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Comparing Physical Assessment to Administrative Data for Detecting Pressure Ulcers in a Large Academic Health Sciences Centre

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Comparing Physical Assessment to Administrative Data for Detecting Pressure Ulcers in a Large Academic Health Sciences Centre

ABSTRACT

Objective: This study aims to compare the accuracy of two different data collection and reporting methods used for pressure ulcers and to make recommendations for future practice and research.

Setting: A retrospective analysis of pooled cross-sectional samples of inpatients assessed across three consecutive prevalence surveys in a large academic health sciences centre between 2012 and 2013.

Participants: There were 2,001 patients for whom physical and chart assessments were completed, and for whom a discharge abstract was also available at the time of analysis. The cohort's mean age was 65.1 years and 54.9% were female.

Results: Based on the physical assessment findings, 17.2% of patients (n=345) had a pressure ulcer (stage I = 162 (8.1%); stage II = 120 (6%); stage III = 22 (1.1%); stage IV = 22 (1.1%); and unstageable = 19 (0.09%). Based on coded information, 78 (3.9%) of patients had a pressure ulcer. Of patients with a pressure ulcer determined by the physical assessment, only 21% also had a pressure ulcer captured in the administrative data. Furthermore, only 6% of the patients with a hospital-acquired pressure ulcer, stage II or greater determined by the physical assessment were coded in the Discharge Abstract Database (DAD).

Conclusions: The results of this study demonstrate that coding in the DAD may underreport and fail to accurately reflect the true burden of pressure ulcers in hospitalized patients. This may occur because the presence of pressure ulcers is currently documented in the health record by nurses and not by physicians, yet the administrative data recorded in the DAD only includes

physician documented pressure ulcers. We recommend enhancements to the coding methods to monitor and report on pressure ulcers.

Strengths and limitations of this study

- We studied a large number of patients in a large academic health sciences centre using the physical assessment as the gold standard comparator. There are no other similar studies of this important problem.
- We compared any pressure ulcer observed on prevalence day to any pressure ulcer documented in the administrative data.
- We compared two different types of prevalence estimates: cross-sectional and period prevalence. Due to the nature of each type of prevalence estimate, the sample population may have been different between each group with longer stay patients being over represented in the cross-sectional prevalence.

INTRODUCTION

Pressure ulcers are a significant issue among hospitalized patients worldwide. In the Canadian context the estimated prevalence ranges from 23.9% to 29.7% among acute care patients.[1] Avoiding skin breakdown and the development of pressure ulcers is a recognized priority for ensuring quality of care and potential cost savings.[2] According to the National Pressure Ulcer Advisory Panel (NPUAP), the cost of caring for pressure ulcers has been estimated at over US $11 billion per year. Since pressure ulcers are for the most part preventable, there is a need to identify at-risk populations and to target early intervention strategies. Despite an increased awareness surrounding the burden of pressure ulcers and the importance of prevention and treatment, there is a lack of accurate population-based methods to detect and monitor pressure ulcer rates. This creates challenges for the measurement of outcomes following efforts to prevent and reduce pressure ulcers over time.

Administrative data are one source for estimating pressure ulcer incidence and prevalence. Each inpatient hospital encounter is summarized upon discharge through abstracts submitted to the Discharge Abstract Database (DAD), based on the Coding Standards for the International Classification for Diseases and Related Health Problems, Tenth Revision (ICD-10). Each diagnosis recorded in the DAD must be coded according to ICD-10, and assigned a Diagnosis Type Code, representing the influence of the condition on the patient's treatment.[3] According to these standards, diagnosis code and diagnosis type are taken directly from the physician documentation. DAD coding and diagnosis typing may also be sought from the documentation of other health care professionals, but only if they have been designated with primary responsibility for the patient's care.[3] Further complicating the coding is the fact that the

staging system used for coding in the DAD differs from the NPUAP guidelines,[4] which are followed by health care professionals.

Due to the potential variation in documentation practices between health care professionals and the provider specifications in the coding guidelines, we hypothesized that the current estimates of pressure ulcers based on these administrative codes likely do not accurately reflect the true burden of this condition.[5] If the information in the DAD does not accurately capture the pressure ulcers, this can have a significant impact on health care policy, that often relies on statistical information from these types of electronic sources. Therefore, the overall aim of this study was to compare classification of pressure ulcers from the DAD with a gold standard assessment, specifically, pressure ulcers confirmed by an independent physical assessment performed by trained nurse surveyors.

METHODS

Study design and setting

This study involved a retrospective analysis of pooled cross-sectional samples of inpatients at a Canadian academic health sciences centre with more than 1,127 inpatient beds. We received Research Ethics Board approval to use these data for research purposes.

Participants

All patients who were admitted and assessed on one of three consecutive prevalence survey days between 2012 and 2013 were included. Each prevalence survey consisted of a one-day cross-sectional survey where nurse surveyors collected data from inpatients' health records (i.e., a chart assessment) and performed a physical assessment of all inpatients to identify patients at risk of developing pressure ulcers, to determine the presence of pressure ulcers, and to assess

health providers' adherence to the hospital's policies and programs. The number of pressure ulcers, their location, and their severity 'stage' (according to the NPUAP definitions that were in effect during the study periods) were recorded for each patient. These were further classified as 'developed in hospital' or 'present on admission', based on the results of the chart assessment. Recently, Backman and colleagues[6] designed a technology-based data collection tool to decrease resource requirements and to obtain more timely data that was employed for the included surveys. There have been similar prevalence surveys conducted since 1993 to provide information on the presence and severity of pressure ulcers, among other conditions. For purposes of this analysis, we used the data from 2012 and 2013 because the data from these two years were available electronically.

