Distal radius fractures
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Analysis of variation in the surgical treatment of distal radial fractures in the Netherlands
The purpose of this study was to examine the variation in surgical treatment rates of patients with distal radius fractures across Dutch hospitals. We obtained all reimbursement data for the treatment of distal radius fractures for 2012 and 2013 categorized by hospital. The surgical rate across hospitals was corrected for possible explanatory variables using linear regression analyses. We analysed a total of 95,754 reimbursements. The operative rate ranged from 0% to 23%, with a mean of 9.6%. Hospital type, the percentage of females, the percentage of patients over 65, the mean age, average socioeconomic status and the total number of patients treated explained only 2.6% of the observed differences in the operative rate among hospitals in 2012 and 11.6% in 2013. Our results suggest that subjective factors, such as surgeon’s opinions and preferences, significantly influence therapeutic decisions in patients with distal radius fractures.
INTRODUCTION

While the optimal treatment for many patients with distal radial fractures is uncontroversial, there are substantial numbers in whom the best management remains a matter of debate. Patient age, fracture pattern, displacement and alleged fracture instability are considered crucial to guide treatment. However, in the absence of recommendations substantiated by evidence in current guidelines, the choice of treatment is likely to be influenced by factors, such as the availability of resources, surgeon density, socioeconomic circumstances and surgeon’s preference. These preferences in turn vary according to surgeon’s age and background. All these factors will potentially result in regional variations in the treatment of patients with distal radius fractures.

Considerable variations in medical practice have already been documented for a number of elective procedures, such as tonsillectomy, hip replacement and prostatectomy. Variation in healthcare practices can arise from three general factors: chance alone, patient-related factors and provider-related factors. Generally, some variation is warranted if it is attributable to patient-related factors that affect the need for surgery. Such factors include variations in regional incidence of diseases that demand surgical treatment, regional differences in patients’ willingness to undergo surgical intervention and the presence of specialized referral centres. Differences in patient-related factors are also known as the case-mix of a treatment centre.

However, surgical variation can also be caused by provider-related (or care-related) factors. These include physicians’ local culture of beliefs and preferences about appropriateness of surgery; the extent to which physicians include patients in treatment decisions; and broader factors such as regional diffusion of developments in surgical care. Variation based on these factors is unwarranted and suggests the potential to improve cost-effectiveness by reducing provision of unnecessary surgery.

Nevertheless, variation cannot be regarded as strictly unwarranted if there is no clear optimum treatment. The results of one large randomised clinical trial have been published recently, and the results of other trials to delineate the optimum treatment for distal radius fractures are awaited. Until better evidence is available, the first step in addressing potentially unwarranted variation is to gain insight into the extent to which variation across practices exists.
Only one previous study has examined such variation in distal radial fracture management across regions or practices. In this study, the authors assessed the regional variation in treatment of distal radius fractures in the United States.\textsuperscript{13} They studied a sample of Medicare claims and found a significant variation that was mainly driven by age and region. However, variation in the surgical treatment rate of distal radius fractures has never been investigated in a European setting. We hypothesized that, although the Dutch health care system is different from that in the United States and basic health insurance is mandatory, there would still be a considerable variation in practice. Hence, the aim of this study was to examine the variation in surgical treatment rates across all Dutch hospitals.

**METHODS**

We obtained data for the calendar years 2012 and 2013 from the national insurance database on healthcare; this covers 100% of the Dutch population. This database is managed by a third party (Vektis, Zeist, The Netherlands) and contains reimbursement data of all medical treatments paid for by Dutch insurance companies. Almost 99% of Dutch inhabitants have private health care insurance, which pays for treatment of a distal radius fracture (http://statline.cbs.nl/Statweb/?LA=en). Reimbursement of hospital care is exclusively claimed using the Diagnosis Treatment Combinations Codes (Diagnose Behandeling Code (DBC)). These codes are recorded by physicians for reimbursement purposes, similar to the internationally recognized Disease Related Group system. Each DBC code contains information about the diagnosis, the type of treatment and the physician. DBC codes for distal radius fractures differentiate between conservative treatment and surgical treatment. The billing for a conservatively (non-operatively) treated distal radius fracture is €506 and €6073 for a surgically treated distal radius fracture. Our database comprised the following data arranged by each Dutch hospital: the number of patients treated conservatively, the number of patients treated surgically, the percentage of female patients, the percentage of patients aged over 65 years, the mean age and the mean socioeconomic status.

Socioeconomic status was based on patients’ residential postal codes, which were correlated to data from 2010 from the Netherlands Institute for Social Research. The socioeconomic status indicates the social status of a neighbourhood compared with different neighbourhoods in the Netherlands. Neighbourhoods
are classified as districts with the same 4-number zip code. The socioeconomic status is the sum of four parameters: the average income in a neighbourhood, the percentage of people with low incomes, the percentage of low-skilled people and the percentage of people who are unemployed. The higher the score, the better the socioeconomic status of the neighbourhood. A negative score indicates that the socioeconomic status of the neighbourhood is below the average status in the Netherlands. For a small percentage of DBCs (<0.1%), no patient characteristics were available. These DBCs were equally distributed across all hospitals.

