

BMJ Open Comparing physical assessment with administrative data for detecting pressure ulcers in a large Canadian academic health sciences centre

Chantal Backman,^{1,2} Saskia E Vanderloo,³ Toba B Miller,⁴ Lisa Freeman,⁵ Alan J Forster^{3,6}

To cite: Backman C, Vanderloo SE, Miller TB, *et al.* Comparing physical assessment with administrative data for detecting pressure ulcers in a large Canadian academic health sciences centre. *BMJ Open* 2016;**6**:e012490. doi:10.1136/bmjopen-2016-012490

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2016-012490>).

Received 2 May 2016

Revised 6 July 2016

Accepted 8 September 2016

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.

Setting: A retrospective analysis of pooled cross-sectional samples of inpatients assessed across 3 consecutive prevalence surveys in a large academic health sciences centre between 2012 and 2013.

Participants: There were 2001 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 women.

Results: Based on the physical assessment findings, 14.6% of patients (n=292) had at least 1 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 under-report and fail to accurately reflect the true burden of pressure ulcers in hospitalised 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.

INTRODUCTION

Pressure ulcers are a significant issue among hospitalised patients worldwide. In the Canadian context, the estimated prevalence

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. Owing 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.

ranges from 23.9% to 29.7% among acute care patients.¹ Avoiding skin breakdown and the development of pressure ulcers is a recognised priority for ensuring quality of care and potential cost-savings.² According to the US-based 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 the 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



CrossMark

For numbered affiliations see end of article.

Correspondence to

Professor Chantal Backman; chantal.backman@uottawa.ca

summarised on 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, 10th 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's documentation. DAD coding and diagnosis typing may also be sought from the documentation of other healthcare 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 healthcare professionals in Canada.⁴

Owing to the potential variation in documentation practices between healthcare professionals and the provider specifications in the coding guidelines, we hypothesised 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 healthcare 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 1127 inpatient beds. We received Research Ethics Board approval to use these data for research purposes.

Participants

All patients who were admitted and assessed on 1 of 3 consecutive prevalence survey days between 2012 and 2013 were included. Each prevalence survey consisted of a 1-day cross-sectional survey where nurse surveyors collected data from inpatients' health records (ie, 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 programmes. 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 to 2013 because the data from these 2 years were available electronically.⁶

The case selection process is described in [figure 1](#). We pooled data from patients who were present on 1 of the 3 consecutive prevalence days (25 April 2012, 21 November 2012 and 25 April 2013). A small number of patients did not undergo a physical or chart assessment for various reasons (eg, 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 (ie, 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 summarised in an abstract that was submitted to the DAD and that included a diagnostic code (ICD-10 classification) and a diagnostic type (eg, M: most responsible diagnosis; type 1: preadmission comorbidity; type 2: post-admission comorbidity).³

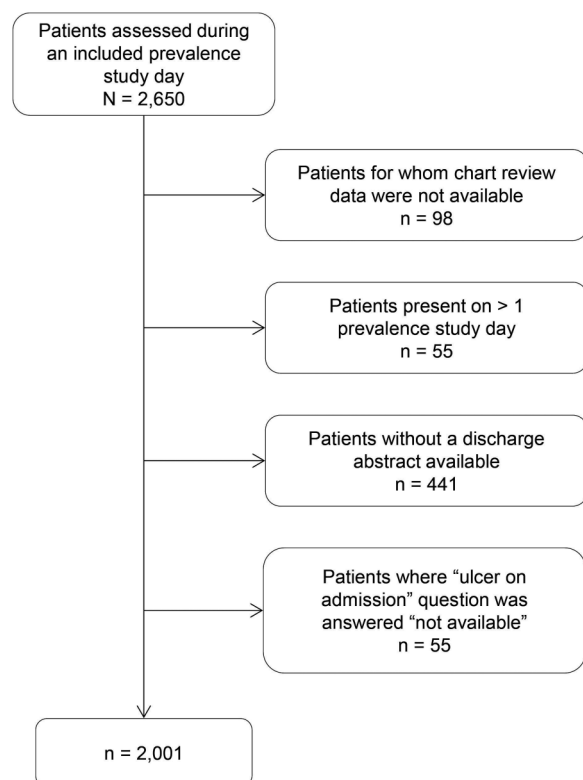


Figure 1 Derivation of study cohort.

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 1 of the 3 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: L89.0–L89.9). Second, we narrowed the analyses to patients with a pressure ulcer that developed after admission only, compared with pressure ulcers coded as a type 2 diagnosis in the DAD record (ie, postadmission 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 recognised or documented as frequently as the 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, specificity, positive predictive value and negative predictive value for each of the comparisons, using the nurse-confirmed physical assessment as the 'gold standard'. We also calculated the κ statistic and 95% CIs to account for the level of agreement due to chance, where a κ of 1.0 would indicate perfect agreement and a κ 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 *et al*¹⁰ to summarise the comorbidity in this patient sample.

