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Variation in care for patients presenting with hip fracture in six high-income countries: A cross-sectional cohort study

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Abstract

Background: Hip fractures are costly and common in older adults, but there is limited understanding of how treatment patterns and outcomes might differ between countries.

Methods: We performed a retrospective serial cross-sectional cohort study of adults aged ≥66 years hospitalized with hip fracture between 2011 and 2018 in the US, Canada, England, the Netherlands, Taiwan, and Israel using population-representative administrative data. We examined mortality, hip fracture treatment approaches (total hip arthroplasty [THA], hemiarthroplasty [HA],

Bruce E. Landon and Peter Cram contributed equally and are co-senior authors.

internal fixation [IF], and nonoperative), and health system performance measures, including hospital length of stay (LOS), 30-day readmission rates, and time-to-surgery.

Results: The total number of hip fracture admissions between 2011 and 2018 ranged from 23,941 in Israel to 1,219,696 in the US. In 2018, 30-day mortality varied from 3% (16% at 1 year) in Taiwan to 10% (27%) in the Netherlands. With regards to processes of care, the proportion of hip fractures treated with HA (range 23%–45%) and THA (0.2%–10%) differed widely across countries. For example, in 2018, THA was used to treat approximately 9% of patients in England and Israel but less than 1% in Taiwan. Overall, IF was the most common surgery performed in all countries (40%–60% of patients). IF was used in approximately 60% of patients in the US and Israel, but only 40% in England. In 2018, rates of nonoperative management ranged from 5% of patients in Taiwan to nearly 10% in England. Mean hospital LOS in 2018 ranged from 6.4 days (US) to 18.7 days (England). The 30-day readmission rate in 2018 ranged from 8% (in Canada and the Netherlands) to nearly 18% in England. The mean days to surgery in 2018 ranged from 0.5 days (Israel) to 1.6 days (Canada).

Conclusions: We observed substantial between-country variation in mortality, surgical approaches, and health system performance measures. These findings underscore the need for further research to inform evidence-based surgical approaches.

KEYWORDS

healthcare policy, hip fracture, international comparison, longevity, osteoporosis

INTRODUCTION

Hip fractures are costly and a common cause of morbidity and mortality in older patients, with an expected annual cost of $25.3 billion in the US ($1.25 billion in England).[1–3] Despite improvements in surgical technique and postoperative management, mortality within 1 year of a hip fracture remains high (14%–36%), and survivors frequently do not return to their functional baseline.[4–6] Moreover, the aging population in high-income countries portends future increases in the number of hip fractures.[2]

The vast majority of older adults hospitalized with hip fractures undergo surgical repair. However, a significant percentage (5%–15%) with limited functional status or advanced illness may receive nonoperative management with palliation.[7–10] There are three principal types of surgical repair approaches for hip fractures: total hip arthroplasty (THA); hemiarthroplasty (HA); and internal fixation (IF), with nonoperative management an option for those who are particularly frail. With very few randomized trials to guide the choice of surgery, treatment often depends upon fracture type, surgeon preference, hospital capabilities (e.g., implant availability), and health system factors (e.g., regionalization, payment incentives for physicians and hospitals).[11–14]

Hip fracture provides an ideal condition for international comparisons of hospital-based care and outcomes because it is common, and virtually all patients require hospitalization, minimizing selection effects that might be present for conditions where hospitalization is discretionary. Studies comparing hip fracture treatment across high-income countries are limited. Some were not nationally representative,[15,16] limited to a small number of countries,[15,17–19] or relied upon aggregated data.[2,20] Moreover, many studies have not evaluated between-country differences in the repair procedure used.[16,21,22]

In this study from the International Health Systems Research Collaborative (IHSRC: https://projects.iq.harvard.edu/ihsrc/people), we used nationally representative patient-level data from six high-income countries (US, Canada, England, Netherlands, Israel, and Taiwan) to identify older adults hospitalized with a hip fracture between 2011 and 2018.[23,24] We compared countries with respect to surgical treatments (THA, HA, IF, and

nonoperative), mortality, hospital length of stay (LOS), 30-day readmission, discharge disposition, and days from presentation to surgery and examined how rates changed over time.

Key points

- There is substantial variation in mortality, surgical approaches, and health system performance for hip fracture care across six high-income countries.
- The most common surgery performed was internal fixation, followed by hemiarthroplasty and total hip arthroplasty, but the rate of these and nonoperative treatments varied substantially across countries.
- The variation in surgical treatment highlights the need for additional research to determine the most effective surgical procedures based on individual patient and fracture characteristics.

Why does this paper matter?