The case selection process is described in **Figure 1.** We pooled data from patients that were present on one of the three consecutive prevalence days (April 25, 2012, November 21, 2012, and April 25, 2013). A small number of patients did not undergo a physical or chart assessment for various reasons (e.g., patient was receiving a procedure at the time of the prevalence survey or the patient's chart was not available at the time of survey). We excluded these patients. If a patient was in the hospital on more than one prevalence survey day, or if a patient's discharge abstract was not available at the time of analysis (i.e., where a patient was still in hospital, or the discharge abstract was not complete) they were also excluded. Each of the included patient encounters was also summarized in an abstract that was submitted to the DAD and that included a diagnostic code (ICD-10 classification) and a diagnostic type (e.g., M: most responsible diagnosis; Type 1: pre-admission comorbidity; Type 2: post-admission comorbidity).[3]

Analysis

To assess the accuracy of administrative data in identifying pressure ulcers among patients discharged from hospital, we compared pressure ulcer cases identified in the DAD against the reference standard of 'nurse-confirmed' pressure ulcers that were assessed and documented on one of the three prevalence days. The analysis was divided into three parts. First, we compared patients with any pressure ulcer identified on prevalence day to any pressure ulcer coded in the corresponding DAD records (ICD-10 codes: L89-L89.9). Second, we narrowed the analyses to patients with a pressure ulcer that developed after admission only, compared to pressure ulcers coded as a Type 2 diagnosis in the DAD record (i.e., post-admission comorbidity). Third, we further limited the comparison to patients with a stage II pressure ulcer developed in hospital against pressure ulcers coded as Type 2 diagnoses in the corresponding DAD records. Stage I pressure ulcers may not be recognized nor documented as frequently as more severe stages of the condition,[7;8] and therefore we expected higher agreement between the prevalence data and the DAD when we limited the analyses to stage II pressure ulcers and above. The data analysis for this study was generated using SAS software, Version 9.3. Copyright © 2011 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

RESULTS

Across three consecutive prevalence days, there were 2,001 patients for whom physical and chart assessments were completed, and for whom a discharge abstract was also available at the time of analysis **(Figure 1).** The cohort's mean age was 65.1 years and 54.9% were female. The cohort is described further in **Table 1.** Based on the physical assessment findings, 17.2% of patients (n=345) had a pressure ulcer (stage I = 162 (8.1%); stage II = 120 (6%); stage III = 22

(1.1%); stage IV = 22 (1.1%); and unstageable = 19 (0.09%) compared with the results from the coded information that showed only 78 (3.9%) of patients having a pressure ulcer. **Table 2a** provides the prevalence of pressure ulcers, by severity and origin (in hospital or on admission) among the prevalence sample and **Table 2b** provides the prevalence of pressure ulcers, by severity and diagnostic type, as coded in the DAD.

Among patients who were assessed on prevalence day and also had DAD data available, 292 had at least one pressure ulcer identified on prevalence day **(Table 3)**. Of these nurse-confirmed cases, only 21% were captured in the administrative data; however, only a small percentage (1%) of patients with a pressure ulcer coded in the DAD did not have a pressure ulcer on prevalence day (either not present or not observed).

The agreement between the two sources decreased when we limited the sample to patients who developed a pressure ulcer after admission **(Table 4)**. Only 4% of the patients with a pressure ulcer that developed in hospital were also coded in DAD as a Type 2 diagnosis. Furthermore, only 6% of the patients with at least one pressure ulcer stage II or greater that developed in hospital and was observed through physical assessment were also coded in DAD **(Table 5)**. Kappa observer agreement calculations identified very little agreement between the two tests.

DISCUSSION

The results of this study suggest that a large proportion of pressure ulcers may not be captured in the administrative data that are routinely collected to summarize a patient's stay in hospital. This is consistent with a recent study by Meddings et al.[5] that found that administrative data was a poor indicator of pressure ulcer performance in a large sample of California hospitals,

compared to pressure ulcers detected through surveillance. The inconsistencies identified by the authors highlight why pressure ulcer rates from administrative data are underreported and are unlikely suitable for performance benchmarking efforts. These shortcomings in the administrative data are, in part, related to poor pressure ulcer documentation practices in the patient record. In Sweden, Gunningberg and colleagues found that paper-based pressure ulcer documentation was poor,[7] but that documentation improved with the implementation of an electronic health record.[9] In the U.S., Dahlstrom and colleagues found an opposite effect with respect to the completeness of documentation, when documentation was moved to an electronic system; however, this trend subsequently reversed for nurses, but not among physicians.[10]

A potential explanation for the differences observed between the prevalence survey data and the DAD relates to who was documenting the pressure ulcer. This is largely due to the fact that pressure ulcers are routinely documented by nurses and not by physicians. In the United States, Arora and colleagues observed that the rate of pressure ulcer risk assessment among nurses was 100%, compared to just under 3% among physicians, and that physicians documented fewer than one out of every two pressure ulcers identified by nurses.[11] In a related study, following a campaign to improve pressure ulcer documentation, researchers observed that nurses documented almost all pressure ulcers (96.7%) compared to significantly fewer documented by physicians (70.6%). This difference increased when the researchers considered "complete" documentation, only (46.2% and 15.2% among nurses and physicians, respectively).[10] Therefore, if nurse documentation is not being considered when pressure ulcers are being coded, then the administrative data are likely missing a large proportion of these cases.

