in 2014. For example, as LOS is not predicative of trauma treatment cost variance, perhaps a new AR-DRG should be developed, or a higher clinical complexity National Weighted Activity Unit allocated to trauma patients with polytrauma and traumatic brain injury, which are known predictors of higher treatment costs and cost variance.[8]

Institutions around the world have attempted to enhance their coding accuracy by directly engaging clinicians to document clearly and comprehensively, but this strategy has proven to be both unsuccessful and difficult to sustain. Healthcare organisations need to continue to assess clinical documentation and identify problems,[35] as well as adopt site-specific strategies known to improve coding quality, such as: improved coder career opportunities; higher staffing levels; reduced throughput; and increased coder interactions with clinical staff.[36] A study in 2002 demonstrated that when trauma nurse case managers who routinely collected trauma data and coordinated patient care collaborated with clinical coding staff, coding accuracy and financial return for the hospital were improved.[10] More recently in NSW, the Health Education and Training Institute has implemented a Clinical Coding Workforce Enhancement project and will be more closely involved in the recruitment, education and training of clinical coders.[37]

Patients in the high-variance group had polytrauma and high ICU and operating room costs. Polytrauma occurs when the severity of injury in each body regions rises above an AIS of 2. It is intuitive that polytrauma is associated with higher treatment costs as it requires the involvement of multiple health teams, is highly resource intensive, and often involves massive resuscitation efforts, extensive imaging, multiple operations, extended ICU stays and complex rehabilitation programs.[38] Admission to ICU as a predictor of cost has been demonstrated previously. The challenge for critical care practitioners is to meticulously assess new innovations in therapy and to adopt the most efficient technologies that improve unit function and staff efficiency, and enhance patient outcome at a reasonable cost.[39]

As trauma increases as a significant aspect of the global burden of disease, it is imperative that the most common mechanisms are adequately represented in funding models, particularly as trauma patients are likely to sustain injury to multiple body regions.[38,39] In the current study, trauma patients who had the highest cost variance commonly sustained their injury as a result of a fall, a road traffic crash or violence, which is reflective of wider injury patterns. Injurious falls in the older person population are the leading cause of injury-related mortality and hospitalised morbidity in most developed countries.[40] By 2030, road traffic injuries are expected to become the fifth leading cause of death and the third leading cause of disability worldwide, prompting the United Nations General Assembly to proclaim 2011–20 as the Decade of Action for Road Safety.[41] The road trauma patients in the present study with the highest cost variance were vulnerable road users, such as pedestrians, pedal cyclists and motorcyclists, who have less protection from high-energy impact. There is an increasing rate of interpersonal violence in Australia.[42,43] Early intervention and education while young males are at school has become a focus of prevention strategies to address this,[44] as well as other programs, such as the prevention of alcohol-related trauma in youth, which was found to effectively reduce the incidence of traumatic injuries among its participants, although more so in women than men.[45]

There are several limitations of the current research. It only included those injured individuals admitted to one of the 12 major trauma centres, some of which were only able to provide information on severely injured patients. The acute treatment costs of trauma represent a fraction of the overall financial costs of trauma[3] and the present study did not include any post-acute rehabilitative treatment costs or individual costs incurred by the patients' families. Longitudinal costing studies are required in order to

determine the complete financial burden of traumatic injury to the healthcare system. There was some variability in trauma data classifications between trauma centres. The authors undertook stringent quality processes to address these problems. The implementation of a mandatory NSW state-wide trauma registry and an increase in the data items recorded in the NSW trauma minimum dataset will go some way toward reducing these problems.

Conclusion

With the globally increasing burden of injury, accurate costing information is essential for health service resource strategies. AR-DRG classifications do not adequately describe the trauma patient episode of care. Future research should examine the process of allocation of AR-DRG for trauma and a revision of trauma-related AR-DRG should be conducted to prevent the underfunding of trauma patient episodes.

Competing interests

The authors declare there are no competing interests.

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