Title

Comparison of methods to correct the miscounting of multiple episodes of care when estimating the incidence of hospitalised injury in child motor vehicle passengers

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Abstract

Objectives: To evaluate the performance of different case selection criteria for accounting for multiple episodes of care for an injury when estimating the hospitalisation rate for road trauma of children.

Methods: This study used the internally-linked NSW Inpatient Statistics Collection (ISC) dataset for the period between 1st July, 2000 and 30th June, 2003 to identify the "first" episode of care for a hospitalised child vehicle passenger residing in NSW. We used three hospitalised injury definitions of a case based on the external cause, all-diagnoses and principal diagnosis only. We then developed "new case" selection criteria based on selected variables readily available from both the linked and un-linked ISC datasets to exclude multiple episodes of care for an injury. Changes in the estimated hospitalisation rate, and sensitivity and specificity, were calculated for each selection criteria compared to the findings from linkage methods as the "gold standard".

Results: The criterion of excluding cases "readmitted to hospital within 28 days" produced an incidence rate closest to the gold standard for almost all hospitalised injury definitions, but with a loss in specificity compared with linkage methods; application of the "separation mode" criterion produced high specificity for hospitalised injuries in all injury definitions. The criterion of excluding episodes with "non-urgent status" was consistently advantageous in terms of sensitivity, but also consistently demonstrated the lowest specificity.

Conclusion and Implications: None of the correction methods for multiple episodes of care was clearly superior in terms of incidence estimation, sensitivity, specificity and agreement with the linkage gold standard. However, it may be possible for different criteria to be applied to achieve different study objectives for certain types of hospitalised injuries.

Introduction

Injury prevention strategies rely on quality injury surveillance data to set priorities, evaluate the efforts of current countermeasures, and plan for future interventions (1). Amongst various surveillance systems, routinely collected hospital separation data provide extensive details of injury diagnoses relating to external causes based on a population-based case collection (2), which can be widely used to monitor the burden of injuries that require hospitalisation (3-6).

When estimating an injury incidence rate, researchers first need to identify cases in the context of specific study objectives, such as:

1) selecting cases with relevant external causes for evaluating healthcare costs and utilisation patterns (3);
2) selecting cases by reviewing all diagnoses in search of injury details to obtain a complete profile (4); or
3) selecting cases having an injury coded in the primary or principal diagnosis field (5).

Secondly, researchers need to identify all "new cases" (i.e., a single-count of hospitalisation resulted from an injury-event) as the numerator of corresponding incidence estimation. A data challenge arises in that an injured person may have multiple episodes of care in hospital for injuries from the same incident. Multiple episodes of care for a person-injury event may also occur for various reasons such as being transferred from a different hospital; a planned return for follow-up care or rehabilitation; subsequent admission for the original condition(s); or the onset of unexpected conditions or complications after discharge. As a consequence, the numerator may be inflated by simply counting episodes of care as the measure of "new cases" in hospital separation datasets (7).

At present, the majority of hospital separation datasets available to researchers consist of de-identified and unlinked episodes of care to monitor the health service delivery, rather than linked episodes of care. Without access to unique patient identifiers, some studies in the United States have used internal linkage methods to identify multiple admissions by matching routinely collected information such as month of discharge, date of birth, sex, and community of residence (8, 9). Unfortunately, however, a general lack of personal identifying details in many other hospital separation datasets makes linkage methods impractical. In the absence of such information, it is possible to develop solutions to correct miscounting from readily available variables that can give indications of multiple episodes of care for a single person-injury event (10, 11). For example, if the "mode of separation" for an episode of care in hospital A is recorded as a transfer to hospital B, and the "mode of separation" for the subsequent episode of care for the same person-injury event in hospital B is recorded as a discharge, then counting the episode in hospital B and removing the episode in hospital A would produce a correct count of this person-injury event. However, incidence estimates based on using different variables to reduce multiple counting for a person-injury event can differ markedly (10, 11). Therefore, care needs to be taken with the use of correction methods to obtain an accurate estimate of the true hospitalised injury burden.