The data analysis for this study was generated using SAS software, V.9.3, 2011 SAS Institute, SAS and all other SAS Institute product or service names are registered trademarks or trademarks of SAS Institute, Cary, North Carolina, USA.

RESULTS

Across 3 consecutive prevalence days, there were 2001 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 women. The cohort is described further in table 1.

Based on the physical assessment findings, 14.6% of patients (n=292) had at least 1 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 (ie, 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 2 provides the prevalence of pressure ulcers among the prevalence

Table 1 Description of the cohort

Total patients	N=2001*
Age (years)	
Mean	65.1±18.6
Median	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)
Obstetrics/gynaecology/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)

Continuous characteristics are presented with the mean±SD and median (IQR).

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.

*Categorical characteristics are presented with percentages.

Acute LOS (total LOS)–(days spent in 'ALC' status).

ALC, alternate level of care; F, female; LOS, length of stay; M, male.

Table 2 Pooled data from three consecutive prevalence surveys

Patients with physical assessment	N=2001 (%)
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)

sample and table 3 provides the prevalence of pressure ulcers as coded in the DAD.

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 4).

The agreement between the two sources decreased when we analysed the sample by patients who developed a pressure ulcer after admission compared with patients with a type 2 diagnosis code in the DAD (postadmission comorbidity; table 5). 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 3 DAD records corresponding to patients observed on one of three consecutive prevalence surveys

DAD records		N=2001 (%)
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)

DAD, Discharge Abstract Database; ICD-10, International Classification for Diseases and Related Health Problems, 10th Revision.

Table 4 Patients with a pressure ulcer present on physical assessment, compared with patients with a pressure ulcer coded in the DAD

	Pressure ulcer on assessment		Total
	Yes	No	
Any ICD-10 pressure ulcer code			
Yes	61	17	78
No	231	1692	1923
Total	292	1709	2001

Sn=0.21; Sp=0.99; PPV=0.78; NPV=0.88; κ =0.29 (95% CI 0.23 to 0.35).

DAD, Discharge Abstract Database; ICD-10, International Classification for Diseases and Related Health Problems, 10th Revision; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity.

Table 5 Patients who developed a pressure ulcer while in hospital, compared with patients with a type 2 pressure ulcer coded in the DAD

	Pressure ulcer developed while in hospital		Total
	Yes	No	
Any type 2 ICD-10 pressure ulcer code			
Yes	8	8	16
No	193	1792	1985
Total	201	1800	2001

Sn=0.04; Sp=1.00; PPV=0.50; NPV=0.90; κ =0.06 (95% CI 0.01 to 0.10).

DAD, Discharge Abstract Database; ICD-10, International Classification for Diseases and Related Health Problems, 10th Revision; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity.

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 6). The κ observer agreement calculations identified, at best, 'fair' agreement between the two sources (κ =0.29), but otherwise showed only 'slight' agreement between the two

Table 6 Patients who developed a stage II or greater pressure ulcer while in hospital, compared with 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	1902	1985
Total	89	1912	2001

Sn=0.07; Sp=0.99; PPV=0.38; NPV=0.96; κ =0.10 (95% CI 0.02 to 0.18).

DAD, Discharge Abstract Database; ICD-10, International Classification for Diseases and Related Health Problems, 10th Revision; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity.

detection methods, according to the categories presented by Landis and Koch.¹¹

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 summarise a patient's stay in hospital. This is consistent with a recent study by Meddings *et al*⁵ which found that administrative data were a poor indicator of pressure ulcer performance in a large sample of California hospitals, compared with pressure ulcers detected through surveillance. The inconsistencies identified by the authors highlight why pressure ulcer rates from administrative data are under-reported 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 Ehrenberg⁷ found that paper-based pressure ulcer documentation was poor, but that documentation improved with the implementation of an electronic health record.¹² In the USA, Dahlstrom *et al*¹³ 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.

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 USA, Arora *et al*¹⁴ observed that the rate of pressure ulcer risk assessment among nurses was 100%, compared with just under 3% among physicians, and that physicians documented fewer than one out of every two pressure ulcers identified by nurses. In a related study by Dahlstrom *et al*¹³ following a campaign to improve pressure ulcer documentation, researchers observed that nurses documented almost all pressure ulcers (96.7%) compared with 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 (ie, size, location and stage).¹³ In Iceland, Thoroddsen *et al*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 Ehrenberg⁷ 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 whereas, 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 over-represented 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 length of stay 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 ICD-10 mandates that diagnosis and diagnosis type are taken directly from the physician's documentation. Further investigation regarding how DAD coding and diagnosis typing for pressure ulcers can be more reflective of documentation by other healthcare professionals should be considered. Agreement on a common staging system for coding that aligns with the 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 standardising the staging system used, and by considering the use of documented pressure ulcers by other healthcare professionals. With good benchmarking data, organisations 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.