A few limitations should be considered when interpreting this study's results. The main limitation is that we compared any pressure ulcer observed on prevalence day to any pressure

ulcer documented in the administrative data. Therefore, it is possible that we recorded agreement between the two sources where, in reality, the pressure ulcers were mutually exclusive.

A related limitation is that we compared two different types of prevalence estimates: cross-sectional and period prevalence. In general, cross-sectional prevalence studies are limited because they represent a single point in time. When patients are sampled in this way, those who are in hospital longer are more likely to be sampled during the course of their stay than those with a shorter length of stay. Therefore, if a condition being studied is related to a longer length of stay, patients with this condition will be overrepresented in a cross-sectional sample.[12] Given that pressure ulcers are an example of a condition that can extend a patient's length of stay,[13;14] and where a longer length of stay can also increase the risk of developing the condition,[2] the prevalence of pressure ulcers measured on each prevalence day is likely to overestimate the prevalence of this condition. Further, if pressure ulcer severity is associated with additional increases in the length of stay, then a higher proportion of severe cases would likely be observed on a prevalence day. Then, if severe pressure ulcers are documented more often,[7;8] the correlation between the administrative data and observed pressure ulcers would also appear to be higher.

Our results should be considered in further iterations of the standards used to code pressure ulcers. In its current state, the Coding Standards for the International Classification for Diseases and Related Health Problems, Tenth Revision (ICD-10) mandate that diagnosis and diagnosis type are taken directly from the physician documentation. Further investigation regarding how DAD coding and diagnosis typing for pressure ulcers can be more reflective of documentation by other health care professionals should be considered. Agreement on a common staging system for coding that aligns with the National Pressure Ulcer Advisory Panel (NPUAP)

guidelines would likely also improve the quality of the documentation. Further research is needed to understand if nursing documentation can improve the accuracy of pressure ulcer reporting and to design targeted quality improvement work.

CONCLUSION

The results of this study demonstrate that coding in the DAD may not accurately reflect the burden of hospital-acquired pressure ulcers. We recommend enhancements to the coding methods used to monitor and report on pressure ulcers by standardizing the staging system used, and by considering the use of documented pressure ulcers by other health care professionals. With good benchmarking data, organizations will ultimately be able to design quality improvement strategies to prevent the development of hospital-acquired pressure ulcers and accurately evaluate the impact of the strategies.

Figure 1 – Derivation of study cohort

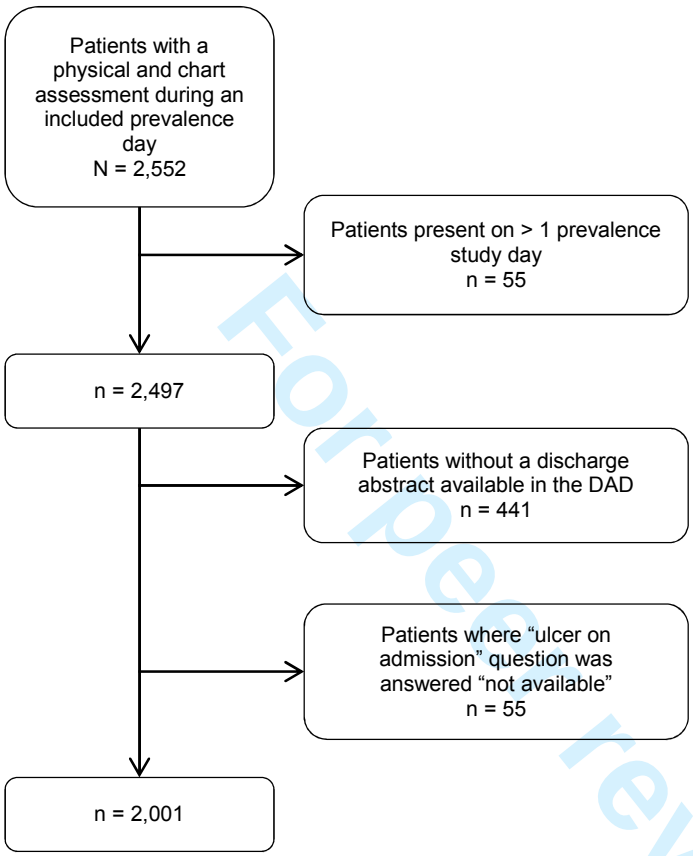

Table 1 – Description of the cohort

Characteristics		N = 2,001
Age	Mean ± SD	65.14 ± 18.62
	Median (IQR)	68 (53-80)
Gender	F	1099 (54.9%)
	M	902 (45.1%)
Department	Medicine	897 (44.8%)
	Surgery	744 (37.2%)
	Other	122 (6.1%)
	Ob/Gyn/Newborn Care	120 (6.0%)
	Family Practice	118 (5.9%)
Elixhauser Score	Mean ± SD	4.89 ± 6.42
	Median (IQR)	3 (0-8)
LOS	Mean ± SD	30.08 ± 48.32
	Median (IQR)	15 (6-31)
LOS (Acute)	Mean ± SD	19.65 ± 29.08
	Median (IQR)	12 (6-23)

Table 2a – Pooled data from three consecutive prevalence surveys

Patients Assessed	N=2,001
Pressure ulcers	345 (17.2%)
Patients with ulcers stage II or greater	183 (9.1%)
Patients who developed ulcer while in hospital	201 (10.0%)
Patients with ulcer documented on admission	144 (7.2%)

Table 2b – DAD records corresponding to patients observed on one of three consecutive prevalence surveys