This study aims to evaluate the validity of selected correction methods to exclude multiple episodes of care for an injury from de-identified hospital separation data, compared to results of linkage methods, focusing on injuries sustained to children aged (0-15 years) as a motor vehicle passenger in a traffic crash. In doing so, we hypothesize that

1) different "new case" selection criteria would produce different incidence estimates not only within the injury context of primary-diagnosis-based definition but also within injury contexts of either external-cause or all-diagnosis-based definitions; and

2) a differentiation in incidence estimates would also apply when examining the burden of different injury types such as fractures, head and abdominal injuries.

It was also considered possible that the analyses conducted to examine hypotheses 1) and 2) could show that the optimal "new case" selection criterion depends on injury context and/or type.

Methods

Data sources

In NSW, the state-wide Inpatient Statistics Collection (ISC) is a census of episodes of care from all public and private hospitals (12). Within unlinked ISC datasets, episodes of care were recorded without personal identifying details. To account for the multiple episodes of care, the ISC has also been linked to itself by the NSW Department of Health using probabilistic data linkage software. Variables use to match records include patient characteristics such as name, date of birth, sex, and residential address (12). For the same patient, after internal matching, a unique sequential identification number is allocated to all his/her episode records within the linked datasets. We used ISC internally linked datasets from 7/00-6/03 to identify multiple episodes of care for any given child identified by this unique number.

We also obtained 2001 end-of-year Australian Bureau of Statistics (ABS) derived annual age- and sex-specific NSW child (aged ≤15 years) population estimates for the period of 7/00-6/03, and 2001-census-derived Australian population estimates from ABS (12).

Study participants

Currently, there are more than one external causes recorded in both linked and unlinked ISC datasets. From the ISC linked datasets, we extracted complete records of NSW resident children aged ≤15 years with a first ICD-10-AM (edition 2 and 3) external cause in the range V40-V48 and V50-V58 (with a fourth digit of 6 or 9), V49.5, V49.6, V49.9, V59.5, V59.6

and V59.9, to identify cases hospitalised due to traffic crash as passengers of a car-design-based motor vehicle (13).

Injury context

Three case selections were made: set 1 consisted of records with a first external cause indicating a car passenger in a traffic accident, i.e. the complete sample; set 2 included those records with injury in at least one diagnosis field; and set 3 included records with injury as a primary diagnosis (set 3), respectively. Thus, there exists a hierarchical relationship amongst these three sets in our study: set 3 is a subset of set 2, which in turn is a subset of set 1. For sets 2 and 3, an injury diagnosis was defined as being in the range S00-S99, T00-T14, T20-T31, T79 or T89 according to the XIX part of ICD-10-AM (13). We also selected three specific types of injuries because of their significance in terms of their incidence and severity in child road trauma cases: head injury (S00-S09); abdominal injury (S30-S39); and fracture (S codes with third digit as 2, plus T02, T08, T10, T12, T14.2). Subsequent analyses on injury types were conducted within sets 2 and 3 only because set 1 context would produce the identical outputs to the other study sets.

Validity criteria

Incidence rate estimates and their percentage change compared with the gold standard (linkage methods) were calculated to measure the fluctuation in incidence magnitude. In addition, the sensitivity of identifying the “true” single-count episode of care, and the specificity of identifying “true” redundant episodes of care were calculated as in Table 1.

<Insert table 1 about here>

Potential criteria to eliminate miscounting of multiple episodes of care

To compare with the gold standard (linkage methods), we selected five variables included in both the ISC linked and unlinked ISC datasets that are potentially able to identify multiple episodes of care for the same injury (14). Corresponding correction methods were based on eliminating episodes of care that met the prescribed specifications [Table 2]. Because the coding for the "transfer from hospital" field does not distinguish between cases *that were transferred from an unknown hospital* and cases *that were not transferred from a hospital*, we assumed that when this field was empty the patient had not been transferred.

