Original Paper

Skin and Wound Map From 23,453 Nursing Home Resident Records: Relative Prevalence Study

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Abstract

Background: The overall distribution of all skin and wound problems experienced by residents in skilled nursing facilities, with respect to the location on the body, is poorly understood. Previous studies focused largely on one disease type, rather than all possible skin lesions. Hence, the relative distribution of skin and wound problems as mapped on the body has not previously been reported. In addition, existing data come mainly from clinical studies and voluntarily reported statistics; unbiased real-world evidence is lacking.

Objective: The aim of this study was to understand the type and location of skin and wound lesions found in skilled nursing facilities and to map these on the body.

Methods: Data from 23,453 wounds were used to generate heat maps to identify the most common areas of skin and wound lesions, as well as the most common wound types at different body locations.

Results: The most common wound types were abrasion (8792/23,453, 37.49%), pressure ulcers (4089/23,453, 17.43%), surgical wounds (3107/23,453, 13.25%), skin tears (2206/23,453, 9.41%), and moisture-associated skin damage (959/23,453, 4.09%). The most common skin and wound locations were the coccyx (962/23,453, 4.10%), right (853/23,453, 3.64%) and left (841/23,453, 3.59%) forearms, and sacrum (818/23,453, 3.49%).

Conclusions: Here, we present the body location hot spots of skin and wound lesions experienced by residents of skilled nursing facilities. In addition, the relative prevalence of these conditions is presented. We believe that identifying areas on the body prone to preventable wounds can help direct actions by care workers and improve the quality of care for skilled nursing residents. This study represents an example of how analysis of specialized electronic medical records can be used to generate insights to educate and inform facility managers where to focus their efforts to prevent these injuries from occurring, not only from retrospective database analysis but also in near real time.

Introduction

Background

Our ability to generate, acquire, and analyze data has increased exponentially over the past decade, leading to profound insights into clinically important problems. The digital health care revolution enabled by *big data* has expanded the realm of possibilities in health care and is transforming how it is executed, including the management of workflows, clinical guidelines, and care pathways, in ways that will undoubtedly yield valuable improvements in the delivery of care. An abundance of data already exists in electronic medical records, but the meaningful use of these data has yet to be fully explored in detail because little analysis has been conducted on such datasets. Specialized apps built on data analytics and centered on specific health care areas present a powerful and focused means to gain clinically valuable insights that can help improve the quality of care.

The overall care for residents in skilled nursing facilities (also known as nursing homes or long-term care facilities) is mandated using the Long Term Care Minimum Data Set, which is a standardized screening tool designed to measure resident health status at facilities covered by the Centers for Medicare and Medicaid Services [1]. Features measured by this tool include routine skin assessments, which cover wounds such as pressure ulcers (PUs); these guidelines are described by the National Pressure Ulcer Advisory Panel [2]. PUs are an unfortunate occurrence and represent a key quality metric for skilled nursing facilities.

Numerous studies spanning many years indicate that PUs are a significant problem for skilled nursing residents [3-7]. The multiyear nature of these studies means they do not provide dynamic measures of prevalence but an average over long time frames. It can therefore be difficult to identify mitigating or exacerbating factors that could be easily acted on, particularly those pertinent to care and management strategy and workflow.

The reported prevalence rates of PUs are fairly consistent; for example, the 1999 National Pressure Ulcer Prevalence Survey, which included data from almost 43,000 patients from 356 acute care facilities across the United States, found an overall prevalence rate of 14.8% [8]. A 2009 study in a hospital setting spanning 2 years (2008-2009) and covering data from over 90,000 patients, reported an overall prevalence rate of 13.5% and 12.3% for the years analyzed [4]. Rates were found to be highest in patients experiencing long-term acute care, with prevalence almost double at 22%.

More recently, a 10-year study involving almost 920,000 patients in acute and long-term care facilities revealed a decline in the overall prevalence of PUs from 13.5% to 9.3% [6]. Separate studies have examined the most frequent locations of PUs, which include the sacrum, heels [3,9,10], and buttocks [3,5]. A major caveat is these results have been obtained in a clinical setting where data collection is based on voluntary participation, which by itself introduces a bias as facilities that do not participate are excluded from these analyses.