The findings of this study have important implications for policymakers, healthcare providers, and researchers. By identifying the differences in hip fracture care across countries, this study provides insights into opportunities for improvement and shared learning. Additionally, the study highlights the need to identify optimal treatment strategies for hip fractures and investigate the factors contributing to higher mortality rates in certain countries. As the global population continues to age, hip fractures are expected to become more common, making it imperative to improve care and outcomes for this patient population.

METHODS

Data sources and study patients

In this retrospective serial cross-sectional cohort study, we identified patients aged 66 years and older who were hospitalized with a primary diagnosis of hip fracture between January 1, 2011 and December 31, 2018 (2013–2018 for the Netherlands). In each consecutive year within the study period, we compared each nation separately, using administrative data that broadly represented the population (Supplementary S1). To identify patients hospitalized with hip fractures, we used established coding algorithms based on relevant ICD-9 and ICD-10 codes (Supplementary S2).[23] We allowed minor adaptations to the coding scheme to reflect differences between countries. We applied identical inclusion and exclusion criteria in the same order in each country, with slight country-specific exceptions.

We excluded high-energy hip fractures[25] (e.g., falls from significant heights, vehicular trauma, etc.) and patients with hip fracture admissions during the preceding 180-day period (to avoid counting readmissions as new admissions). We also excluded small numbers of patients with missing age or sex, residence outside the jurisdiction of admission, and patients with less than 1 year of preadmission or postadmission follow-up data with the exception of those who died during follow-up (Supplementary S3). We also excluded US patients who were enrolled in Medicare Advantage insurance plans for two or more months during the year before or after hip fracture hospitalization because certain data elements may not be available. For patients transferred between hospitals, we evaluated the complete episode of care from initial admission to final hospital discharge. Comorbid conditions were identified from the index admission and prior hospitalizations in the year before the index admission using an adaptation of the Elixhauser comorbidity measures.[26] In Israel, comorbid diagnoses included those given in primary care ambulatory settings, as medical record systems integrate both hospital and primary care visits.

Outcomes

First, we evaluated mortality within 30 days and one year of index hospital admission. Second, we evaluated the percentage of patients with hip fractures receiving each type of treatment (THA, HA, IF, and nonoperative). For patients with multiple procedures during the index admission, we assigned the most extensive repair type first (THA > HA > IF), and patients were only deemed nonoperative if they lacked procedure codes for all surgical repair types. We also examined hospital LOS and readmission within 30 days of discharge among those discharged alive. We also examined discharge disposition (home versus not) and days from hospital admission to surgery (for those receiving surgery) in the four countries (US, Canada, Netherlands, and Israel) that could provide these data.

Statistical analyses

We calculated the annual hip fracture rate as the number of hospitalizations per 1000 population age

≥66 years for each country and calendar year and directly standardized it to the age-sex distribution of the US age 66+ population in 2018.[27] We similarly used direct standardization to compare the outcomes specified above. For simplicity, we report data from the first (2011) and last (2018) years, with data for all years in the Supplementary Appendix. We did not adjust our outcomes for comorbid conditions because of the implausibly large between-country differences in the prevalence of comorbid conditions; these differences are less likely to reflect actual differences in the hip fracture populations across countries but rather differences in the financial incentives to code patient complexity.[28,29] Furthermore, multiple studies have shown that comorbid conditions have a little overall impact on hip fracture outcomes above age and sex alone.[30]

To evaluate the robustness of our results among patients with greater and lesser frailty, we performed subgroup analysis among individuals greater than and less than 90 years of age, using age as a proxy for frailty and underlying health status, again standardized to the US 2018 sex distribution of these strata. This study intends to draw attention to the differences in hip fracture care patterns between countries over time and is descriptive in nature. Moreover, given our large sample size, we chose not to conduct formal statistical testing (e.g., reporting p values), cognizant of the potential for such testing to overemphasize clinically inconsequential differences.[31] Our analyses were conducted using SAS (US, Canada, and Taiwan) and R (England, Israel, and the Netherlands). Analyses were conducted locally in each country, and ethics approval was obtained following local guidelines.

RESULTS

Patient populations

The number of hip fracture admissions across the study period ranged from 23,941 in Israel to 1,219,696 in the US (Table 1 and Supplementary S4). The mean age was 83–84 years in most countries but slightly younger in Taiwan; females comprised 71%–75% of the population but somewhat less (64%–67%) in Taiwan (Table 1). There were significant between-country differences in the recorded prevalence of comorbid conditions, including hypertension, diabetes, and hypothyroidism (Table 1). In 2018, the age and sex-standardized annual incidence of hip fracture was 4.6 per 1000 population in the US but, was somewhat higher in Taiwan (6.3) and lower in England (3.6) (Supplementary S5).