Data were provided as aggregate data arranged by hospital. There are four types of hospital in the Netherlands: (1) university hospitals; (2) tertiary teaching hospitals that provide both basic and highly specialized care and train doctors in collaboration with university hospitals; (3) general hospitals that provide non-specialized care; and (4) independent single-specialty treatment centres for specialist care. In the Netherlands, most patients with fractures are treated by trauma surgeons with a general surgery background. Only a small percentage is treated by orthopaedic surgeons.

For the purpose of our analyses, we assumed that the number of procedures (both conservative and surgical treatment) equalled the number of patients. This assumption does not account for patients with bilateral fractures; however, from experience we expect this number to be negligible and estimate that it is not more than 50 patients each year.14

Data were analysed using SPSS version 21.0 (IBM Corp. Released 2012, IBM SPSS Statistics for Windows, Version 21.0: IBM Corp, Armonk, NY). Continuous variables were reported as mean with standard deviation. We created dummy variables for the categorical variable hospital type. We used ordinary multiple linear regression analyses to model the relationship between the surgical treatment rate and possible explanatory variables (hospital type, percentage of females, percentage of patients over 65, mean age, mean socioeconomic status and total number of patients). A value of p<0.05 was considered significant in the linear regression analyses.
RESULTS

We obtained aggregated data on a total of 95,754 reimbursements for distal radius fractures: 49,615 in 2012 and 46,139 in 2013. A total of 79% of the patients were treated by a general/trauma surgeon and 21% by an orthopaedic surgeon. Overall, general/trauma surgeons had an operative rate of 10% and orthopaedic surgeons a rate of 9%.

The operative rate per hospital ranged from 0% to 23%. Figures 1 and 2 illustrate the spread in operative rates per hospital in 2012 and 2013. The mean operative rate was similar for 2012 and 2013, 9.6% with a standard deviation of 3.9% and 3.8%, respectively (Table 1).

The 90 hospitals in the Netherlands included in this study comprised eight university hospitals, 53 general hospitals, 28 tertiary teaching hospitals and one independent treatment centre specialized in orthopaedic surgery. The operative rate was highest in the university hospitals (Figure 3).

Regression analysis showed that hospital type, the percentage of females, the percentage of patients over 65, the mean age, the mean socioeconomic status and the total number of patients explained 2.6% of the differences in the operative rate among hospitals in 2012, and 11.6% in 2013 (adjusted R squared =0.026 and 0.116). Except for the mean age in 2013, none of these variables was independently related to the operative rate (Table 2).

<table>
<thead>
<tr>
<th>Table 1. Demographic overview (N = 95,754)</th>
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<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>Percentage of operative treatments (minimum-maximum)</td>
</tr>
<tr>
<td>Percentage of females (minimum-maximum)</td>
</tr>
<tr>
<td>Percentage of patients &gt;65 (minimum-maximum)</td>
</tr>
<tr>
<td>Mean age (minimum-maximum)</td>
</tr>
<tr>
<td>Mean SES (minimum-maximum)</td>
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</tbody>
</table>

SES: socioeconomic status
Figure 1. Operative rates per hospital for 2012. Each bar reflects the percentage of operative treatments in one hospital in the year 2012, arranged from high to low.

Figure 2. Operative rates per hospital for 2013. Each bar reflects the percentage of operative treatments in one hospital in the year 2013, arranged from high to low. Please note: because the percentage are arranged from high to low, the first bar in this graph reflects the hospitals with the highest operative rate in 2013. This is not necessarily the same hospital depicted by the first bar in the graph for the year 2012.
Table 2. Results of multiple linear regression analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>p-value</td>
</tr>
<tr>
<td>University hospital</td>
<td>0.008</td>
<td>0.686</td>
</tr>
<tr>
<td>Tertiary teaching hospital</td>
<td>0.009</td>
<td>0.382</td>
</tr>
<tr>
<td>Percentage of females</td>
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<td>0.896</td>
</tr>
<tr>
<td>Percentage of patients &gt;65</td>
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<tr>
<td>Mean age</td>
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<td>0.089</td>
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<tr>
<td>Mean SES</td>
<td>0.007</td>
<td>0.391</td>
</tr>
<tr>
<td>Total number of patients</td>
<td>0.000</td>
<td>0.935</td>
</tr>
</tbody>
</table>

The regression coefficients represent the mean change in the operative rate for one unit of change in the predictor variable while holding other predictors in the model constant. The p-value of each predictor is a reflection of whether the linear relationship between the predictor and the operative rate is significant (p<0.05 was considered significant). Values presented in **bold** are statistically significant. SES: socioeconomic status; B: regression coefficient.

