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ORIGINAL ARTICLE

Exploration of pressure ulcer and related skin problems across the spectrum of health care settings in Ontario using administrative data

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Abstract

This is a prospective cohort study using population-level administrative data to describe the scope of pressure ulcers in terms of its prevalence, incidence risk, associating factors and the extent to which best practices were applied across a spectrum of health care settings. The data for this study includes the information of Ontario residents who were admitted to acute care, home care, long term care or continuing care and whose health care data is contained in the resident assessment instrument-minimum data set (RAI-MDS) and the health outcomes for better information and care (HOBIC) database from 2010 to 2013. The analysis included 203 035 unique patients. The overall prevalence of pressure ulcers was approximately 13% and highest in the complex continuing care setting. Over 25% of pressure ulcers in long-term care developed one week after discharge from acute care hospitalisation. Individuals with cardiovascular disease, dementia, bed mobility problems, bowel incontinence, end-stage diseases, daily pain, weight loss and shortness of breath were more likely to develop pressure ulcers. While there were a number of evidence-based interventions implemented to treat pressure ulcers, only half of the patients received nutritional interventions.

Introduction

Pressure ulcer (PrU), also referred to as bedsore, decubitus ulcer or pressure sore, is an area of skin breakdown incurred by excessive or prolonged exposure to pressure, shear and to a lesser extent friction, leading to tissue ischaemia and ultimately cell death (1). Pressure is defined as the perpendicular force that is applied to the skin, distorting and compressing underlying soft tissues, especially over bony prominences. PrUs are categorised into four stages. Stage 1 PrUs are characterised by the non-blanchable erythema of intact skin that may be coupled with alterations in skin temperature and tissue consistency. Stage 2 PrUs are superficial lesions that erode the epidermis and expose the dermal base. Stage 3 and stage 4 PrUs are full thickness wounds that involve subcutaneous tissue and extend into the muscle and/or supporting structures (e.g. tendon, bone and joint capsule), respectively (1). In contrast, shear or shear stress is produced by the displacement or deformation of tissue (usually in a diagonal direction), altering the original alignment of

Key Messages

- pressure ulcers are a common health problem across the continuum of health care settings
- a higher proportion of patients with pressure ulcers had cardiovascular diseases, dementia, diabetes, dyspnoea, fatigue and daily pain than those without pressure ulcers
- individuals with bed mobility problems, bowel incontinence, end-stage diseases, daily pain, weight loss and shortness of breath were more likely to develop pressure ulcers
- one-fourth of long-term care residents had skin tears or lacerations

tissue as one layer slides over the deeper structure in an opposite direction (1).

PrUs do not follow a predictable trajectory of healing and may persist for months or years contingent on co-existing health conditions, treatment adherence and development of complications (e.g. infection). With an aging population and increased prevalence of chronic diseases, PrUs are anticipated to remain a common health condition that places a significant burden on the health care system and individual patients. According to the results of nine international PrU prevalence surveys from 1989 to 2005 that include a total of 447 930 patients (2), PrU prevalence ranged from 9·2% in 1989 to 10% in 2004. The highest prevalence was estimated at 27·3% in long-term care (LTC) with the majority of PrUs categorised as stage 1 and stage 2. A series of large-scale cross-sectional surveys were conducted in Sweden that involved over 70 000 individuals from hospitals and nursing homes from 2011 to 2012 (3). The overall prevalence of PrUs was 14·4–16·6% in hospitals and 11·8–14·5% in nursing homes. In Canada, a recent study of >12 000 patients in an acute care (AC) hospital reported an annual prevalence estimate ranging from ∼13% to 17% between 1994 and 2008 ($n = 12\,787$) (4).

The economic burden of PrUs as a chronic health condition is staggering. In a recent economic analysis of annual expenditures for PrU care in Dutch hospitals (5), the calculated costs ranged from €206·3 to €238·1 million. The average cost associated with the treatment of deep PrUs and related complications in the United States (US) was US $129 248 for a single instance of hospitalisation (6). In Canada (CAD), the estimated cost for the management of PrUs in people with spinal cord injuries ranged between CAD $7000–$9000 per month in the home care (HC) setting (7). People with PrUs experience poor quality of life, and they often suffer from social isolation, loss of independence, depression, persistent pain and recurrent infection (8). PrUs have been linked to a number of adverse patient outcomes including prolonged hospital stay, decline in physical functioning and mortality (3,4). Patients with a PrU are 3·6 times more likely to die within 21 months compared with those without a PrU (9). The mortality rate has been documented to be as high as 50% in patients with bacteraemia secondary to wound-related infection (10).