TABLE 1 Sociodemographic characteristics and select comorbid conditions for patients hospitalized with hip fracture in 2011 and 2018 in the US, Canada (Ontario and Manitoba), England, the Netherlands (2013 and 2018), Israel, and Taiwan.

	2011						2018					
Metric	**US, $N = 161,626$**	**Canada, 9495**	**England, 9603**	**Netherlands, 12,945[a]**	**Israel, 2628**	**Taiwan, 15,792**	**US, 143,329**	**Canada, 11,006**	**England, 7531**	**Netherlands, 15,170**	**Israel, 3298**	**Taiwan, 17,917**
Female (%)	73.7	73.4	74.9	74.0	70.6	63.6	71.2	70.8	71.5	71.1	67.2	67.3
Age, mean	84.2	83.9	84.8	83.9	82.8	80.9	83.7	83.9	84.4	83.4	83.0	81.9
Comorbid conditions (%)												
CHF	21.7	4.1[b]	11.1	1.2	13.6	7.3	22.5	4.0[c]	14.4	0.8	13.1	6.6
Hypertension uncomplicated	63.8	28.4[b]	53.2	16.7	60.8	44.3	54.9	21.1[c]	60.7	29.0	56.5	42.5
Diabetes uncomplicated	20.5	6.5[b]	15.2	12.9	31.5	29.2	13.2	6.3[c]	17.4	16.6	32.0	23.8
Hypothyroidism	23.3	N/A	10.5	1.1	11.3	0.4	26.0	N/A	13.1	2.6	11.5	0.4

[a]2013 data shown; data unavailable for 2011–2012.
[b]2011 and 2012 were pooled due to small cell sizes.
[c]2017 and 2018 data were pooled due to small cell sizes.

Mortality

Age and sex-standardized 30-day and 1-year mortality varied widely between countries (Figure 1 and Supplementary S6). In 2018, standardized 30-day mortality was lowest in Taiwan (3.0%) and highest in the Netherlands (10.3%). One-year mortality in 2018 was lowest in Taiwan (15.7%) and England (19.4%) and highest in the US (26.2%) and the Netherlands (27.5%). Between 2011 and 2018, 1-year mortality declined by between 0.4% and 1.5% in all countries except England (0.9% increase).

Surgical approach

There were vast differences between countries in the treatment practices of hip fractures (Figure 2 and Supplementary S7 and S8). For example, in 2018, THA was used to treat 9.4% of hip fractures in England, 9.1% of hip fractures in Israel, and just 0.7% in Taiwan. Similarly, in 2018, HA was used to treat 39.1% of hip fractures in England and Taiwan but 22.8% in Israel. In 2018, fixation was used to treat 50%–60% of hip fractures in most countries but just 42.2% in England. The percentage of patients treated nonoperatively in 2018 ranged from 4.6% (Taiwan) to 9.7% (England). Rates of nonoperative management decreased from 2011 to 2018 in England, Israel, and Taiwan (11.6%–9.7% and 13.5%–6.1%, 5.4%–4.6%, respectively), but increased in the remaining countries.

Health system performance factors

In 2018, hospital LOS was the shortest in the US (6.4 days) and longest in Canada (14.0 days) and England (18.7 days) (Figure 3). Between 2011 and 2018 the mean LOS decreased by at least 1 day in all countries except the Netherlands, with a decrease of 3.6 days in England. The 2018 30-day hospital readmission rate was lowest in Canada (7.8%) and highest in England (17.6%). Between 2011 and 2018, the 30-day readmission rate declined in four countries but increased in two (England and Israel) (Figure 3). Among the four countries with available data, the mean days between hospital admission and surgical repair in 2018 ranged from 0.5 days (Israel) to 1.6 days in Canada (1.1 in the US and 1.5 in England). (Figure 4). The percentage of patients discharged home in 2018 was lowest in the US (9.6%) and highest in Israel (59.3%) (Figure 4).

Stratified analysis by age

Comparing patients aged below 90 and ≥90 years demonstrated several noteworthy findings (Supplementary S9 and S10). First, utilization of THA was 40%–70% lower among patients aged 90 and above than among patients younger than 90, but these findings showed substantial variation across countries. Second, the US showed the largest difference in the use of nonoperative management across the age groups, increasing from