Figure 3. The median of the operative rates per hospital type. There is only one independent treatment centre where three patients in 2012 and no patients in 2013 were treated operatively. IQR: interquartile range.
DISCUSSION

There is considerable variation in the treatment of patients with distal radius fractures across the Netherlands, with operative rates varying from 0% to as much as 23%. These differences could not be explained by the hospital type, the percentage of females, the percentage of patients over 65 years of age, the mean age, the mean socioeconomic status or the total number of patients in each hospital. In fact, there was no single variable that was significantly associated with the operative rate. Only the mean age of the patients had a small significant influence on the operative rate in 2013 (B=0.005, p=0.022). Adjusted for the other factors, an increase in average age of the population of 1 year, results in an average increase in operative rate of 0.5%. However, this relationship was not significant for 2012.

These results might suggest that the choice for operative treatment of patients with distal radius fractures is not completely attributable to patient-related factors, but also to care-related factors such as the surgeon’s beliefs and preferences. Previous studies have already indicated that younger surgeons are more likely to perform open reduction and internal fixation (ORIF) of distal radius fractures in patients over 65 years of age compared with older surgeons. The surgeon’s background also plays a role: orthopaedic surgeons are significantly more likely to use ORIF than hand surgeons. Given the lack of evidence supporting the appropriate treatment option for most patients with distal radius fractures, these findings are not surprising. After all, in the absence of an optimum treatment, a surgeon’s preference (ideally in a shared decision-making process with the patient) is decisive.

Another possible explanation for differences in operative rates is the high variability in fracture patterns. Every patient is unique and every fracture is different, thus requiring a patient-tailored treatment. The higher operative rate found in university hospitals might be explained by a larger percentage of multitrauma patients who sustained high energy trauma resulting in comminuted fractures.

This study has several limitations. The usefulness of reimbursement data is limited by the depth of the data. Ideally we would have considered other case mix factors that might influence the type of treatment, such as injury mechanism, fracture pattern, hand dominance, functional status of the patient and occupation. Unfortunately, this data is not centrally registered, nor is it possible to receive individual patient data due to confidentiality issues. Therefore, aggregated data...
per hospital was provided. We attempted to correct for individual differences by accounting for the percentage of females and the percentage of patients over 65 years of age in each hospital. However, correcting for age, sex and social economic status is only a surrogate for all factors that might influence choice of treatment. Therefore, the results of our study should be interpreted with some caution.

Another limitation of the data is that the reimbursement codes do not differentiate between external fixation and ORIF. In our experience, external fixation is performed infrequently and surgeons prefer ORIF.\textsuperscript{17,18} Nevertheless, we were unable to examine any difference in the rates of external fixation among hospitals.

Although our results only relate to the situation in the Netherlands, variation in surgery rates within countries has been noted in other locations.\textsuperscript{7} A previous study by Fanuele et al. (2009) already showed a significant regional variation in the treatment of distal radius fractures in the United States.\textsuperscript{13} They concluded that the type of treatment depended mostly on the patient’s age and address. We also found a substantial variation among hospital service areas; however, the patient’s age appeared to be of minor importance.

Variation in treatment is not just restricted to distal radius fractures. Considerable variations in medical practice have previously been identified for a number of elective procedures, such as tonsillectomy, hip replacement and prostatectomy.\textsuperscript{7,19} Some of this regional variation might be due to the presence of specialized referral centres that focus on operative treatment of complicated cases. However, distal radius fractures are not commonly referred to specialized centres but treated locally in the nearest hospital. It is also evident from our data that all hospitals in the Netherlands, including highly specialized university hospitals, treat patients with distal radius fractures. Patients with distal radius fractures are thus a valid population for a variation in treatment study.

Considering the €5500 difference in billings between conservative treatment and surgical treatment, and assuming that conservative treatment prevails in the majority of the cases, there is a substantial potential to reduce costs. If we regard an operative rate of 10% appropriate (around the mean that we observed in 2013), the annual savings from one hospital with a rate of 15% and a volume of 600 patients are potentially as high as €165,000 (0.05 × 600 × €5500). On a national scale, this figure could run into millions of Euros cost-savings each year. Conversely, the low operative rates found in some hospitals could also be an indication of suboptimal treatment of patients with distal radius fractures. A hospital that has an operative rate of only 5% might achieve worse functional results than a hospital with a higher rate.
Our database provided a comprehensive overview of all reimbursements of distal radius fractures in the Netherlands. It also showed that there is considerable variation in the treatment of distal radius fractures among hospitals. Although these findings might not be surprising, they are alarming. The variation across the country reflects a lack of evidence and suggests that non-scientific influences, such as surgeon's age, background and local culture, prevail and drive therapeutic decisions.

The appropriate rate of operative treatment for a given case-mix of distal radial fractures is unknown, and without detailed information on individual patients, their injuries and outcomes, it is impossible to comment on the appropriateness of surgical intervention. Nevertheless, the variation that we observed suggests the potential for improved quality and appropriateness of care for patients with distal radius fractures. It also supports the notion that we require well-designed randomised studies to delineate the optimum treatment for patients with distal radius fractures.20
REFERENCES