Insights into the frequency of occurrence and of the common body locations of PUs, other types of wounds, as well as skin lesions would enable better care management and help guide care providers. Access to more holistic information in wound care management can also improve outcomes; a study on the prevalence of skin tears and pressure injuries at 2 aged care facilities highlighted the importance of care practices that are often ignored and the positive impact they can have in mitigating these injuries [11]. However, in virtually all health care settings including skilled nursing facilities, there remains a lack of understanding of all types of skin and wound occurrence frequency and wound-prone body locations.

Swift Medical has produced Swift Skin and Wound, a point-of-care wound care management software that includes a smartphone app, Web-based dashboards that provide real-time views of critical wound data, and the HealX, a Food and Drug Administration and Health Canada registered marker that calibrates wound images for size, color, and lighting. Swift Skin and Wound was developed to provide objective, standardized wound assessments using digital wound imaging and instant, automatic measurements, providing an accurate record of wounds. It also allows the tracking of wound healing over time, enabling consistent and standardized wound care management [12].

Swift Skin and Wound has been adopted by over 1000 skilled nursing facilities. This has resulted in the accumulation of an extensive and unique dataset that can be analyzed to provide novel insights that can guide care practices at different levels, from facility to organizational. Swift Skin and Wound data are particularly unique and valuable for researchers and clinicians because they are gathered at the point-of-care and provide near real-time information on all individuals monitored by the Swift app as part of a facility's routine workflow. By comparison, other datasets are derived by information submitted for surveys, making them subject to acquisition bias. Previous studies on the prevalence of wounds have generally documented the presence and location of single wound types.

Objectives

The objective of this study was to understand the location of all types of skin and wound lesions of patients in skilled nursing facilities by analyzing data from skin and wound assessments using Swift Skin and Wound and to represent the most common locations of occurrence on a body heat map. This relative prevalence study considers the common locations for various wound types among a population of individuals already affected by some kind of lesion. It includes all wound assessments in a dataset of 23,453 different wounds from 7500 patients across 200 facilities, eliminating bias and enhancing the generality of our findings. To the best of our knowledge, the location of a variety of skin and wound conditions has not previously been represented simultaneously and compared using body heat maps.

Methods

The source data for this study are limited to facilities in the United States and comply with Health Insurance Portability and Accountability Act policies [13]. Any piece of information that

might identify residents was removed using the Safe Harbor Process [14]. We also aggregated, standardized, and normalized the data presented in this study to further protect patient health record confidentiality. In total, information from 23,453 skin and wound assessments from 7500 patients across 200 facilities was pooled for analysis. Structured Query Language (SQL) queries were used to group assessments by body location and then by wound type. Data were then summarized into count tables to report the number of each wound type at each body location. Values in the count table were scaled between 0 and 1 and then used to generate heat maps at each body location. Additional SQL aggregations were performed to isolate wound locations of a specific wound type to produce body heat maps for specific wounds.

Results

For the analyses performed, wounds were classified into 17 different categories, and 94 body locations were defined (see Textbox 1 and Multimedia Appendix 1). Figure 1 shows the locations on the body of all types of wounds, with the frequency at each body location indicated by a normalized heat map, giving the relative prevalence of these conditions. From our dataset of 23,453 skin wounds, the 5 most frequent types of wounds observed were abrasions (8792/23,453, 37.49%), PUs (4089/23,453, 17.43%), surgical (3107/23,453, 13.25%), skin tears (2206/23,453, 9.41%), and moisture-associated skin damage (MASD; 959/23,453, 4.09%). The relative prevalence of these wounds was mapped on the front and back of a diagram of a body (Figure 1).

Next, we determined the most prevalent locations of the 5 most frequent wound types identified from our dataset. We also analyzed diabetic ulcers, a major type of chronic wound increasing in prevalence. Abrasions were most commonly found on the arms and associated regions (inner and outer forearms, antecubitals, elbows, and back of the hands), with a total prevalence of 37.49% (Figure 2). With regard to the forearms, we note that there was a 1.5 times greater occurrence of

abrasions on the outer (extensor aspect) compared with the inner regions.

PUs were most frequently located on the coccyx and sacrum (1267/4089, 30.99%), heels (836/4089, 20.45%), buttocks (750/4089, 18.34%), and ischial tuberosities (174/4089, 4.26%; Figure 3).

A majority of skin tears were located on the arms: more than half of all skin tears (1138/2206, 51.59%) were located on the forearms, elbows, and dorsa combined (Figure 4). However, unlike PUs, skin tears were also frequently located on the legs (433/2206, 19.62% on shins and calves).