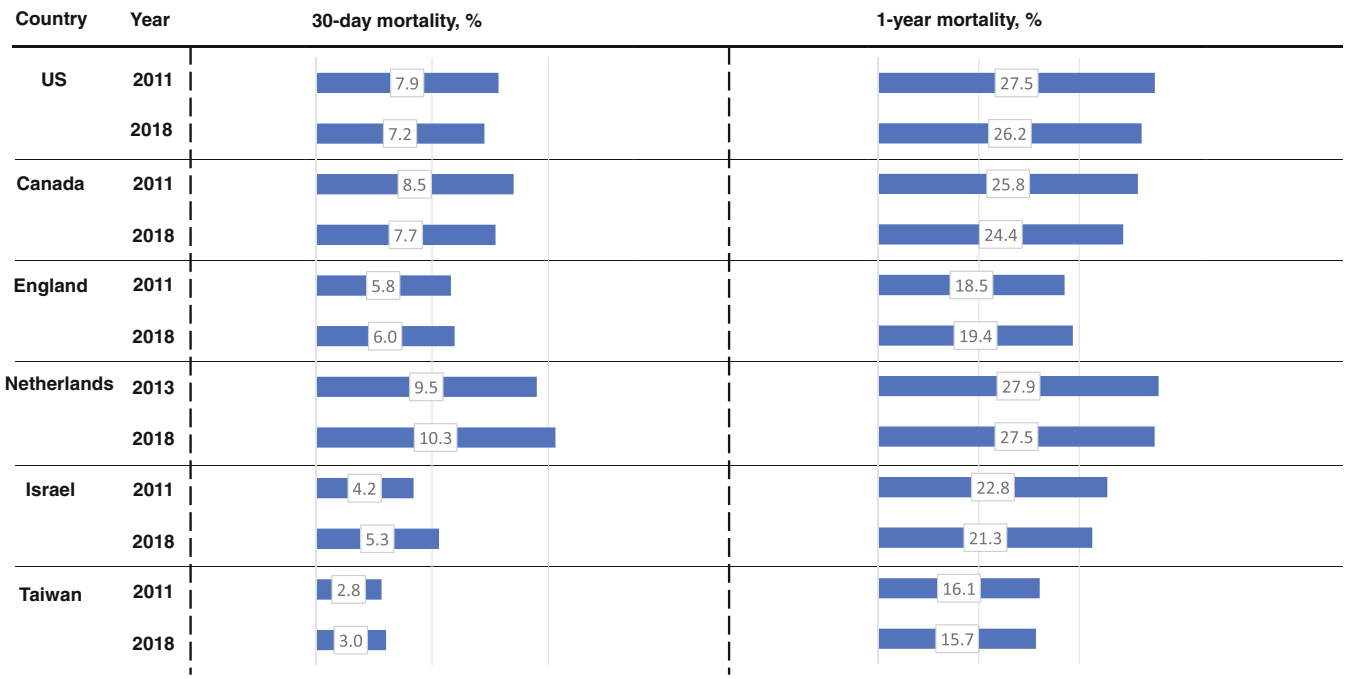

FIGURE 1 Age- and sex-standardized 30-day and 1-year mortality, 2011 and 2018.