Combining methods of selecting cases will increase the specificity at a cost of sensitivity given a study subject must satisfy each component method (15), which would have benefits for studies focusing on injured population. Two-way combinations of these criteria were therefore also considered when identifying "new cases" and eliminating multiple episodes. The exception to this was for those between "separation mode", "source of referral" and "transfer from hospital" because they are logically linked in their definitions [Table 2].

<Insert Table 2 about here>

Statistical analysis

We used end-of-year population estimates by single year of age and sex derived from the Australian census to give the denominator in our rates. Directly age-standardised rates were calculated allowing by using the corresponding Australian population for 2001 as the standard population. All rates were expressed per 100,000 person-years for NSW resident children aged ≤15 years. For each case identification criterion, the sensitivity and specificity were calculated based on Table 1. Their corresponding 95% confidence intervals (CI) were calculated by the Agresti-Coull method (16). The SAS 9.1 package (SAS Institute, Cary, NC) was used to perform all data analyses (17).

Results

For the period 07/00-06/03, there were more episodes of care than corresponding children [Table 3], and so counting episodes without exclusion would result in an overestimation of injury incidence.

<Insert Table 3 about here>

Elimination of episodes of care with multiple admissions indicated by the “readmission” criterion best approximated the gold standard incidence rate in all sets and resulted in an underestimation of the incidence in set 3, but an overestimation in sets 1 and 2 [Table 4].

<Insert Table 4 about here>

With regard to selected injuries in set 2, the “readmission”-based criterion consistently performed the best in estimating the rate of hospitalised fractures, head and abdominal injuries, although it overestimated the hospitalisation rate for abdominal injuries but underestimated the hospitalisation rate for fractures and head injuries [Table 5]. Applying this criterion to exclude multiple counting of episodes of care was outperformed by the criterion of eliminating “non-urgent episodes” when approximating the fracture incidence in child road trauma cases in set 3 [Table 6].

<Insert table 5 about here>

<Insert table 6 about here>

The “emergency status” criterion consistently had the highest sensitivity for determining single-count episodes of care, but it was least able to screen out redundant episodes of care (i.e., it had the lowest specificity) [Tables 4, 5 and 6]. In every scenario, the “emergency status” variable in isolation overestimated the incidence rate whereas other criteria resulted in underestimation [Tables 4, 5 and 6]. The combination of “separation mode” and ‘readmission” variables consistently produced the highest specificity output in all scenarios, but at a cost of losing sensitivity [Tables 4, 5 and 6]. The criterion best approximating the “true” incidence rate estimates was generally associated with a loss in specificity, which indicated a multiple counting of redundant episodes of care into the rate numerator [Tables 4, 5 and 6].

Discussion

This study provides evidence that different case identification criteria influences hospitalised injury incidence estimates for NSW child motor vehicle passengers aged 0-15 years, which is consistent with studies focusing on overall injury surveillance (10) and fall-related injuries (11). The findings suggest it is inappropriate to select a single criterion for correcting multiple counting of episodes of care in de-identified hospital separation datasets to be applied in all studies. Although application of the “readmission within 28 days” criterion may best approximate the incidence rate derived from linkage methods, it had a low specificity and thus failed to exclude redundant episodes of care.

Although the application of the “readmission” criterion led to an underestimation when approximating the injurious falls incidence rate in older people (11), it resulted in a slight overestimation in our study. This difference may be because older people are more likely to have been hospitalized in the 28 days before an injury than children (18), noting that the definition of readmission does not require the readmission to be for the same condition as the original admission (14). This is assuming that this field is coded as YES even when the previous admission was for a different condition.

Although the “emergency status” criterion had the highest sensitivity, it had the lowest specificity. This high sensitivity is to be expected because it is likely that almost all first episodes of care will be emergencies, while the low specificity is probably due to a large proportion of subsequent episodes of care also being emergencies.