Surgical wounds were more likely to be located around the hips (499/3107, 16.06%), knees (465/3107, 14.97%), thighs (307/3107, 9.88%), abdomen (396/3107, 12.75%), and spine (98/3107, 3.15%; Figure 5).

MASD can be a precursor to PUs and similar to this wound type, the most common locations were the coccyx (183/959, 19.1%), sacrum (123/959, 12.8%), buttocks (233/959, 24.3% for left and right), and groin (107/959, 11.2%; Figure 6). There are four categories of MASD, including incontinence-associated dermatitis. Given that incontinence is common among skilled facility residents, these findings are unsurprising. However, unlike other common PU sites, heels are not a prominent site of MASD.

Finally, diabetic wounds were predominantly localized on the feet and heels: more than three-quarters of all these wounds were located in the toes, heels, and feet (306/353, 86.7%; Figure 7).

The coccyx, sacrum, and forearms, particularly the inner and outer regions, were frequent sites of a number of wounds, which prompted us to take a closer look at the most frequent types of wounds that occur at these regions (Figure 8). Both coccyx and sacrum had wound frequencies in close agreement, with the most frequent being PUs (675/962, 70.2 % and 592/818, 72.4%, respectively), MASD (183/962, 19.0% and 123/818, 15.0%, respectively), and abrasions and rashes (56/962, 5.8% and 62/818, 7.6% combined, respectively).

Textbox 1. List of wound types reported in this study.

- Abrasion
- Arterial
- Blister
- Burn
- Cancer lesion
- Diabetic
- Hidradenitis suppurativa
- Laceration
- Lesion
- Moisture-associated skin damage
- Mole
- Pressure ulcer
- Rash
- Skin tear
- Surgical
- Unclassified
- Venous