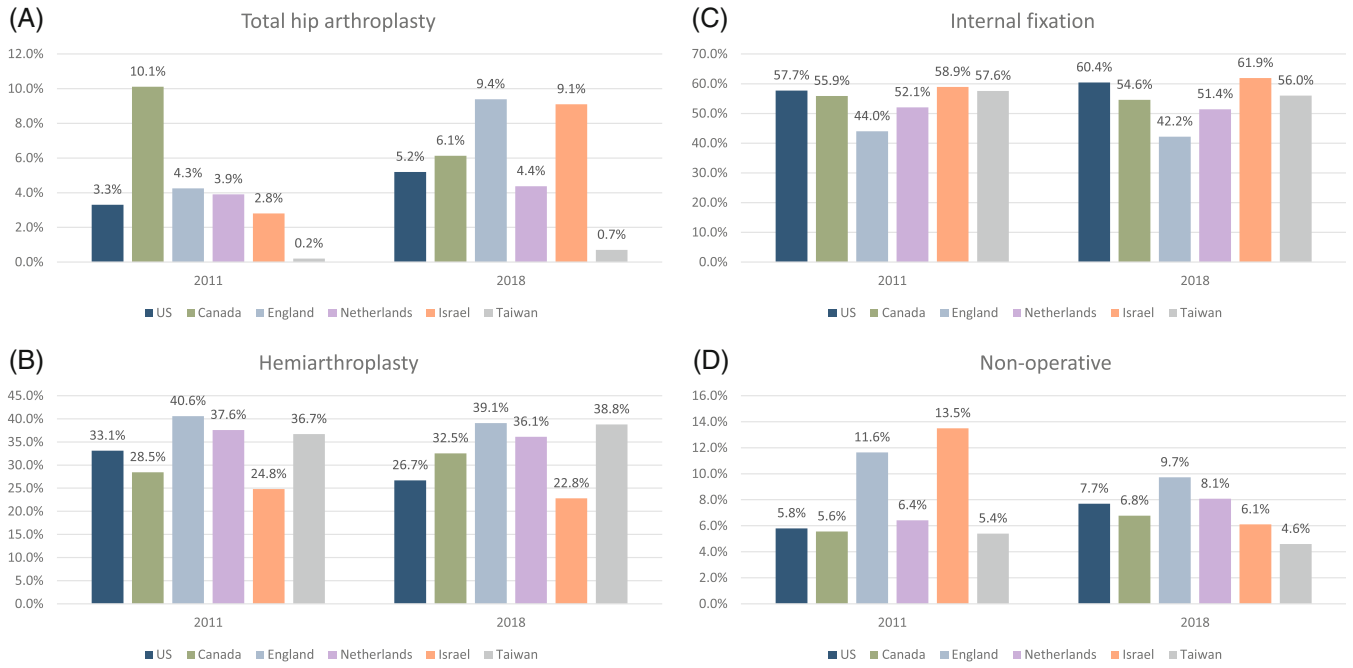

FIGURE 2 Age- and sex-standardized rates of total hip arthroplasty (THA), hemiarthroplasty (HA), internal fixation (IF), and nonoperative management (non-op) after hospitalization for hip fracture in 2011 and 2018.

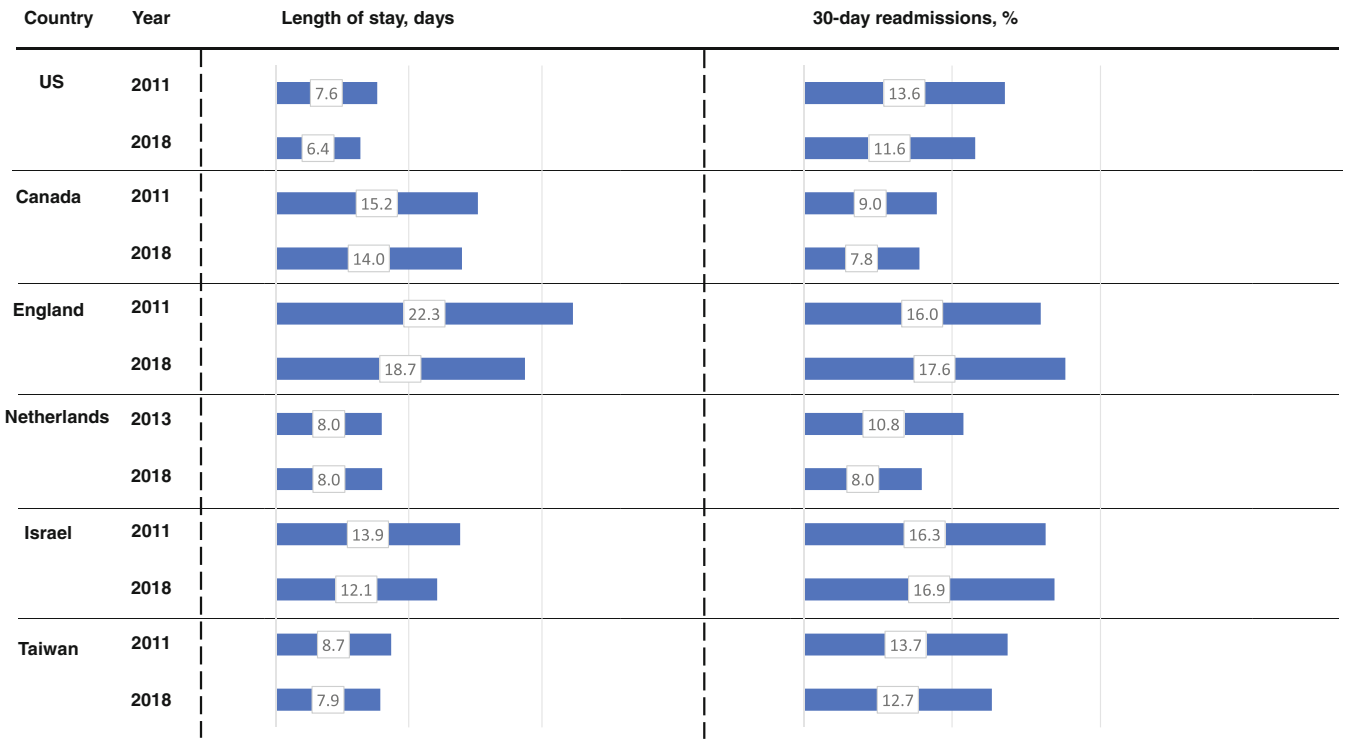

FIGURE 3 Age- and sex-standardized length of stay and 30-day readmissions rates, 2011 and 2018.