Although the “separation mode” criterion focused on the end-of-episode, it was consistently advantageous in terms of specificity but had sensitivity loss in some circumstances. This may be because “separation mode” is most related to injury definition. For example, for a case whose first hospitalisation ended with a transfer, this hospitalisation would be eliminated. If the subsequent episodes of care have follow-up care [non-injury ICD10 code falling outside Part XIX] in the primary diagnosis field, this episode would also be excluded in corresponding numerator counting in primary-diagnosis-based injury context even it ends with a discharge. Similarly, a study with a focus on an individual injury type may suffer over-correction (i.e. underestimation) if applying the “separation mode” criterion. For example, suppose a child was first hospitalised for injuries X and Y. During the first episode of care, injury X was cured whilst the accompanied injury Y required a transfer for further treatment (i.e., this episode of care ended as a transfer). Accordingly, injury X would not be recorded in the subsequent episode of care. Consequently, applying “separation mode” may recruit the last episode for injury Y but none for injury X.

Correctly counting one case ONLY for an injury event might be affected by the quality of the data. A large amount of missing and/or unspecified values in the external cause field may produce errors in incidence rate estimation, especially for those studies relying on external-cause selection as a foundation such as transport related injuries. For example, given an injured inpatient due to a traffic crash having two episodes of care:

1) case loss may occur assuming the missing external causes was associated with the first episodes only, because this case would not be identified if its first episode of care was eliminated due to missing external causes, and the subsequent episode of care was eliminated by applying variable-based multiple counting correction criteria with a focus on beginning of the episode (e.g., criterion based on “readmission within 28 days”, “source of referral”, “transfer from hospitals” or “emergency status”);
2) case loss may occur assuming the missing external causes was associated with the subsequent episode of care only, because this case would not be identified if the first episode of care ended as a transfer was eliminated by applying variable-based multiple counting correction criteria with a focus on ending of the episode (e.g., “separation mode”) and the subsequent episode was eliminated due to missing external causes;
3) case loss may occur assuming the missing external causes was associated with both episodes of care, because none would be identified when selecting targeted external causes.

Although previous studies have demonstrated a high completeness of external cause coding for injury in healthcare administrative databases (19, 20), more investigations into specific injury categories are required to see if specific selection criteria are needed.

Regarding the “gold standard” in our study, there was an undetermined number of missed links, that is two unlinked episodes from the same person-injury event. Additionally, we were unable to distinguish different injury events (i.e., two linked episodes from two injury events), which may have resulted in incorrect estimation of the real incidence rate of hospitalised child road trauma. Therefore, it is of considerable importance to introduce both a unique patient identifier (21) and date of injury fields (22) into routinely collected hospital data in order to enable multiple episodes of care for the same person-injury event to be distinguished in the future. However, for injuries occurring before the introduction of such fields, retrospective studies will need to continue to rely on the selection of correction methods to provide a true assessment of injury incidence.

In conclusion, we found no consistent advantage for a particular case identification criterion for eliminating multiple counting of episodes of care in de-identified hospital separation datasets. Excluding episodes indicating a “readmission” best approximated the hospitalised injury incidence rate for child road trauma, whereas excluding episodes with non-urgent status performed the best in recruiting true “new cases”. Different criteria for avoiding miscounting may be applied to different injuries, different populations, and different study designs, until unique personal identifiers and date of injury event fields are incorporated into hospital separation datasets.

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Table 1

Table 1: Case identification comparison between one multiple counting correction method and linkage method

		Case selection criterion		
		Single-count* episode	Redundant episode	Total
True status defined by linkage method	Single-count* episode	a†	b	n_0†
	Redundant episode	c	d	n_1
	Total	m_0‡	m_1	N§

Note:
Sensitivity=a/n_0
Specificity=d/n_1
* Single-count episode refers to either a first or a subsequent episode of care
† a and n_0 can be obtained by unique patient record number
‡ m_0 refers to total episodes of care obtained by applying the criterion
§ N refers to total episodes of care within a subset of injured cases