Benchmarking the prevalence of PrUs as a quality indicator allows goal setting and the comparison of performance over time and among health care sectors. With a growing emphasis on optimising safety and reducing risk within the health care system, an analysis of aggregated administrative data is necessary to identify the gaps in health care and vulnerable populations to whom necessary resources should be allocated. The development of a thorough and comprehensive understanding of the existing problem is the first and critical step in the process of addressing patient safety at a national level. In light of the enormity of PrUs and their impact on both the individual and the health care system, health care providers should be held accountable for the provision of evidence-based PrU care. A systematic approach using population databases will provide a comprehensive evaluation of the characteristics, trend, severity, chronicity, disease burden, determinants and distribution of PrUs across the continuum of care in Canada.

Purpose/objectives

The purpose of this study was to describe and outline the scope of PrUs and related skin problems across the continuum of health care settings in Ontario from 2010 to 2013.

The specific research objectives were:

1. to describe the annual prevalence, incidence risk and characteristics of PrUs
2. to examine the factors associated with PrUs and
3. to evaluate the extent to which best practices are instituted in LTC for older people with PrUs

Methods

This is a prospective cohort study using population-level administrative data.

Data sources

The data required for this study are available on Ontario's administrative health databases housed at the Institute for Clinical Evaluative Sciences (ICES), an independent, non-profit organization funded by the Ontario Ministry of Health and Long-Term Care. The data repository consists of record-level, coded and linkable data of the publicly funded administrative health care services for the Ontario population eligible for universal health coverage since 1986. The data for this study cohort includes information about Ontario residents whose health care data is contained in the resident assessment instrument-minimum data set (RAI-MDS), the health outcomes for better information and care (HOBIC) database from 2010 to 2013 and the registered persons database (demographic data).

The resident assessment instrument-minimum data set (RAI-MDS) 2.0

The RAI-MDS is designed to collect the minimum amount of data to guide planning and monitoring of health care for residents in LTC settings (11). These data are collected on a regular basis and are used to compute indicators of care quality. A study using RAI-MDS consisting of 39 649 observations on 14 607 residents at 108 nursing homes reported that incontinent residents were at a 40% higher risk of developing PrUs [odds ratio (OR) = 1·4; 95% confidence interval (CI) = 1·1–1·6) (12]. Bates-Jensen *et al.* (13) reported that LTC facilities with high PrU prevalence also documented frequent use of specialty surfaces to help treat and prevent PrUs according to data from RAI-MDS. The results justified criterion validity of the RAI-MDS. It is mandatory that LTC facilities submit RAI-MDS every 3 months. Missing from the RAI-MDS is information from other clinical settings; an alternative database was sought to extract relevant data for comparison.

Health outcomes for better information and care (HOBIC)

HOBIC, funded by the Ontario Ministry of Health and Long-Term Care, is focused on the collection of nursing-sensitive patient outcomes across four health care

sectors: acute care (AC), home care (HC), long- term care (LTC), and hospital-based continuing care (CC)(14). AC encompasses a range of clinical services, including emergency medicine, surgery and critical care, offered in hospital settings. HC signifies the delivery of health care services in the home, residential, retirement and community settings as opposed to LTC facilities that are referred to as nursing homes where 24-hour nursing care is provided to their residents. Hospital-based CC provides services to individuals with extended, chronic or complex care needs. The HOBIC data provide an opportunity to compare the impact of human resource utilisation, quality work environments and nursing practices on patient health outcomes between AC and other health care sectors (15).