Figure 1. Unbiased analysis of 17 wound types in 94 anatomical locations from a dataset of 23,453 wounds, giving a view of relative prevalence of these conditions. (A) Bar chart indicating the 8 most prevalent wound types and their frequency. (B) Front and back body heat maps of all wounds.
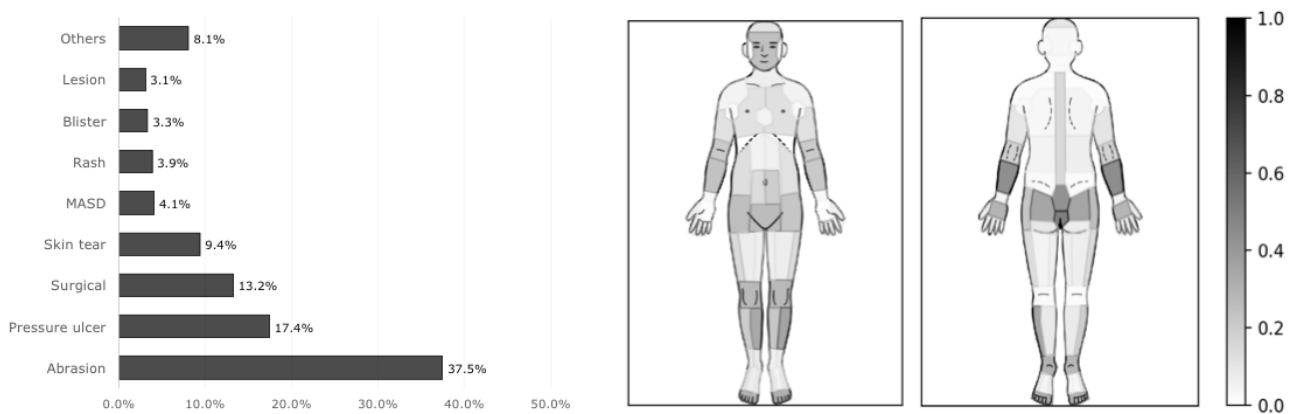
Figure 2. Anatomical distribution of abrasions. (A) Bar chart indicating most prevalent locations of abrasions. (B) Front and back body heat maps of abrasions.
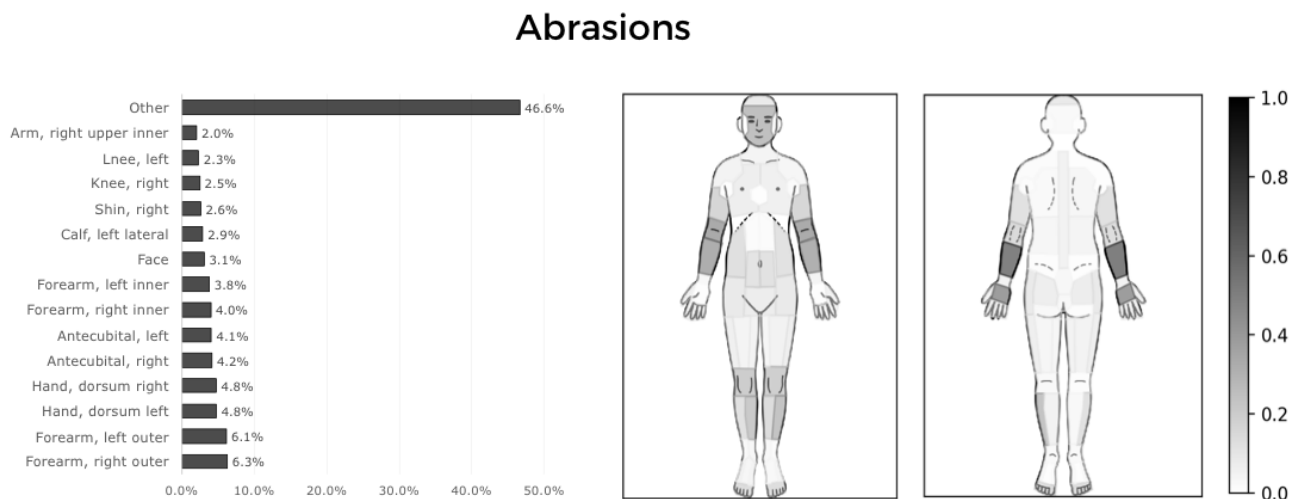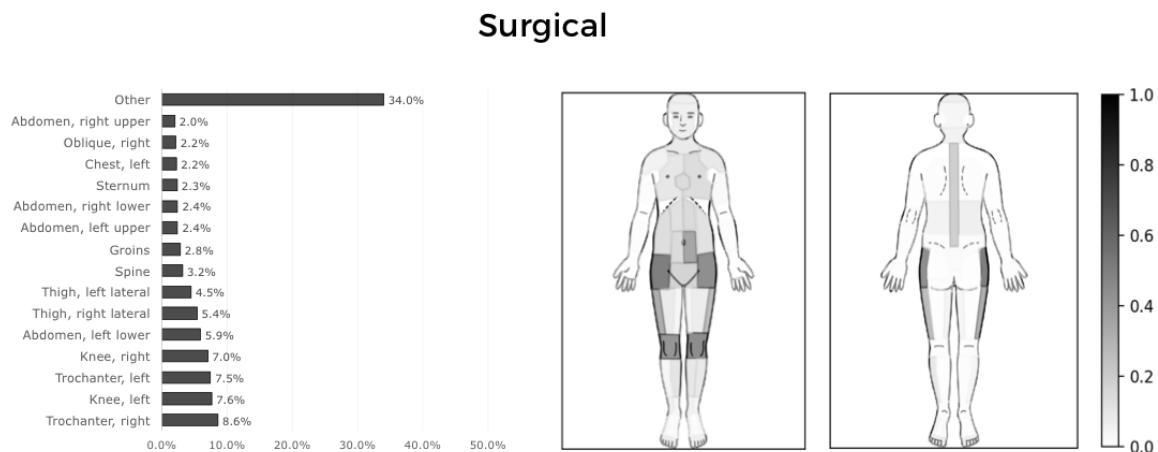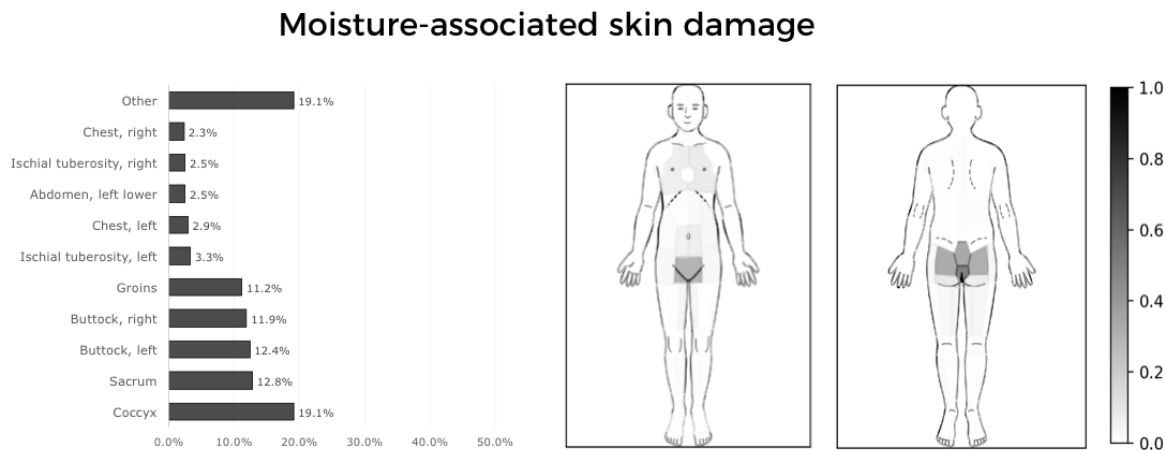