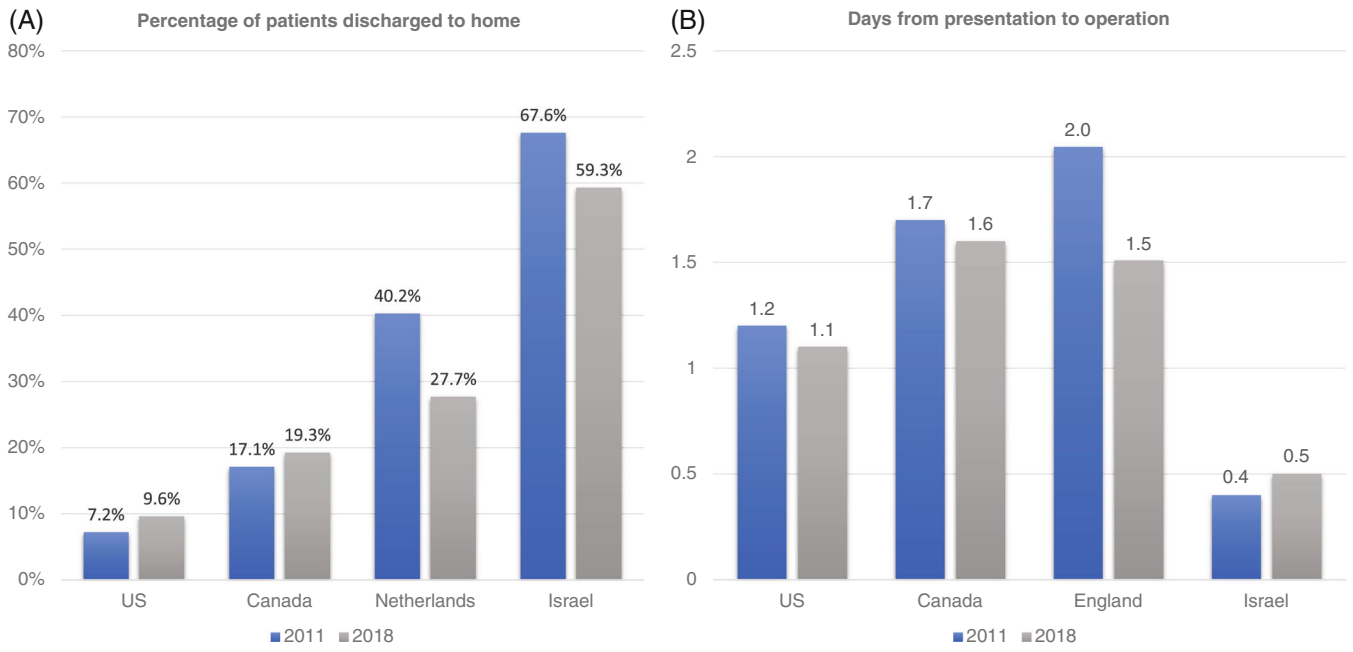

FIGURE 4 Age- and sex-standardized percentage of patients discharged to home and days from presentation to operation in 2011 and 2018.

~3% in the <90 cohort to ~10% in those 90 and older. In contrast, several of the countries showed relatively stable rates of nonoperative management. For instance, rates of nonrepair in the ≥90 versus <90 cohort in Canada and England showed a 2% or lower difference. Third, 30-day mortality rates were two times higher (or more) in the 90+ cohort versus those below 90 in all countries.

DISCUSSION

In this population-based study of patients hospitalized with acute hip fracture using health administrative data from six high-income countries, several findings are noteworthy. First, we observed substantial differences in both 30-day and one-year mortality across the countries, despite the similarities in the age and sex distribution of the populations. Second, there was marked between-country variation in the types of surgical repair used, and rates of nonoperative treatment varied by up to a factor of two in the most recent year. Third, we observed significant between-country differences in hospital LOS, readmissions, the proportion of patients discharged home, and time from hospital presentation to surgery, suggesting substantial opportunities for countries to improve the efficiency of care provision.

Several findings deserve further discussion. First, the finding that one-year mortality in certain countries, including the US and the Netherlands, was 10% higher than in other countries is noteworthy. The finding of high mortality in the US is concerning in the context of other recent studies demonstrating that American patients hospitalized with other conditions also seem to have significantly higher mortality than their international peers.[22,23] There is an urgent need to better understand the specific causes of this excess mortality in the US and to identify targets for intervention. The high mortality observed in the Netherlands is consistent with another recent study, but as in the US, we do not understand the underlying causes.[32] In contrast, the low mortality observed in Taiwan is interesting and consistent with a recent study that found lower inpatient mortality for patients in Taiwan than in either Japan or Korea.[19]