Table 2

Table 2. Criteria to eliminate multiple counting of episodes of care

Criteria	Expected exclusion of episodes of care
Linkage methods	those having a previously existing patient record number
Selected variable-based methods*	
(A) Separation mode	those indicating a transfer to another hospital or a statistical discharge (which occurs when an inpatient's status changes, for example, from an acute to a rehabilitation patient)
(B) Readmission within 28 days	those indicating being readmitted within 28 days of last being admitted to either the same or other facilities, for example, an unexpected surgical failure incurs an additional episode of care after a previous separation
(C) Source of referral	those indicating inpatients were admitted by referral from other hospitals or an internal statistical type change (similar to statistical discharge in "Separation mode")
(D) Transfer from hospitals	those indicating being transferred from any hospital
(E) Emergency status	those indicating either a non-emergency or planned admission

* Missing values were treated as no indication of multiple admissions. Within the external-cause-based set (set 1), there were no missing values for the "separation mode" and "referral source" variable fields, whilst 30 and 2 missing values were found in the "readmission" and "emergency status" fields, respectively.

Table 3

Table 3. Study participant sets derived from internally-linked NSW ISC datasets for child motor vehicle passengers aged 0-15 years in NSW, July 2000-June 2003. Age-standardised incidence rate and corresponding 95%CI also indicated.

Study participant set	Injuries	Number of children*	Number of episode a of care	Rate [†] (95%CI)
Set 1. External cause based	Total	1068	1220	24.96 (23.49-26.50)
Set 2. All-diagnoses based	Total	965	1113	22.57 (21.17-24.04)
	Head	485	555	11.32 (10.34-12.37)
	Abdominal	300	346	7.03 (6.25-7.87)
	Fracture	314	379	7.35 (6.56-8.21)
Set 3. Primary diagnosis based	Total	955	1085	22.33 (20.94-23.79)
	Head	367	415	8.56 (7.71-9.48)
	Abdominal	198	227	4.64 (4.01-5.33)
	Fracture	256	298	5.99 (5.28-6.77)

* Number of children was obtained by recognition of unique patient record number.

[†] Rates were calculated based on number of children and expressed as per 100,000 person-years.

Table 4

Table 4: Percentage change* in age standardised rate derived from the linkage method by various criteria when estimating incidence rate of hospitalised injuries for child vehicle passengers aged 0-15 year in NSW, July 2000 – June 2003. Incidence rate estimate, sensitivity †, specificity ‡, and corresponding 95% CI for each criterion also indicated.