In Ontario, the HOBIC database currently includes over 500 000 assessments from 188 participating sites. The Ontario data are collected electronically at the point of care when nurses complete patient assessments. HOBIC introduces a systematic, structured language to the admission and discharge assessments of patients receiving AC and to the admission, quarterly (if condition changes) and discharge assessments of patients receiving CC, LTC or HC. The outcome data for this analysis, consisting of patients' functional status (walking, bed mobility, continence), pain and PrUs, were collected using a standardised methodology. Functional status such as bed mobility, transfer and walking was assessed based on whether, in the last 7 days, the patient or resident required: (i) minimal assistance on only one or two occasions, but the person was considered to be mostly independent; (ii) supervision and verbal cueing in addition to minimal physical assistance; (iii) limited, non-weight bearing assistance on three or more occasions; (iv) extensive assistance with weight-bearing support on three or more times; or (v) total assistance in all aspects of the activities. Pain or discomfort in any part of the body was coded according to frequency (0 for no pain, 1 for pain less than daily and 2 for daily pain symptoms) and intensity, ranging from mild to moderate or horrible/excruciating pain in HC, LTC and CC. Pain exhibited in last 24 hours was captured in AC. Fatigue was described as mild, moderate to severe levels and unable to commence any normal day-to-day activities. Dyspnoea was defined as difficulty in breathing or shortness of breath during the last 3 days; it could be experienced during performance of moderate activities, day-to-day activities or at rest.

PrUs were reported quarterly, and from this, an annual prevalence was calculated for each setting, taking into account the differences in the number of patients observed in each quarter (denominator). To examine the effect of hospitalisation on PrU development in LTC, the numbers of ulcers developed 1 week after discharge from hospital were tabulated.

Ethical considerations

These data sets were linked using unique encoded identifiers and analysed within ICES facilities. This study was approved by the institutional review board at Sunnybrook Health Sciences Centre, Toronto, Canada and the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (REB#: 6006970).

Statistical analysis

Descriptive statistics (frequency, percentage) were used to summarise measures on key demographic variables, prevalence and incidence of PrUs and other skin problems, stratified by setting. Prevalence was calculated by dividing the number of persons with PrUs during the specified time period by all the patients that were assessed across different health care sectors. The result is expressed as a percentage.

$$\frac{\text{Number of persons with PrUs}}{\text{Total number of persons assessed}} \times 100 = \text{Prevalence (as \%)}$$

Incidence is the proportion of individuals in a population initially free of disease who develop the disease within a specified time interval. The incidence of PrUs was calculated by counting the number of new PrUs from each quarterly report that were not documented in previous assessments and divided by the PrU-free individuals at the start of the assessment period.

$$\frac{\text{Number of persons with new PrU per quarter}}{\text{Number of PrU-free persons at the beginning of that assessment period}} \times 100 = \text{Incidence (as \%)}$$

PrU interventions in LTC were described using frequency and percent. Cochran-Mantel-Haenszel statistics were used to assess the differences in demographic characteristics between patients with and without PrUs. Univariate logistic regression analyses were used to explore the relationships between PrU prevalence and individuals' symptoms, functional status and health conditions. The strength and precision of the relationships are expressed as ORs and 95% CIs.

Results

The analysis involved data from 203 035 unique patients across four health care settings. Due to the large sample size many of the comparisons were statistically significant, however most also appeared clinically relevant. There was a significant association between patient characteristics and the presence of a PrU (all *P*-values <0·001). A higher proportion of patients with PrUs had cardiovascular diseases (including myocardial infarction, congested heart failure, peripheral vascular disease and cerebrovascular disease), dementia, diabetes, dyspnoea (with activities and at rest), mild to severe levels of fatigue and daily pain than patients without PrUs. The demographic characteristics for each setting are summarised in Table 1.

Between 2010 and 2013, the annual prevalence of PrUs ranged from 8·2 to 9·1; CC had the highest prevalence (22·6%) followed by AC (10·2%), LTC (8·4%) and HC (3·7%) (Table 2). Seventy-two percent of residents with PrUs in LTC had more than one PrU.