Second, despite an estimated 2.6 million hip fractures annually worldwide by 2025, there remains substantial uncertainty about which type of surgical repair a given patient should receive.[33] The choice of repair approach depends, in part, on the anatomy of the fracture (e.g., fixation for nondisplaced or intertrochanteric fractures versus THA or HA for displaced fractures of the femoral neck); age and functional status are also important considerations, with THA generally reserved for younger, healthier patients.[11,34] Though the HEALTH study found no appreciable benefit over 2 years for THA Vs. HA, we find wide variation in rates of THA and HA across the IHSRC countries. We also see rates of IF that vary by as much as 20%, which seems unlikely to be driven by differences in fracture epidemiology across countries. Thus, our study highlights the urgent need for more

randomized and comparative effectiveness trials to better understand the optimal treatment approaches for hip fracture in older adults.[11,12,35]

In the context of the limited evidence to guide the choice of repair strategies, it is essential to consider how best to interpret the between-country variation we observed. We suspect that the large variation between countries reflects differences in surgical team preferences and experience and in health system financing and organization within each country. This pertains especially to patients for whom several surgical options can be considered, as in the case of nondisplaced cervical fractures or the choice between THA and HA for displaced fractures.[11,12] Looking at specific countries is particularly interesting; in 2018, England had the highest use of THA (9.4% of fractures), HA (39.1% of fractures), and nonoperative management (9.7% of fractures) but far lower use of internal fixation (42.2%) than all other countries. Fixation is typically considered the least complex and least expensive surgical option, with HA being intermediate and THA being the most complex, requiring significantly more time and more costly implants than the other options but potentially better outcomes for younger and healthier patients. Our results suggest a more treatment-intensive approach for most patients in England, paired with a higher rate of nonoperative management, presumably reserved for the frailest patients. In contrast, in 2018, Taiwan had the lowest rate of both THA (0.7%) and nonoperative management (4.6%) but higher use of both HA and fixation.

We doubt that these differences can be attributed to country-specific clinical factors such as differences in fracture anatomy or patient complexity, given our rigorous study protocol designed to capture the whole hip fracture population in each country. Furthermore, our surgical procedure rates were age and sex standardized to enhance comparability. Instead, we suspect that policy decisions, such as how care is organized, reimbursed, and incentivized, play an important role. Since 2010, hospitals in England have been receiving a supplement for patient care that meets six clinical standards under the 'Best Practice Tariff' (BPT) program.[36] These include a timed surgery within 36 hours, geriatric and rehabilitation specialist evaluation, and admission according to joint assessment protocol. Israel reduced nonoperative rates by over half over the study period, possibly due to increased awareness of the importance of surgical repair and accompanying changes to direct payments for repair, particularly for THA, which tripled in rate.[37,38] In contrast, the Taiwanese reimbursement system may not adequately incentivize surgeons and hospitals to perform THA and HA, resulting in higher rates of less complex fixation.[19] In the US, modest rates of THA and higher rates of IF may well reflect discordance between the high amount of surgeon effort required to perform THA relative to reimbursement.[39] In aggregate, the variation that we see likely reflects the more intentional design of hip fracture management programs and reimbursement models in certain countries combined with a lack of compelling data to generate strong international consensus on the best approaches. Moreover, it is essential to acknowledge that variations in nonoperative rates are influenced by factors such as differing perspectives among surgeons, the availability of palliative care, and cultural and religious preferences surrounding end-of-life treatment.[7] These factors likely contribute to the variation in nonoperative management we observed and emphasize the need for future research to prioritize addressing them at a national level.

Third, it is important to consider health system performance measures. In 2018, mean hospital LOS ranged from 6.4 days in the US to 18.7 days in England, while 30-day readmissions ranged from 7.8% in Canada to 17.6% in England. The US (2018 LOS 6.0 days, readmission rate 11.6%) and the Netherlands (2018 LOS 8.0 days, readmission rate 8.0%) were both notable for short hospital LOS and low readmission rates. In the US, the short LOS is made possible by the high availability of skilled nursing facilities (SNFs). Alternatively, England's combination of prolonged hospital LOS and high readmission rates is likely reflective of misaligned incentives for either hospitals or surgeons and suggests significant opportunities for improvement from a system perspective. It is noteworthy that there was no clear relationship between LOS and readmission rates across the countries. This suggests that other factors, such as postdischarge care arrangements or patient characteristics, may be more prominent in determining readmission rates. Our finding that certain countries commonly discharged patients to postacute care while others discharged patients home is also important; in Israel, 59% of patients were discharged home compared to 10% in the US and 19% in Canada. These differences likely reflect each country's availability of and funding for postacute care and the expectations of patients and their families. In Israel, the high proportion of patients discharged home contributes to Israel's achieving good health outcomes while simultaneously spending only 7.5% of its gross domestic product (GDP) on healthcare. In contrast, patients in the US were rarely discharged home, which is consistent with a country that spends nearly 20% of its GDP on healthcare.[40] Notably, decreases in the use of postacute care under CMS's Comprehensive Joint Replacement and Accountable Care Organization bundled payment programs suggest that misaligned incentives for hospitals contribute to high rates of use in the US.[41,42]