criteria to identify "new" cases	Set 1. external causes based				Set 2. all diagnosis based				Set 3. primary diagnosis based			
	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)
No correction (simply counting episodes)	28.51	14.2	n/a	n/a	26.02	15.3	n/a	n/a	25.37	13.6	n/a	n/a
Correction options												
Linkage method	24.96	--	--	--	22.57	--	--	--	22.33	--	--	--
Separation mode (A)	24.45	-2.0	94.6(93.2-95.9)	76.9(70.3-83.5)	21.98	-2.6	93.9(92.4-95.4)	77.6(71.0-84.3)	21.38	-4.3	93.0(91.4-94.6)	80.6(73.9-87.3)
Readmission (B)	25.15	**0.8**	94.6(93.2-95.9)	57.7(49.9-65.4)	22.78	**0.9**	94.4(93.0-95.9)	58.6(50.7-66.4)	22.31	**-0.1**	94.6(93.2-96.0)	61.9(53.7-70.2)
Source of referral (C)	24.68	-1.1	94.0(92.6-95.5)	66.7(59.3-74.1)	22.24	-1.5	93.5(92.0-95.1)	67.8(60.3-75.2)	21.75	-2.6	93.5(92.0-95.1)	72.4(64.8-80.0)
Being transferred (D)	24.61	-1.4	94.0(92.6-95.5)	68.6(61.3-75.9)	22.17	-1.8	93.5(92.0-95.1)	69.7(62.4-77.0)	21.70	-2.8	93.5(92.0-95.1)	73.9(66.4-81.3)
Emergency status (E)	27.25	9.2	**97.4(96.4-98.3)**	19.2(13.1-25.4)	24.85	10.1	**97.5(96.5-98.5)**	19.7(13.4-26.1)	24.41	9.3	**97.6(96.6-98.6)**	16.4(10.2-22.7)
A AND B	21.46	-14.0	84.5(82.3-86.7)	**89.7(85.0-94.5)**	19.11	-15.3	83.3(80.9-85.6)	**90.8(86.2-95.4)**	18.69	-16.3	82.8(80.4-85.2)	**93.3(89.0-97.5)**
A AND E	23.32	-6.6	91.3(89.6-93.0)	85.3(79.7-90.8)	20.95	-7.2	90.7(88.9-92.5)	86.2(80.7-91.7)	20.56	-7.9	90.3(88.4-92.2)	87.3(81.7-93.0)
B AND C	23.72	-5.0	91.8(90.2-93.4)	77.6(71.0-84.1)	21.38	-5.3	91.4(89.7-93.2)	79.0(72.5-85.4)	20.98	-6.0	91.7(89.9-93.4)	83.6(77.3-89.9)
B AND D	23.68	-5.1	91.8(90.2-93.4)	78.9(72.4-85.3)	21.33	-5.5	91.4(89.7-93.2)	80.3(73.9-86.6)	20.95	-6.2	91.7(89.9-93.4)	84.3(78.2-90.5)
B AND E	24.43	-2.1	92.8(91.3-94.4)	65.4(57.9-72.9)	22.12	-2.0	92.8(91.2-94.4)	66.5(58.9-74.0)	21.75	-2.6	92.8(91.2-94.4)	67.2(59.2-75.1)
C AND E	23.77	-4.8	91.7(90.1-93.4)	75.6(68.9-82.4)	21.42	-5.1	91.3(89.6-93.1)	77.0(70.3-83.7)	21.05	-5.7	91.4(89.6-93.1)	79.1(72.2-86.0)
D AND E	23.72	-5.0	91.7(90.1-93.4)	76.9(70.3-83.5)	21.38	-5.3	91.3(89.6-93.1)	78.3(71.7-84.8)	21.00	-6.0	91.4(89.6-93.1)	80.6(73.9-87.3)

* Percentage change in rate = (rate by selection criteria – rate by linkage method)*100/rate by linkage method, and the smallest change in rate across different case identification criteria was highlighted in each study participant set respectively.

† The highest value in sensitivity across different case identification criteria in each study participant set is highlighted in bold.

‡ The highest value specificity across different case identification criteria in each study participant set is highlighted in bold.

Table 5

Table 5: Percentage change* in age standardised rate derived from the linkage method by various criteria when estimating incidence rate of selected hospitalised injuries for child vehicle passengers aged 0-15 year in NSW, July 2000 – June 2003. Incidence rate estimate, sensitivity †, specificity ‡, and corresponding 95% CI for each criterion also indicated.