Figure 3. Anatomical distribution of pressure ulcers. (A) Bar chart indicating most prevalent locations of pressure ulcers. (B) Front and back body heat maps of pressure ulcers.
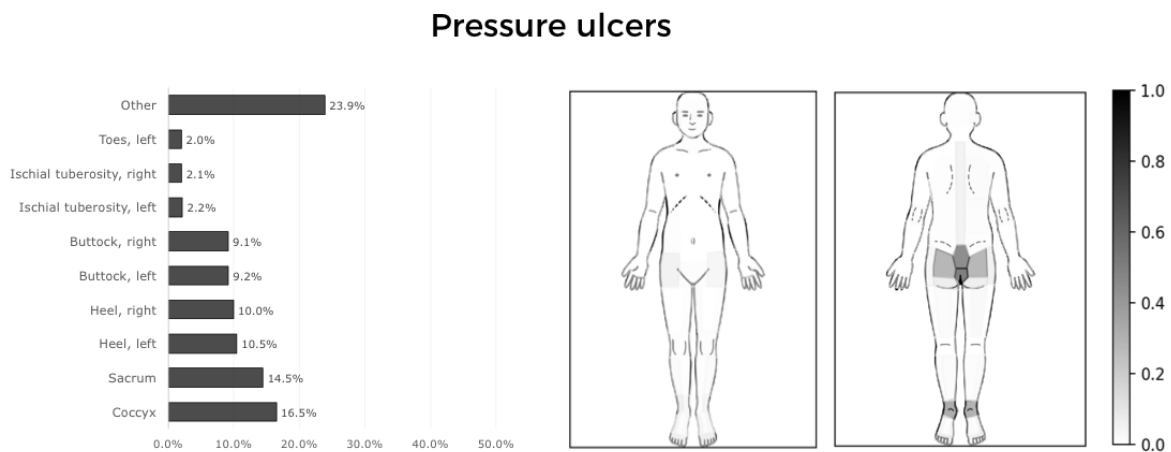

Figure 4. Anatomical distribution of skin tears. (A) Bar chart indicating most prevalent locations of skin tears. (B) Front and back body heat maps of skin tears.
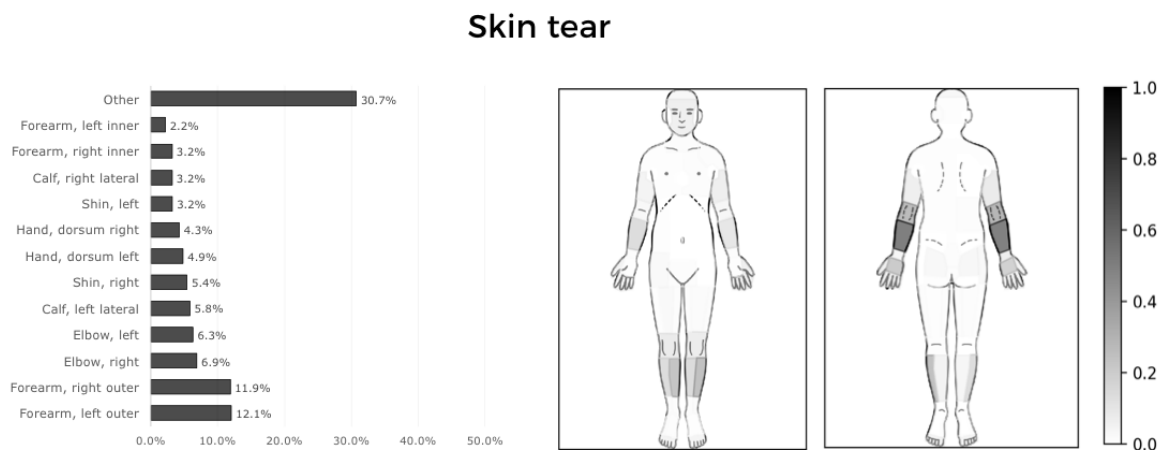
Figure 5. Anatomical distribution of surgical wounds. (A) Bar chart indicating most prevalent locations of surgical wounds. (B) Front and back body heat maps of surgical wounds.