Table 1 Demographical characteristics of individuals with PrUs across the spectrum of health care settings

Demographics	AC		HC		LTC		CC	
	PrU	No PrU	PrU	No PrU	PrU	No PrU	PrU	No PrU
Mean age in years (95% CI)	74·20 (73·95, 74·45)	65·44 (65·37, 65·52)	71·12 (70·20, 72·03)	64·27 (63·96, 64·58)	81·44 (81·03, 81·85)	81·14 (80·93, 81·35)	77·28 (76·50, 78·05)	76·71 (76·37, 77·05)
Gender: female (%)	49·7	50·0	52·3	50·6	63·0	65·7	55·4	58·3
Mean Charlson comorbidity score* (95% CI)	2·58 (2·54, 2·62)	1·57 (1·56, 1·58)	1·63 (1·52, 1·75)	1·26 (1·23, 1·30)	2·10 (2·02, 2·18)	1·51 (1·47, 1·55)	2·57 (2·41, 2·72)	2·24 (2·18, 2·31)
Cardiovascular diseases (%)†	56·8	33·6	36·9	20·4	50·0	35·5	55·4	45·0
Dementia (%)	12·6	4·1	3·2	1·2	22·3	20·2	11·0	10·1
Diabetes (%)	34·4	21·2	27·7	17·5	26·4	20·1	33·0	25·8
Dyspnoea (%)‡	38·4	21·8	17·1	15·6	31·9	22·8	33·2	25·3
Fatigue (%)§	82·7	57·4	51·4	46·2	71·5	53·1	81·2	73·7
Pain (%)¶	45·2	38·8	41·8	40·7	49·5	29·9	53·0	37·9

AC, acute care; CC, continuing care; CI, confidence interval; HC, home care; LTC, long-term care.
*The higher the score, the more likely the predicted outcome will result in mortality or higher resource use.
†Cardiovascular diseases included myocardial infarct, congested heart failure, peripheral vascular disease and cerebrovascular disease.
‡Dyspnoea during activities or at rest.
§Fatigue was described as mild, moderate to severe levels and unable to commence any normal day-to-day activities.
¶Pain that was experienced on a daily basis and rated as mild, moderate, severe in HC, LTC, and CC; pain exhibited in last 24 hours in AC.

Average annual PrU incidence ranged from 1·4% in HC to 7·0% in CC. Annual incidence was the highest in CC where the average rate of new ulcers was 7·0% (Table 2). In comparison, the average incidence of PrUs in AC was 4·5; LTC was 4·1 and HC was 1·4. Of all the newly developed PrUs documented in LTC, 28·3% developed 1 week after the individuals were discharged from AC. In addition to PrUs, the MDS provided information pertaining to other skin problems. The most common skin condition was skin tears/abrasions documented in 26% of LTC residents followed by skin rash that developed in 18% of the population.

PrUs were more likely to be found among individuals who had limited bed mobility (OR = 9·50, 95% CI = 9·22–9·78), difficulty walking, requiring two people to assist (OR = 5·78, 95% CI = 5·30–6·30), frequent bowel incontinence (OR = 4·15, 95% CI = 4·07–4·23), end-stage disease with a prognosis of less than 6 months to live (OR = 3·18, 95% CI = 3·09–3·28), daily pain (OR = 2·66, 95% CI = 2·62–2·71), weight loss (OR = 2·46, 95% CI = 2·40–2·51) and shortness of breath (OR = 1·28, 95% CI = 1·22–1·34).

Only LTC facilities were required to report the types of treatment for PrUs. A summary of the treatment by PrU stages is provided in Table 3. The majority of the individuals with documented stage 3 or 4 PrUs were treated with pressure-relieving devices on chairs (68·7%) and pressure-relieving mattresses (75%); only half of the affected individuals received nutritional intervention.