Study participant set 2. All-diagnoses based												
	Head injuries				Abdominal injuries				Fractures			
criteria to identify "new" cases	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)
No correction (simply counting episodes)	12.95	14.4	n/a	n/a	8.10	15.2	n/a	n/a	8.87	20.7	n/a	n/a
Correction options												
Linkage method	11.32	--	--	--	7.03	--	--	--	7.35	--	--	--
Separation mode (A)	10.62	-6.2	90.6(88.0-93.2)	78.4(69.0-87.8)	6.51	-7.4	89.8(86.4-93.2)	82.0(71.4-92.7)	6.93	-5.7	89.3(85.9-92.7)	76.8(66.9-86.8)
Readmission (B)	11.23	**-0.8**	93.3(91.0-95.5)	60.8(49.7-71.9)	7.05	**0.3**	92.4(89.5-95.4)	52.0(38.2-65.9)	7.03	**-4.4**	87.7(84.1-91.3)	63.8(52.4-75.1)
Source of referral (C)	11.09	-2.0	93.7(91.5-95.8)	71.6(61.4-81.9)	6.70	-4.7	89.5(86.0-92.9)	64.0(50.7-77.3)	6.79	-7.6	85.5(81.7-89.4)	68.1(57.1-79.1)
Being transferred (D)	11.07	-2.2	93.7(91.5-95.8)	73.0(62.9-83.1)	6.68	-5.0	89.8(86.4-93.2)	68.0(55.1-80.9)	6.75	-8.2	85.5(81.7-89.4)	71.0(60.3-81.7)
Emergency status (E)	12.51	10.5	**97.6(96.2-98.9)**	14.9(6.8-23.0)	7.82	11.2	**97.7(96.0-99.4)**	18.0(7.4-28.7)	8.01	9.0	**93.4(90.7-96.1)**	29.0(18.3-39.7)
A AND B	9.08	-19.8	79.4(75.8-82.9)	**93.2(87.5-99.0)**	5.65	-19.6	79.0(74.4-83.5)	**90.0(81.7-98.3)**	5.34	-27.3	70.4(65.4-75.5)	**88.4(80.9-96.0)**
A AND E	10.25	-9.5	88.3(85.5-91.2)	85.1(77.0-93.2)	6.30	-10.4	87.2(83.4-90.9)	84.0(73.8-94.2)	6.16	-16.2	81.5(77.2-85.7)	**88.4(80.9-96.0)**
B AND C	10.57	-6.6	91.0(88.5-93.5)	83.8(75.4-92.2)	6.42	-8.7	87.5(83.8-91.2)	76.0(64.2-87.8)	6.32	-14.0	81.1(76.8-85.4)	76.8(66.9-86.8)
B AND D	10.57	-6.6	91.0(88.5-93.5)	83.8(75.4-92.2)	6.42	-8.7	87.8(84.2-91.5)	78.0(66.5-89.5)	6.28	-14.6	81.1(76.8-85.4)	79.7(70.2-89.2)
B AND E	10.97	-3.1	92.0(89.6-94.4)	67.6(56.9-78.2)	6.98	-0.7	92.1(89.1-95.1)	56.0(42.2-69.8)	6.51	-11.4	83.3(79.2-87.4)	75.4(65.2-85.5)
C AND E	10.76	-4.9	91.8(89.4-94.3)	78.4(69.0-87.8)	6.63	-5.7	89.1(85.6-92.6)	68.0(55.1-80.9)	6.21	-15.5	80.5(76.2-84.9)	81.2(71.9-90.4)
D AND E	10.74	-5.1	91.8(89.4-94.3)	79.7(70.6-88.9)	6.63	-5.7	89.5(86.0-92.9)	70.0(57.3-82.7)	6.18	-15.9	80.5(76.2-84.9)	82.6(73.7-91.6)

* Percentage change in rate = (rate by selection criteria - rate by linkage method)*100/rate by linkage method, and the smallest change in rate across different case identification criteria was highlighted in each study participant set respectively.

† The highest value in sensitivity across different case identification criteria in each study participant set is highlighted in bold..

‡ The highest value specificity across different case identification criteria in each study participant set is highlighted in bold..

§ Analysis of particular injuries in set 1 would have yielded identical results to analysis of set 2 and 3, respectively, because of the need to select cases on the basis of injury diagnosis.

Table 6

Table 6: Percentage change* in age standardised rate derived from the linkage method by various criteria when estimating incidence rate of selected hospitalised injuries for child vehicle passengers aged 0-15 year in NSW, July 2000 – June 2003. Incidence rate estimate, sensitivity †, specificity ‡, and corresponding 95% CI for each criterion also indicated.