Surgical

Figure 6. Anatomical distribution of moisture-associated skin damage. (A) Bar chart indicating most prevalent locations of moisture-associated skin damage. (B) Front and back body heat maps of moisture-associated skin damage.

Moisture-associated skin damage

Figure 7. Anatomical distribution of diabetic ulcers. (A) Bar chart indicating most prevalent locations of diabetic ulcers. (B) Front and back body heat maps of diabetic ulcers.

Diabetic
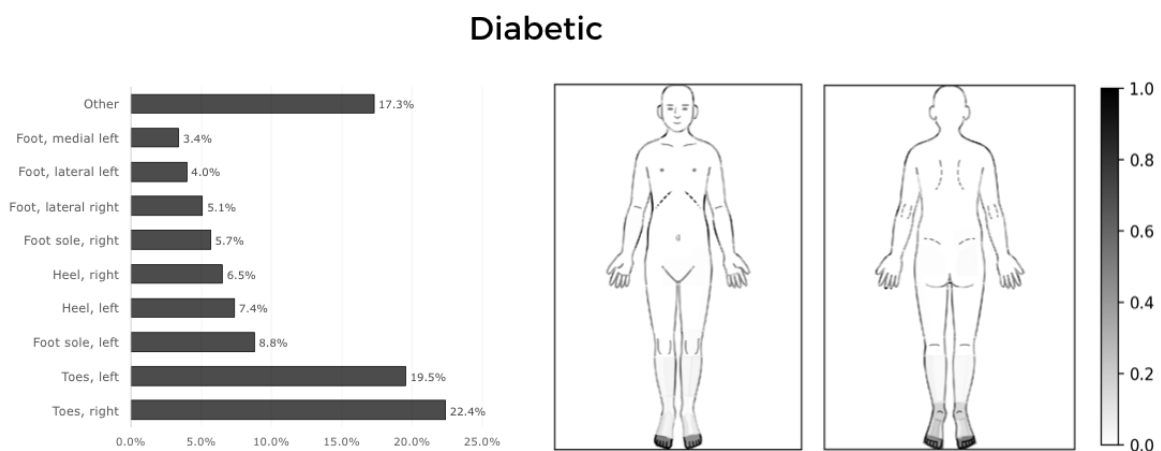
Figure 8. Distribution of wound types located at four anatomical locations. Bar charts showing proportion of different wound types located at the regions indicated.
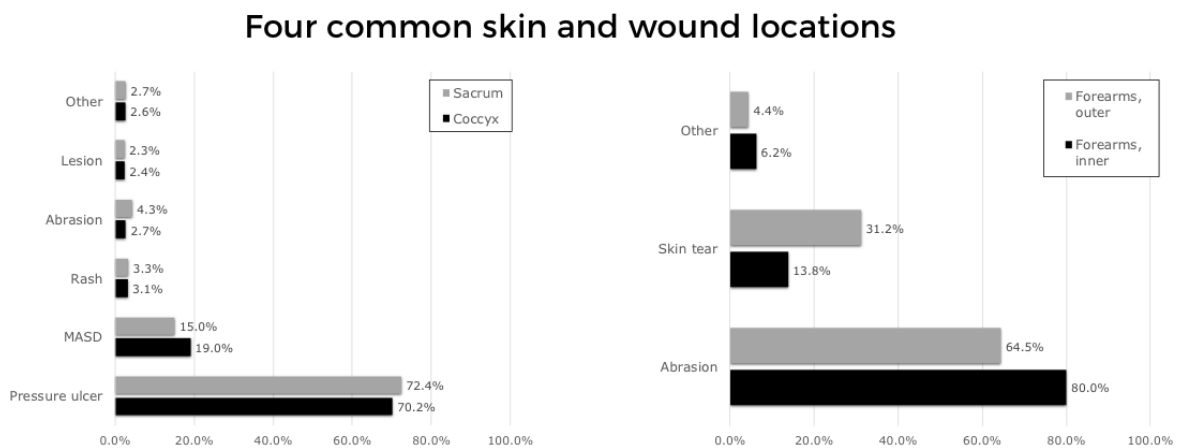
As noted previously, although abrasions were the most common wound type on forearms, their distribution was not the same; although abrasions accounted for 80.0% (685/856) of all wounds on the inner forearm, they only accounted for 64.46% (1092/1694) on the outer forearm. Instead, outer forearms had more than double the frequency of skin tears compared with inner forearms (31.2% vs 13.8%).