Records Assessed	N= 2,001
Number of patients with at least one diagnosis code for a pressure ulcer (L89-L89.9)	78 (3.9%)
Diagnosis Code (L89.1 or greater) (i.e. Stage II pressure ulcer or greater)	71 (3.5%)

Patient with ulcer developed while in hospital (Diagnosis Type 2 only)	16 (0.8%)
Patient with ulcer on admission (Diagnosis Types M, 1 only)	50 (2.5%)

Table 3 – Patients with a pressure ulcer present upon physical assessment, compared to patients with a pressure ulcer coded in the Discharge Abstract Database

		Ulcer on assessment		
Any ICD-10 Pressure Ulcer code		Yes	No	Total
	Yes	61 (20.9%)	17 (1.0%)	78
	No	231 (79.1%)	1,692 (99.0%)	1,923
	Total	292	1,709	2,001

Sensitivity (Sn) = 61/292 = 0.21
Specificity (Sp) = 1692/1709 = 0.99
Positive Predictive Value (PPV) = 61/78 = 0.78
Negative Predictive Value (NPV) = 1692/1923 = 0.88
Kappa = 0.29

Table 4 – Patients who developed a pressure ulcer while in hospital, compared to patients with a Type 2 pressure ulcer coded in the Discharge Abstract Database

		Pressure ulcer developed while in hospital		
Any ICD-10 Type 2 Pressure Ulcer code		Yes	No	Total
	Yes	8 (4.0%)	8 (0.4%)	16
	No	193 (96.0%)	1,792 (99.6%)	1,985
	Total	201	1,800	2,001

Sensitivity (Sn) = 8/201 = 0.04
Specificity (Sp) = 1792/1800 = 1.00
Positive Predictive Value (PPV) = 8/16 = 0.50
Negative Predictive Value (NPV) = 1792/1985= 0.90
Kappa = 0.06

Table 5 - Patients who developed a stage II or greater pressure ulcer while in hospital, compared to patients with a Type 2 pressure ulcer coded in the Discharge Abstract Database

		Pressure ulcer stage II or greater developed while in hospital		
Any ICD-10 Type 2 Pressure Ulcer code		Yes	No	Total
	Yes	6 (6.7%)	10 (0.5%)	16
	No	83 (93.3%)	1,902 (99.5%)	1,985
	Total	89	1,912	2,001

Sensitivity (Sn) = 6/89 = 0.07
Specificity (Sp) = 1902/1912 = 0.99
Positive Predictive Value (PPV) = 6/16 = 0.38
Negative Predictive Value (NPV) = 1902/1985 = 0.96
Kappa = 0.10

Contributorship statement

CB designed the project, performed data acquisition, analysis and interpretation. She also drafted the article. SV participated in project design, data acquisition and interpretation of data. She also critically appraised and edited the manuscript. TBM and LF participated in interpretation of data and critical appraisal of the manuscript. AJF designed the project, performed data acquisition, analysis and interpretation. He also critically appraised and revised the manuscript.

Competing interests

There are no competing interests.

Funding

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Data sharing statement

There are no additional unpublished data from the study.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	*p.1*
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	*p.1*
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	*p.3*
Objectives	3	State specific objectives, including any prespecified hypotheses	*p.4*
Methods			
Study design	4	Present key elements of study design early in the paper	*p.4*
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	*p.4*
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	*p.4*
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	*p.5*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*p.5*
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*p.5*
Bias	9	Describe any efforts to address potential sources of bias	*p.5*
Study size	10	Explain how the study size was arrived at	*p.5*
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	*p.6*
Statistical methods	12	(*a*) Describe all statistical methods	*p.6*
		(*b*) Describe any methods used to examine subgroups and interactions	*p.6*
		(*c*) Explain how missing data were addressed	*p.6*
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	Tables 2-5

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	*p.6*
		(b) Give reasons for non-participation at each stage	*p.6*
		(c) Consider use of a flow diagram	*p.6*
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	*p.6*
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	n/a
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	*p.7*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	*p.7*
Discussion			
Key results	18	Summarise key results with reference to study objectives	*p.7*
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	*p.8*
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	*p.8*
Generalisability	21	Discuss the generalisability (external validity) of the study results	*p.9*
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

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ABSTRACT

Objective: This study aimed to compare classification of pressure ulcers from administrative data with a gold standard assessment, specifically; pressure ulcers confirmed by an independent physical assessment performed by trained nurse surveyors.

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Participants: There were 2,001 patients for whom physical and chart assessments were completed, and for whom a discharge abstract was also available at the time of analysis. The cohort's mean age was 65 years and 55% were female.

Results: Based on the physical assessment findings, 14.6% of patients (n=292) had at least one pressure ulcer, with a total of 345 pressure ulcers documented among these patients: (stage I = 162; stage II = 120; stage III = 22; stage IV = 22; and unstageable = 19). Based on coded information, 78 (3.9%) of patients had a pressure ulcer. Of patients with a pressure ulcer determined by the physical assessment, only 21% also had a pressure ulcer captured in the administrative data. Furthermore, only 6% of the patients with a hospital-acquired pressure ulcer, stage II or greater determined by the physical assessment were coded in the Discharge Abstract Database (DAD).

Conclusions: The results of this study demonstrate that coding in the DAD may underreport and fail to accurately reflect the true burden of pressure ulcers in hospitalized patients. This may occur because the presence of pressure ulcers is currently documented in the health record by nurses and not by physicians, yet the administrative data recorded in the DAD only includes

physician documented pressure ulcers. We recommend enhancements to the coding methods to monitor and report on pressure ulcers.