Finally, there is convincing evidence that timely surgical repair is associated with improved patient outcomes,[5,43–50] and timely surgery is increasingly incentivized and monitored by payers and government regulators.[44,51,52] Our finding that the time from hospital presentation to surgery in 2018 ranged from 0.5 days in Israel to 1.6 and 1.5 days in Canada and England, respectively, is noteworthy and suggests significant opportunities for improvement. In 2004, Israel introduced a payment model that rewarded hospitals for surgical repairs completed within 48 hours but penalized hospitals for unjustified delays.[52] Interestingly, while both Canada and England have recommendations and guidelines advocating early repair,[53,54] the financial incentives in both countries are less tangible and direct, which may explain the differences that we observed.

Our study has several limitations that should be acknowledged. First, our data are based on health administrative records; we lacked detailed clinical information on fracture subtype (i.e., cervical vs. intertrochanteric) as well as patient complexity and acuity that could influence treatment decisions. However, our large population-representative cohorts and detailed inclusion and exclusion criteria make it unlikely that widespread between-country differences in fracture subtype or patient complexity could explain our findings; moreover, we standardized for age and sex, thus adding further strength to our results. Second, although we use population-representative patient-level administrative data, we lacked data from 2011 and 2012 in the Netherlands and data about time-to-surgery and discharge disposition in England and Taiwan. Finally, we limited our study to hip fracture patients aged 66 years or older due to data availability in the US. However, most hip fractures occur in this age group.[1] Thus, the findings may not be generalizable to younger patients or those covered by private insurance or Medicare-managed care in the US.

CONCLUSION

We discovered substantial between-country variation in mortality, in addition to similarly large differences in surgical approaches and health system performance measures. The study findings emphasize the need for further research that can provide objective evidence for the superiority of specific surgeries based on patient clinical conditions.

AUTHOR CONTRIBUTIONS

Study conceptualization: Nitzan Burrack, Bruce E. Landon, Laura A. Hatfield, Pieter Bakx, Amitava Banerjee, Victor Novack, Dennis T. Ko, and Peter Cram. *Statistical analysis*: Nitzan Burrack, Laura A. Hatfield, Saeed Al-Azazi, Yu-Chin Chen, Christina Fu, Renaud Heine, Nicole Huang, Laura Pasea, Feng Qiu, and Gabe Weinreb. *Acquisition of data*: Bruce E. Landon, Amitava Banerjee, Nicole Huang, Dennis T. Ko, Lisa M. Lix, Victor Novack, Michal Gordon, Therese A. Stukel, Carin Uyl-de Groot, and Peter Cram. *Obtaining funding*: Peter Cram and Bruce E. Landon. *Writing—Original Draft Preparation*: Nitzan Burrack. *Writing—Review and Editing*: All.

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CONFLICT OF INTEREST STATEMENT

We declare no competing interests.

DATA AVAILABILITY STATEMENT

Data are largely unavailable because of the privacy regulations of participating jurisdictions.

SPONSOR'S ROLE

The funders had no role in study design, data collection and analysis, the decision to publish, or the preparation of the manuscript.

ETHICS STATEMENT

Approvals from each country can be found in the Supplementary Appendix.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Supplementary S1. Description of data sources and research ethics approval from each country/jurisdiction.

Supplementary S2. List of codes used by each country to identify hip fractures, Total hip arthroplasty (THA), Hemiarthroplasty, and Internal Fixation (IF).

Supplementary S3. Cohorts generation steps.

Supplementary S4. Number of hip fracture hospitalizations by country and year.

Supplementary S5. Age- and sex-standardized incidence of hospital admissions for hip fracture by country and year, admissions per 1000 per year.

Supplementary S6. Age and sex standardized mortality and readmissions after hospitalization for hip fracture by country, 2011–2018.

Supplementary S7. Age and sex standardized percentages of patients receiving THA, HA, and IF for patients hospitalized with hip fracture, 2011–2018.

Supplementary S8. Age and sex standardized percentages of patients receiving THA, HA, and IF for patients hospitalized with hip fracture for all years, by country.

Supplementary S9. Stratified Age and sex standardized percentages of patients receiving THA, HA, and IF for patients hospitalized with hip fracture, 2011–2018.

Supplementary S10. Stratified Age and sex standardized mortality for hip fracture by country, 2011-2018.

Supplementary S11. Age and sex standardized percentages of patients receiving THA, HA, and IF for patients hospitalized with hip fracture, 2011-2018 (Netherlands before upscaling).

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