Discussion

Principal Findings

The objective of this study was to understand the location of skin and wound lesions in patients in skilled nursing facilities by analyzing data generated by Swift Skin and Wound. At the same time, we sought to demonstrate the relative ease and power of using big data in the analysis of wound information acquired using point-of-care wound visioning technology.

Abrasions, PUs, skin tears, and wounds resulting from surgery are a serious concern in skilled nursing facilities. Some of these wounds may already exist at the time of a resident's admission, whereas others are acquired during the care period. The common locations of wounds on the body are not well understood and have not been visualized previously using heat maps. Past studies have examined the presence and location of a single wound type to assess a patient's risk of developing such a wound. Indeed, very few studies on wound prevalence have examined more than one wound type simultaneously. We are unaware of any previous study that has been able to assess as many different wound types in an unbiased manner using real-world data at this scale.

Limitations

Although the size of the dataset that we used to conduct this analysis was sufficient, a larger study could be performed. The advantages of such a study could be to analyze some of the rarer skin and wound conditions that occur in a more statistically robust fashion. In addition, the dataset that we used is primarily in the setting of skilled nursing facilities only; meaning that its generalizability of the results in different health care settings such as acute care settings is limited.

Comparison With Prior Work

Our findings on PUs, which accounted for 17.43% (4089/23,453) of all wounds in our dataset, underlined the validity of our study. The most common locations observed were the coccyx or sacrum (1267/4089, 30.99%), heels (836/4089, 20.45%), and buttocks (750/4089, 18.34%). This aligns with 2 previously published studies: A 17-year study of almost 448,000 patients in long-term postacute care facilities found that the most common sites of PUs were located in the sacrum (28%), heels (23.6%), and buttocks (17.2%) [3]. Another study, a 6-year study on acute care facilities involving almost 32,000 patients, reported that the 2 most frequent sites of stage I and II PUs were the sacrum and heels (30.7% and 23.2%, respectively) [9].

Conclusions

The design of Swift Skin and Wound enabled our study, which was generated from data acquired over 2 years from over 23,000 wounds. This illustrates the immense speed and power of focusing computational approaches on the analysis of large datasets acquired as a matter of routine workflow.

A consequence of our study was the generation and use of body heat maps to display data at a depth and consistency not possible in previous studies. In our opinion, heat maps represent a better way to display skin and wound information, allowing better visualization of common locations for different skin and wound issues. Beyond the visual benefit, rapid insights can be gained by looking at a map. For example, the preponderance of PUs on the buttocks and heels highlight the importance of correctly managing the continence, turning, repositioning, and mobility of patients. The frequent occurrence of abrasions on arms suggests that, where possible, the use of protective sleeves might be helpful. Alternatively, these could be signs of possible resident mistreatment, which could highlight the need to assess staff or caregiver conduct and performance. These examples highlight the benefits, at an organizational and management level, of adopting a digital system that provides accurate and reliable skin and wound care measurements with automated documentation, allowing facility performance to be monitored in near real time.

Finally, insights generated by studies such as this will have a positive impact on patient care. Informing primary care workers of wound hot spots can prevent or reduce the occurrence of chronic wounds. Identifying the locations prone to different types of wounds will help educate primary care workers and ultimately improve the delivery of patient care.

Acknowledgments

Conflicts of Interest

SCW is a cofounder and chief medical officer of Swift Medical; YA, ML, and KT are employees of Swift Medical.

Multimedia Appendix 1

List of anatomical locations examined in this study.

[PDF File (Adobe PDF File), 266KB-Multimedia Appendix 1]

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Abbreviations

MASD: moisture-associated skin damage

PU: pressure ulcer
SQL: Structured Query Language

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