Discussion

PrUs are monitored and tracked by legal and regulatory bodies as a benchmark for performance, risk and safety (1,14). Accepting the notion that most PrUs are preventable, the prevalence of PrUs remains considerably high. In this study, the overall prevalence of PrUs was approximately 13%; highest in the CC setting. Results of this analysis raise the question of whether the staff mix model and resources available in the CC are appropriate to address the ever-increasing complexity and acuity of patient care. In contrast to current findings, a recent study released by the Canadian Institute for Health Information (CIHI) indicated a much lower prevalence of PrUs across Canada from 2011 to 2012 (16). PrU prevalence was estimated to be 0·4% in AC, 2·4% in HC, 6·7% in LTC and 14·1% in hospital-based CC clients. There are a few possible explanations for this discrepancy. First, discharge statistics were the primary data source for the evaluation of PrUs in AC institutions; documentation is asynchronised and reliant on physicians' recollection of relevant information upon discharge that may lead to inadvertent underreporting. Second, while it is not a mandatory requirement for AC hospitals to submit their data to HOBIC, organisations that opt to participate may be more diligent and motivated to provide high-quality assessments. According to Wodchis *et al.* (17), assessment completeness is adequate in participating AC sites with only 8·4% of the patients missing admission and discharge evaluations. Third, to ensure an accurate estimation of prevalence, we used the total number of individuals older than 18 years as the denominator. Each person had his or her own unique identifier to avoid counting the same person more than once, which could

Table 2 Annual PrU prevalence and incidence across the spectrum of health care settings by year

Settings	All settings	AC	HC	LTC	CC
2010 P (I)	9·1 (4·1)	10·4 (4·5)	4·3 (1·3)	8·3 (3·9)	27·1 (7·0)
2011 P (I)	9·0 (4·3)	10·9 (4·9)	5·1 (1·4)	8·7 (4·3)	21·7 (7·3)
2012 P (I)	8·2 (3·8)	9·9 (4·2)	3·7 (1·3)	8·2 (3·9)	18·7 (6·5)
2013 P (I)	8·3 (4·0)	10·2 (4·3)	3·2 (1·6)	8·4 (4·1)	22·5 (7·2)
Average Annual P (I)	8·6 (4·0)	10·2 (4·5)	3·7 (1·4)	8·4 (4·1)	22·6 (7·0)

AC, acute care; CC, continuing care; HC, home care; I, incidence; LTC, long-term care; P, prevalence; PrU, pressure ulcer.

Table 3 Percentage of individuals who received pressure ulcer (PrU) care strategies by stage in a long-term care setting combining data from 2010 to 2013

Pressure ulcers interventions	S1	S2	S3	S4
Chair pressure-relieving device	56·4	60·8	67·3	68·7
Bed pressure-relieving device	54·1	58·1	74	79·6
Turning/repositioning	57	61·2	68	73·4
Nutrition intervention	23	31·5	52·1	56·2
Topical ointments/medications	42·5	38·9	36·4	36·2

S1 = stage 1 PrUs; S2 = stage 2 PrUs; S3 = stage 3 PrUs; S4 = stage 4 PrUs.

be a problem if clinical encounters or hospital admissions were used.

The finding that 28% of PrUs in LTC developed 1 week after discharge from AC hospitalisation warrants further consideration. Older persons with unstable conditions requiring hospitalisation are at a high risk of skin breakdown because of physiological stress on the body and alteration in functional status (1). Although causality cannot be determined, pressure damage to the skin may have occurred while the person was in the hospital and becomes more evident upon returning to a LTC facility. It seems prudent for AC facilities to cultivate a practice environment that would facilitate early screening, ongoing monitoring and appropriate evidence-based interventions to prevent PrUs among frail, older individuals. The importance of communication between health care facilities to promote seamless care cannot be underestimated.

There are a number of intrinsic and extrinsic factors that place an individual at risk of skin breakdown. Consistent with previous studies that evaluated risk factors for PrUs, limited mobility emerged as the strongest predictor for PrU development (18–20). Skin that is exposed to faecal incontinence and moisture is susceptible to breakdown. The term 'moisture-associated skin damage' (MASD) has been introduced to describe a spectrum of skin damage resulting from prolonged exposure to a variety of moisture sources including wound exudate, sweat, urine, mucus and other bodily fluids (21). Overhydration of the skin causes the stratum corneum to swell and stretch, weakening the connections between epidermal cells and collagen fibres. Increased permeability and disruption of the normal barrier function renders the skin more susceptible to irritants and mechanical damages such as shear and pressure (22). In a recent systematic review and meta-analysis, Beeckman *et al.* (23) confirmed that individuals with bowel and bladder incontinence and related incontinence-associated dermatitis are 4·99 times more likely (OR = 4.99, 95% CI 2·62–9·50) to develop PrUs than those who are continent.