Study participant set 3. Primary-diagnosis based

criteria to identify "new" cases	Head injuries				Abdominal injuries				Fractures			
	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)	Incidence rate estimate	change in rate (%)	Sensitivity (%)	Specificity (%)
No correction (simply counting episodes)	9.68	13.1	n/a	n/a	5.32	14.7	n/a	n/a	6.98	16.5	n/a	n/a
Correction options												
Linkage method	8.56	--	--	--	4.64	--	--	--	5.99	--	--	--
Separation mode (A)	8.05	-6.0	91.4(88.5-94.2)	80.8(70.1-91.5)	4.22	-9.1	88.1(83.7-92.6)	81.8(68.7-95.0)	5.55	-7.3	89.2(85.5-93.0)	80.4(69.0-91.9)
Readmission (B)	8.37	**-2.2**	93.3(90.7-95.8)	67.3(54.6-80.1)	4.52	**-2.6**	90.6(86.6-94.6)	57.6(40.7-74.4)	5.55	-7.3	86.5(82.4-90.7)	65.2(51.5-79.0)
Source of referral (C)	8.35	-2.5	93.8(91.4-96.3)	73.1(61.0-85.1)	4.26	-8.2	87.1(82.5-91.8)	69.7(54.0-85.4)	5.29	-11.7	83.5(78.9-88.0)	71.7(58.7-84.8)
Being transferred (D)	8.33	-2.7	93.8(91.4-96.3)	75.0(63.2-86.8)	4.26	-8.2	87.1(82.5-91.8)	69.7(54.0-85.4)	5.25	-12.4	83.1(78.5-87.6)	73.9(61.2-86.6)
Emergency status (E)	9.45	10.4	**97.8(96.4-99.3)**	11.5(2.9-20.2)	5.11	10.1	**97.5(95.4-99.7)**	24.2(9.6-38.9)	6.34	**5.8**	**91.5(88.2-94.9)**	19.6(8.1-31.0)
A AND B	6.88	-19.6	79.8(75.7-83.9)	**94.2(87.9-101)**	3.58	-22.8	75.7(69.8-81.7)	**87.9(76.7-99.0)**	4.33	-27.7	70.8(65.2-76.3)	**89.1(80.1-98.1)**
A AND E	7.82	-8.6	89.5(86.4-92.6)	86.5(77.3-95.8)	4.05	-12.7	85.2(80.3-90.1)	84.9(72.6-97.1)	4.99	-16.7	81.2(76.4-85.9)	87.0(77.2-96.7)
B AND C	7.98	-6.8	91.4(88.5-94.2)	86.5(77.3-95.8)	4.03	-13.1	84.2(79.1-89.2)	81.8(68.7-95.0)	5.04	-15.9	80.4(75.6-85.2)	78.3(66.3-90.2)
B AND D	7.98	-6.8	91.4(88.5-94.2)	86.5(77.3-95.8)	4.03	-13.1	84.2(79.1-89.2)	81.8(68.7-95.0)	4.99	-16.7	80.0(75.1-84.9)	80.4(69.0-91.9)
B AND E	8.21	-4.1	91.9(89.1-94.7)	71.2(58.8-83.5)	4.47	-3.7	90.1(86.0-94.2)	60.6(43.9-77.3)	5.15	-14.0	81.2(76.4-85.9)	71.7(58.7-84.8)
C AND E	8.14	-4.9	92.2(89.5-94.9)	78.9(67.8-90.0)	4.22	-9.1	86.6(81.9-91.3)	72.7(57.5-87.9)	4.87	-18.7	78.1(73.1-83.1)	80.4(69.0-91.9)
D AND E	8.12	-5.1	92.2(89.5-94.9)	80.8(70.1-91.5)	4.22	-9.1	86.6(81.9-91.3)	72.7(57.5-87.9)	4.83	-19.4	77.7(72.6-82.8)	82.6(71.7-93.6)

* Percentage change in rate = (rate by selection criteria - rate by linkage method)*100/rate by linkage method, and the smallest change in rate across different case identification criteria was highlighted in each study participant set respectively.

† The highest value in sensitivity across different case identification criteria in each study participant set is highlighted in bold..

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§ Analysis of particular injuries in set 1 would have yielded identical results to analysis of set 2 and 3, respectively, because of the need to select cases on the basis of injury diagnosis.