Strengths and limitations of this study

- We studied a large number of patients in a large academic health sciences centre using the physical assessment as the gold standard comparator. There are no other similar studies of this important problem.
- We compared any pressure ulcer observed on prevalence day to any pressure ulcer documented in the administrative data.
- We compared two different types of prevalence estimates: cross-sectional and period prevalence. Due to the nature of each type of prevalence estimate, the sample population may have been different between each group with longer stay patients being over represented in the cross-sectional prevalence.

INTRODUCTION

Pressure ulcers are a significant issue among hospitalized patients worldwide. In the Canadian context the estimated prevalence ranges from 23.9% to 29.7% among acute care patients.[1] Avoiding skin breakdown and the development of pressure ulcers is a recognized priority for ensuring quality of care and potential cost savings.[2] According to the U.S.-based National Pressure Ulcer Advisory Panel (NPUAP), the cost of caring for pressure ulcers has been estimated at over U.S. $11 billion per year. Since pressure ulcers are for the most part preventable, there is a need to identify at-risk populations and to target early intervention strategies. Despite an increased awareness surrounding the burden of pressure ulcers and the importance of prevention and treatment, there is a lack of accurate population-based methods to detect and monitor pressure ulcer rates. This creates challenges for the measurement of outcomes following efforts to prevent and reduce pressure ulcers over time.

Administrative data are one source for estimating pressure ulcer incidence and prevalence. Each inpatient hospital encounter is summarized upon discharge through abstracts submitted to the Discharge Abstract Database (DAD), based on the Coding Standards for the International Classification for Diseases and Related Health Problems, Tenth Revision (ICD-10). Each diagnosis recorded in the DAD must be coded according to ICD-10, and assigned a Diagnosis Type Code, representing the influence of the condition on the patient's treatment.[3] According to these standards, diagnosis code and diagnosis type are taken directly from the physician documentation. DAD coding and diagnosis typing may also be sought from the documentation of other health care professionals, but only if they have been designated with primary responsibility for the patient's care.[3] Further complicating the coding is the fact that the

staging system used for coding in the DAD may differ from the NPUAP staging guidelines that are followed by the majority of nurses and other health care professionals in Canada.[4]

Due to the potential variation in documentation practices between health care professionals and the provider specifications in the coding guidelines, we hypothesized that the current estimates of pressure ulcers based on these administrative codes likely do not accurately reflect the true burden of this condition.[5] If the information in the DAD does not accurately capture the pressure ulcers, this can have a significant impact on health care policy, that often relies on statistical information from these types of electronic sources. Therefore, the overall aim of this study was to compare classification of pressure ulcers from the DAD with a gold standard assessment, specifically, pressure ulcers confirmed by an independent physical assessment performed by trained nurse surveyors.

METHODS

Study design and setting

This study involved a retrospective analysis of pooled cross-sectional samples of inpatients at a Canadian academic health sciences centre with more than 1,127 inpatient beds. We received Research Ethics Board approval to use these data for research purposes.

Participants

All patients who were admitted and assessed on one of three consecutive prevalence survey days between 2012 and 2013 were included. Each prevalence survey consisted of a one-day cross-sectional survey where nurse surveyors collected data from inpatients' health records (i.e., a chart assessment) and performed a physical assessment of all inpatients. The content of the survey was selected to identify patients at risk of developing pressure ulcers, to determine the

presence of pressure ulcers, and to assess health providers' adherence to the hospital's policies and programs. The number of pressure ulcers, their location, and their severity 'stage' (according to the NPUAP definitions that were in effect during the study periods) were recorded for each patient. These were further classified as 'developed in hospital' or 'present on admission', based on the results of the chart assessment. All surveyors received standard training on staging pressure ulcers. On the survey day Enterostomal Therapy Nurses, specialists in wound care, were also available to help with staging pressure ulcers if needed. There has been similar prevalence surveys conducted since 1993 to provide information on the presence and severity of pressure ulcers, among other conditions. For purposes of this analysis, we used the data from 2012 and 2013 because the data from these two years were available electronically.[6]

The case selection process is described in **Figure 1.** We pooled data from patients that were present on one of the three consecutive prevalence days (April 25, 2012, November 21, 2012, and April 25, 2013). A small number of patients did not undergo a physical or chart assessment for various reasons (e.g., patient was receiving a procedure at the time of the prevalence survey or the patient's chart was not available at the time of survey). We excluded these patients. If a patient was in the hospital on more than one prevalence survey day, or if a patient's discharge abstract was not available at the time of analysis (i.e., where a patient was still in hospital, or the discharge abstract was not complete) they were also excluded. Each of the included patient encounters was also summarized in an abstract that was submitted to the DAD and that included a diagnostic code (ICD-10 classification) and a diagnostic type (e.g., M: most responsible diagnosis; Type 1: pre-admission comorbidity; Type 2: post-admission comorbidity).[3]

Analysis

To assess the accuracy of administrative data in identifying pressure ulcers among patients discharged from hospital, we compared pressure ulcer cases identified in the DAD against 'nurse-confirmed' pressure ulcers that were assessed and documented on one of the three prevalence days. The analysis was divided into three parts. First, we compared patients with any pressure ulcer identified on prevalence day to any pressure ulcer coded in the corresponding DAD records (ICD-10 codes: L89-L89.9). Second, we narrowed the analyses to patients with a pressure ulcer that developed after admission only, compared to pressure ulcers coded as a Type 2 diagnosis in the DAD record (i.e., post-admission comorbidity). Third, we further limited the comparison to patients with a stage II pressure ulcer developed in hospital against pressure ulcers coded as Type 2 diagnoses in the corresponding DAD records. Stage I pressure ulcers may not be recognized nor documented as frequently as more severe stages of the condition,[7;8] and therefore we expected higher agreement between the prevalence data and the DAD when we limited the analyses to stage II pressure ulcers and above.