Although standardised risk assessment tools are routinely used in clinical practice to help identify vulnerable patients who are at risk of PrUs, predictive validity of these tools are less than optimal, especially among older individuals (24). General health is linked to PrUs but often omitted in routine evaluation. Some of these key factors may include specific disease co-morbidities (e.g. heart failure, cerebrovascular disease, peripheral vascular disease), poor nutritional intake, low body mass index (BMI<18·5) (25), hypoproteinaemia, low systolic blood pressure (26), anaemia (27), medication (20), contractures and bony prominences, vascular disease, neuropathy and uncontrolled diabetes (28). Based on a mathematical modelling of soft tissue deformations caused by external pressure in sitting positions, Gefen (29) remarked that variability in tissue deformation is influenced by body type and tissue thickness. Decreased tissue thickness is associated with more pronounced tissue deformation, potentially putting the person at risk of skin breakdown. In the current study, PrUs were associated with end-stage diseases, daily pain, weight loss and shortness of breath. A robust approach should be used to validate the metrics of risk assessment in various health care settings and patient populations. Further research is required to address the intricate interplay of multiple factors in precipitating skin breakdown and worsening of PrUs. Insights into the roles that various precipitating and aggravating factors play in PrU development will help in developing strategies to improve PrU care/management.

Best practice guidelines have been developed to outline evidence-based interventions for the prevention and treatment of PrUs. Despite the paucity of high-quality evidence, turning and repositioning remains integral to the treatment of PrUs. Alternatively, support surfaces such as mattresses, overlays and chair cushions are deemed effective interventions to redistribute pressure and promote ulcer healing (30). Lacking in the document was information about the specific types of surfaces, and pressure redistribution devices that were used but not documented in the study. Evidence also supports the need for nutritional supplements to improve PrU healing (1,31). The current analysis indicates that of the 60–80% of the patients in LTC with PrUs who required repositioning and support surfaces, nutritional interventions were instituted in only half of

the patients. Moist wound-healing (MWH) therapies and other treatment modalities have been successfully utilised in the management of wounds such as PrUs. However, descriptions of optical or local wound care treatments (e.g. dressings, ointment/cream, negative pressure wound therapies) for PrUs were not available for this analysis. Differences in the prevalence of PrUs may be related to practice variations and adherence to best practices. However, challenged by austere financial restraints and exorbitant health care costs, many administrators and executives are concerned about delivering high-quality services for their residents and balancing their budgets. It is important to consider current organisational infrastructure that addresses the following:

1. Develop training and education to foster wound care expertise across health care systems to address complex and diverse needs of patients with PrUs.
2. Establish a well-coordinated and inter-professional team with defined roles that incorporates collaboration with health care professionals in fields such as nursing, medicine, social work, infection control, chiropody, rehabilitation and nutrition.
3. Prioritise the optimisation of health services delivery including easy access to resources (support surfaces, dressing supplies, nutritional supplements and mobility devices), appropriate funding/reimbursement mechanisms and sustainable training for staff. The future research agenda must address the identification of a non-invasive, real-time assessment approach and analysis of tissue damage at the point of care to provide guidance for appropriate management.
4. Foster leadership to shift values, beliefs and behaviours of the organisation.
5. Develop seamless and system-wide communicating mechanisms and processes (e.g. visual/electronic medical records) for risk assessment, early implementation of prevention and evidence-based wound treatment plans.

Based on the findings of the Staff Time and Resource Intensity Verification project (32), the resource utilisation group care mix system classified nursing home residents with skin conditions into a category that requires intense daily nursing and ancillary staff support. It is not clear whether the existing resources allocated to LTC and CC are sufficient to implement targeted interventions for the prevention and treatment of PrUs and related problems. Future research should address the cost-effectiveness of various PrU care models.

Conclusion

Clinical research using large computerised databases has made valuable contributions to our knowledge of service gaps, population needs, health outcomes and practice concerns related to PrU care across the spectrum of health care settings. The major advantage of using population-based health databases is the ability to generalise findings because of large sample size and probability sampling. In addition, these databases contain valuable data collected through stringent protocols and processes and using these databases in research is considered to be cost effective in addressing certain questions.

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