Author affiliations

¹Faculty of Health Sciences, School of Nursing, University of Ottawa, Ottawa, Ontario, Canada

²Ottawa Hospital Research Institute, Ottawa, Ontario, Canada

³Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, Ontario, Canada

⁴Wound and Ostomy Team, Advanced Practice Nurse, Wound, Ostomy and Rehabilitation, The Ottawa Hospital, Ottawa, Ontario, Canada

⁵Department of Nursing Best Practices, The Ottawa Hospital, Ottawa, Ontario, Canada

⁶University of Ottawa, Ottawa, Ontario, Canada

Contributors CB designed the project, performed data acquisition, analysis and interpretation. She also drafted the article. SEV 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.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Ethics approval The Ottawa Hospital Research Ethics Board.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

REFERENCES

1. Woodbury MG, Houghton PE. Prevalence of pressure ulcers in Canadian healthcare settings. *Ostomy Wound Manage* 2004;50:22–39.
2. Allman RM, Goode PS, Burst N, *et al.* Pressure ulcers, hospital complications, and disease severity: impact on hospital costs and length of stay. *Adv Wound Care* 1999;12:22–30.
3. Canadian Institute for Health Information. *Canadian coding standards for version 2012 ICD-10-CA and CCI, revised September 2012*. Ottawa, ON: CIHI, 2012.
4. Black J, Baharestani MM, Cuddigan J, *et al.* National Pressure Ulcer Advisory Panel's updated pressure ulcer staging system. *Adv Skin Wound Care* 2007;20:269–74.
5. Meddings JA, Reichert H, Hofer T, *et al.* Hospital report cards for hospital-acquired pressure ulcers: how good are the grades? *Ann Intern Med* 2013;159:505–13.
6. Backman C, Vanderloo S, Momtahan K, *et al.* Implementation of an electronic data collection tool to monitor nursing-sensitive indicators in a large academic health sciences centre. *Nurs Leadersh (Tor Ont)* 2014;28:77–91.
7. Gunningberg L, Ehrenberg A. Accuracy and quality in the nursing documentation of pressure ulcers: a comparison of record content and patient examination. *J Wound Ostomy Continence Nurs* 2004;31:328–35.
8. Defloor T, Schoonhoven L, Katrien V, *et al.* Reliability of the European pressure ulcer advisory panel classification system. *J Adv Nurs* 2006;54:189–98.
9. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. *Fam Med* 2005;37:360–3.
10. van Walraven C, Austin PC, Jennings A, *et al.* A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Med Care* 2009;47:626–33.
11. Landis JR, Koch GG. Measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–74.
12. Gunningberg L, Dahm MF, Ehrenberg A. Accuracy in the recording of pressure ulcers and prevention after implementing an electronic health record in hospital care. *Qual Saf Health Care* 2008;17:281–5.
13. Dahlstrom M, Best T, Baker C, *et al.* Improving identification and documentation of pressure ulcers at an urban academic hospital. *Jt Comm J Qual Patient Saf* 2011;37:123.
14. Arora VM, Johnson M, Olson J, *et al.* Using assessing care of vulnerable elders quality indicators to measure quality of hospital care for vulnerable elders. *J Am Geriatr Soc* 2007;55:1705–11.
15. Thoroddsen A, Sigurjónsdóttir G, Ehnfors M, *et al.* Accuracy, completeness and comprehensiveness of information on pressure ulcers recorded in the patient record. *Scand J Caring Sci* 2013;27:84–91.
16. Rothman KJ, Greenland S, Lash T. Types of epidemiologic studies. In: Rothman KJ, Greenland S, Lash T, eds. *Modern epidemiology*. 3rd edn. Philadelphia: Lippincott Williams & Wilkins, 2008:87–99.
17. Graves N, Birrell F, Whitby M. Effect of pressure ulcers on length of hospital stay. *Infect Control Hosp Epidemiol* 2005;26:293–7.
18. Lyder CH, Wang Y, Metersky M, *et al.* Hospital-acquired pressure ulcers: results from The National Medicare patient safety monitoring system study. *J Am Geriatr Soc* 2012;60:1603–8.
19. The Ottawa Hospital 2012–2013 Annual Report. <http://www.worldclasscare.ca/2013/at-a-glance/> (accessed 24 Jun 2016).

BMJ Open

Comparing physical assessment with administrative data for detecting pressure ulcers in a large Canadian academic health sciences centre

Chantal Backman, Saskia E Vanderloo, Toba B Miller, Lisa Freeman and Alan J Forster

BMJ Open 2016 6:

doi: [10.1136/bmjopen-2016-012490](https://doi.org/10.1136/bmjopen-2016-012490)

Updated information and services can be found at:
<http://bmjopen.bmj.com/content/6/10/e012490>

These include:

References

This article cites 16 articles, 1 of which you can access for free at:
<http://bmjopen.bmj.com/content/6/10/e012490#BIBL>

Open Access

This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections

Articles on similar topics can be found in the following collections

[Health services research](#) (1136)
[Nursing](#) (101)

Notes

To request permissions go to:
<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:
<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:
<http://group.bmj.com/subscribe/>