We calculated the Sensitivity (Sn), Specificity (Sp), Positive Predictive Value (PPV) and Negative Predictive Value (NPV) for each of the comparisons, using the nurse-confirmed physical assessment as the "gold standard". We also calculated the kappa statistic and 95% confidence intervals (CI) to account for the level of agreement due to chance, where a kappa of 1.0 would indicate perfect agreement and a kappa of 0.0 would indicate agreement based on chance alone.[9] We described the study population using basic demographic variables and clinical characteristics. We also calculated the Elixhauser Comorbidity Score developed by van Walraven and colleagues[10] to summarize the comorbidity in this patient sample.

The data analysis for this study was generated using SAS software, Version 9.3.

RESULTS

Across three consecutive prevalence days, there were 2,001 patients for whom physical and chart assessments were completed, and for whom a discharge abstract was also available at the time of analysis **(Figure 1).** The cohort's mean age was 65 years and 55% were female. The cohort is described further in **Table 1.**

Table 1. Description of the cohort

Total patients	**N=2,001**	*
Age (years)		
Mean	65.1	± 18.6
Median	68	(53-80)
Gender		
F	1,099	(54.9)
M	902	(45.1)
Department		
Medicine	897	(44.8)
Surgery	744	(37.2)
Other	122	(6.1)
Obs/Gyn/Newborn Care	120	(6.0)
Family Practice	118	(5.9)
Elixhauser Score		
Mean	4.9	± 6.4
Median	3	(0-8)
Total LOS (days)†		
Mean	30.1	± 48.3
Median	15	(6-31)
Acute LOS (days) †		
Mean	19.7	± 29.1
Median	12	(6-23)

* Categorical characteristics are presented with percentages;
Continuous characteristics are presented with the Mean ± Standard Deviation and Median (Interquartile Range);

† LOS = Length of stay; Acute LOS = [Total LOS] – [Days spent in "Alternate Level of Care" (ALC) status]. ALC patients are those who no longer require acute care services and are waiting to be discharged to a suitable care setting in the community.

Based on the physical assessment findings, 14.6% of patients (n=292) had at least one pressure ulcer, with a total of 345 pressure ulcers documented among these patients: stage I = 162; stage II = 120; stage III = 22; stage IV = 22; and unstageable = 19 (i.e., some patients had multiple pressure ulcers). In contrast, the results from the coded information showed that only 78 (3.9%) of patients had any pressure ulcer. **Table 2a** provides the prevalence of pressure ulcers among the prevalence sample and **Table 2b** provides the prevalence of pressure ulcers as coded in the DAD.

Table 2a. Pooled data from three consecutive prevalence surveys

Patients with Physical Assessment	**N=2,001**	**(%)**
Patients with at least one pressure ulcer	292	(14.6)
Developed while in hospital, any stage	201	(10.0)
Developed while in hospital, stage II or greater	89	(4.4)

Table 2b. DAD records corresponding to patients observed on one of three consecutive prevalence surveys

DAD Records		**N=2,001**	**(%)**
ICD-10 Code	Patients with at least one code for:		
L89.0-L89.9	Pressure ulcer, any stage	78	(3.9)
L89.1-L89.9	Pressure ulcer, stage II or greater	71	(3.5)
Diagnosis Type			
Type 1	Pressure ulcer developed while in hospital	16	(0.8)
Type 2	Pressure ulcer on admission	45	(2.2)

Of the nurse-confirmed cases, only 21% (n=61) were captured in the administrative data; however, only a small percentage (1%) of patients with a pressure ulcer coded in the DAD did not have a pressure ulcer on prevalence day (either not present, not observed or it may have developed later) **(Table 3)**.

Table 3. Patients with a pressure ulcer present upon physical assessment, compared to patients with a pressure ulcer coded in the DAD

		Pressure Ulcer on Assessment		
		Yes	No	Total
Any ICD-10 pressure ulcer code	Yes	61	17	78
	No	231	1,692	1,923
	Total	292	1,709	2,001

Sn = 0.21; Sp = 0.99; PPV = 0.78; NPV = 0.88; Kappa = 0.29 (95% CI: 0.23-0.35)

The agreement between the two sources decreased when we analysed the sample by patients who developed a pressure ulcer after admission compared to patients with a Type 2 diagnosis code in the DAD (post-admission comorbidity) **(Table 4)**. Only 4% (n=8) of the patients with a pressure ulcer that developed in hospital were also coded in DAD as a Type 2 diagnosis.

Table 4. Patients who developed a pressure ulcer while in hospital, compared to patients with a Type 2 pressure ulcer coded in the DAD

		Pressure ulcer developed while in hospital		
		Yes	No	Total
Any Type 2 ICD-10 pressure ulcer code	Yes	8	8	16
	No	193	1,792	1,985
	Total	201	1,800	2,001

Sn = 0.04; Sp = 1.00; PPV = 0.50; NPV = 0.90; Kappa = 0.06 (95% CI: 0.01-0.10)

Furthermore, only 7% (n=6) of the patients with at least one pressure ulcer stage II or greater that developed in hospital and was observed through physical assessment were also coded in DAD **(Table 5)**. Kappa observer agreement calculations identified, at best, "fair" agreement between the two sources (κ=0.29), but otherwise showed only "slight" agreement between the two detection methods, according to the categories presented by Landis & Koch.[11]

Table 5. Patients who developed a stage II or greater pressure ulcer while in hospital, compared to patients with a Type 2 pressure ulcer coded in the DAD

		Pressure ulcer stage II or greater developed while in hospital		
		Yes	No	Total
Any Type 2 ICD-10 pressure ulcer code	Yes	6	10	16
	No	83	1,902	1,985
	Total	89	1,912	2,001

Sn = 0.07; Sp = 0.99; PPV = 0.38; NPV = 0.96; Kappa = 0.10 (95% CI: 0.02-0.18)

DISCUSSION

The results of this study suggest that a large proportion of pressure ulcers may not be captured in the administrative data that are routinely collected to summarize a patient's stay in hospital. This is consistent with a recent study by Meddings et al.[5] that found that administrative data was a poor indicator of pressure ulcer performance in a large sample of California hospitals, compared to pressure ulcers detected through surveillance. The inconsistencies identified by the authors highlight why pressure ulcer rates from administrative data are underreported and are unlikely suitable for performance benchmarking efforts. These shortcomings in the administrative data are, in part, related to poor pressure ulcer documentation practices in the patient record. In Sweden, Gunningberg and colleagues found that paper-based pressure ulcer documentation was poor,[7] but that documentation improved with the implementation of an electronic health record.[12] In the U.S., Dahlstrom and colleagues found an opposite effect with respect to the completeness of documentation, when documentation was moved to an electronic system; however, this trend subsequently reversed for nurses, but not among physicians.[13]

A potential explanation for the differences observed between the prevalence survey data and the DAD relates to who was documenting the pressure ulcer. This is largely due to the fact that pressure ulcers are routinely documented by nurses and not by physicians. In the United

States, Arora and colleagues observed that the rate of pressure ulcer risk assessment among nurses was 100%, compared to just under 3% among physicians, and that physicians documented fewer than one out of every two pressure ulcers identified by nurses.[14] In a related study by Dahlstrom and colleagues[13] following a campaign to improve pressure ulcer documentation, researchers observed that nurses documented almost all pressure ulcers (96.7%) compared to significantly fewer documented by physicians (70.6%). This difference increased when the researchers considered "complete" documentation, only (46.2% and 15.2% among nurses and physicians, respectively). Therefore, if nurse documentation is not being considered when pressure ulcers are being coded, then the administrative data are likely missing a large proportion of these cases.

However, in the same study the authors noted that even after the intervention, fewer than half of the cases documented by nurses contained "complete" information (i.e., size, location and stage).[13] In Iceland, Thoroddsen and colleagues[15] also observed that size and category were documented 11% and 55% of the time, respectively, for recorded pressure ulcers, but found that location was documented more consistently (88%). Similarly, Gunningberg and colleagues[7] found that nursing documentation captured pressure ulcer location 96.6% of the time, but only captured size 15% of the time and category was not documented in any of the records. Therefore, although there is evidence that nurses document pressure ulcers more often than physicians, the quality of the documentation, overall, may still be lacking.

A few limitations should be considered when interpreting our study's results. The main limitation is that we compared any pressure ulcer observed on prevalence day to any pressure ulcer documented in the administrative data. Therefore, it is possible that we recorded agreement between the two sources where, in reality, the pressure ulcers were mutually exclusive.

A related limitation is that we compared two different types of prevalence estimates: cross-sectional and period prevalence. In general, cross-sectional prevalence studies are limited because they represent a single point in time. When patients are sampled in this way, those who are in hospital longer are more likely to be sampled during the course of their stay than those with a shorter length of stay. Therefore, if a condition being studied is related to a longer length of stay, patients with this condition will be overrepresented in a cross-sectional sample.[16] Given that pressure ulcers are an example of a condition that can extend a patient's length of stay,[17;18] and where a longer length of stay can also increase the risk of developing the condition,[2] the prevalence of pressure ulcers measured on each prevalence day is likely to overestimate the prevalence of this condition. Further, if pressure ulcer severity is associated with additional increases in the length of stay, then a higher proportion of severe cases would likely be observed on a prevalence day. Then, if severe pressure ulcers are documented more often,[7;8] the correlation between the administrative data and observed pressure ulcers would also appear to be higher. This cross-sectional sampling bias likely also explain why the Total and Acute LOS for this sample are longer than the hospital's average length of stay (8.5 days, in 2012-2013)[19].

Our results should be considered in further iterations of the standards used to code pressure ulcers. In its current state, the Coding Standards for the International Classification for Diseases and Related Health Problems, Tenth Revision (ICD-10) mandate that diagnosis and diagnosis type are taken directly from the physician documentation. Further investigation regarding how DAD coding and diagnosis typing for pressure ulcers can be more reflective of documentation by other health care professionals should be considered. Agreement on a common staging system for coding that aligns with the National Pressure Ulcer Advisory Panel (NPUAP) guidelines would likely also improve the quality of the documentation. Further research is

needed to understand if nursing documentation can improve the accuracy of pressure ulcer reporting and to design targeted quality improvement work.

CONCLUSION

The results of this study demonstrate that coding in the DAD may not accurately reflect the burden of hospital-acquired pressure ulcers. We recommend enhancements to the coding methods used to monitor and report on pressure ulcers by standardizing the staging system used, and by considering the use of documented pressure ulcers by other health care professionals. With good benchmarking data, organizations will ultimately be able to design quality improvement strategies to prevent the development of hospital-acquired pressure ulcers and accurately evaluate the impact of the strategies.

Contributorship statement

CB designed the project, performed data acquisition, analysis and interpretation. She also drafted the article. SV participated in project design, data acquisition and interpretation of data. She also critically appraised and edited the manuscript. TBM and LF participated in interpretation of data and critical appraisal of the manuscript. AJF designed the project, performed data acquisition, analysis and interpretation. He also critically appraised and revised the manuscript.

Competing interests

There are no competing interests.

Funding

There is no funding to report for this submission.

Data sharing statement

There are no additional unpublished data from the study.

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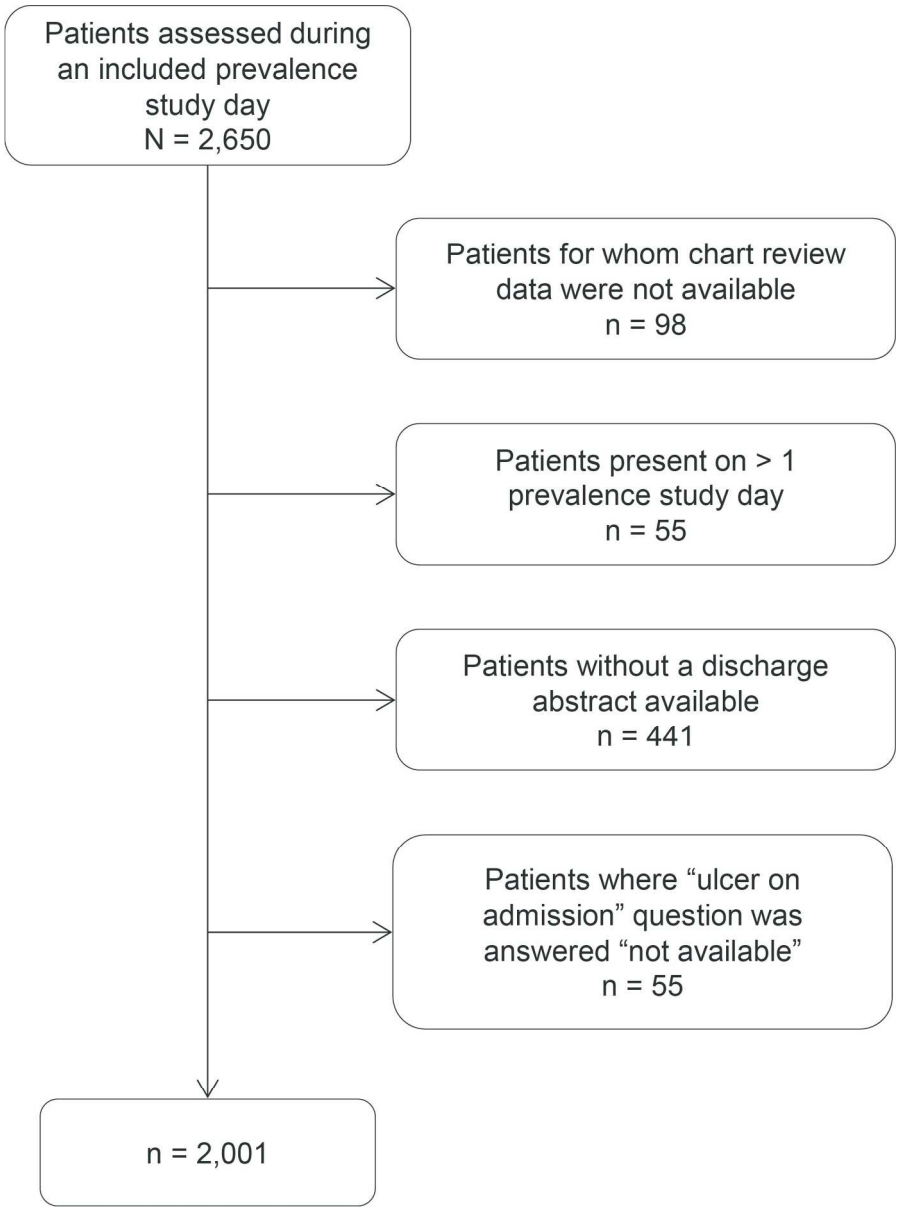

Figure 1 – Derivation of study cohort

158x212mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	*p.1*
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	*p.1*
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	*p.3*
Objectives	3	State specific objectives, including any prespecified hypotheses	*p.4*
Methods			
Study design	4	Present key elements of study design early in the paper	*p.4*
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	*p.4*
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	*p.4*
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	*p.5*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*p.5*
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*p.5*
Bias	9	Describe any efforts to address potential sources of bias	*p.5*
Study size	10	Explain how the study size was arrived at	*p.5*
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	*p.6*
Statistical methods	12	(*a*) Describe all statistical methods	*p.6*
		(*b*) Describe any methods used to examine subgroups and interactions	*p.6*
		(*c*) Explain how missing data were addressed	*p.6*
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	Tables 2-5

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	*p.6*
		(b) Give reasons for non-participation at each stage	*p.6*
		(c) Consider use of a flow diagram	*p.6*
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	*p.6*
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	n/a
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	*p.7*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	*p.7*
Discussion			
Key results	18	Summarise key results with reference to study objectives	*p.7*
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	*p.8*
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	*p.8*
Generalisability	21	Discuss the generalisability (external validity) of the study results	*p.9*
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a