Urban–rural differences in total hip replacements: the next stage
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Abstract

Background The aim of this study was to explore the differences in the incidence of primary elective total hip replacements between urban and rural communities and different age and sex groups in Northern Ireland, and to use this information to develop an equitable method for the allocation of surgical capacity among groups of general practices, in a system where referrals are matched to the contracted capacity.

Methods A retrospective review was performed of all cases of primary elective total hip replacement between 1 April 1994 and 31 March 1997. Incidence rates were calculated using direct standardization. Age, sex, and urban and rural specific rates for Northern Ireland were calculated and applied to each general practice population giving that practice’s annual expected number of total hip replacements.

Results A total of 4147 cases were analysed. The age and sex standardized incidence of primary elective total hip replacement for the total population was 87.6 per 100 000. The incidence was significantly greater in rural populations (101.3 per 100 000), than in urban ones (77.6 per 100 000), \( p < 0.001 \). The overall standardized ratio of males to females was 1:1 although it was 1:1.2 in urban and 1:0.9 in rural populations. Using a 3 year commissioning cycle, commissioning for a population of 130 000 allows a 10 per cent margin of error in the numbers of procedures required.

Conclusions A system of calculating the expected need for a total hip replacements was developed based on the demography and rurality of individual general practices. This system allowed a method of commissioning to be instituted that could significantly reduce in-patient waiting lists for this procedure.

Keywords: total hip replacement, needs assessment, rural, commissioning

Introduction

The length of orthopaedic waiting lists both for in-patients and out-patients has been a UK-wide problem for over a decade. In Northern Ireland in 1994 an orthopaedic out-patient booking system was developed where each general practice was allocated a predetermined number of out-patient appointments or ‘slots’. The calculation of the slots was based on the local clinic capacity serving an area and was divided equitably between the general practitioners (GPs) within that area depending on their practice population size. During the development of the slot system, it was known that there were a number of flaws, the main one being that the slot allocations were based on historical clinic capacity and not any measure of need.

Most GPs were satisfied that the out-patient service had improved, as they decided when patients were seen. The in-patient service for total hip replacements was still a problem, as there remained a long waiting list for surgery. It was suggested that the same slot concept could be applied to in-patient surgery for total hip replacements. The GPs would thus decide when each of their patients should receive surgery after an orthopaedic surgeon had determined their need for surgery.

Existing research has indicated that labour-intensive occupations, such as farming, lead to a higher rate of osteoarthritis and ultimately the need for total hip replacement.\(^1\) A number of GPs were aware of this and expressed a desire that future allocations of slots would take into account not only the age and sex breakdown, but also the urban–rural mix of their practice (D. Beverland, personal communication, 1993).

National rates for total hip replacements are often unhelpful, as differences in the regional population age and sex structure and greatly differing levels of past activity render any mean level irrelevant to local circumstances.\(^2\) It was therefore clear that a targeted approach to the estimation of need was required that was specific to Northern Ireland. A retrospective study was therefore designed to determine age, sex, and urban and rural specific rates for primary elective total hip replacements for the...
population in Northern Ireland using data routinely collected by the hospital information systems.

Methods

All providers of total hip replacement surgery, within both the National Health Service and the private sector, were invited to take part in the study. Information on patients who had travelled to Scottish hospitals for their surgery was also sought. The National Health Service data were collected through downloads from the Belfast Orthopaedic Information System and the hospital Patient Administration System of the main providers. The information on private patients was obtained through manual searches of theatre registers and case notes, if required. The information on each patient included age, sex, postal address, attending GP and underlying diagnosis necessitating surgery. Patients who resided outside Northern Ireland, patients who had their surgery because of a fractured neck of femur and those undergoing revision procedures were excluded.

A population density definition of urban and rural areas was used at electoral ward level, as this was the lowest level at which information on persons per hectare was available – taken from the 1991 Census. An urban ward was defined as having five or more resident persons per hectare and a rural ward as having four or fewer. These definitions were in keeping with other publications. All patients were allocated to an urban or rural ward. Urban or rural and gender specific rates were calculated for each age group starting at age 20 and progressing in 5 year intervals to 89 years. Those over 90 years constituted a single group. Incidence rates were directly standardized using the total population of Northern Ireland as the standard. Confidence intervals (CIs) were computed for the rates using tabular values based on the Poisson distribution. The independent samples t-test was used for the comparisons of means for the demographic variables.

Information on age, sex and postal address was available on all patients in each general practice in Northern Ireland. It was therefore possible to calculate population counts for urban and rural, males and females for each practice. The Northern Ireland age, sex, and urban and rural specific total hip replacement rates were then applied to these totals to calculate expected numbers of total hip replacements for each category. The numbers for each age group were aggregated to a final practice total. These were compared with historical numbers of total hip replacements actually carried out for these practices over the previous 3 years. The standard error of the observed to expected ratio was calculated along with 95 per cent CIs. Using the standard deviation of the Poisson distribution, CIs around the expected number of procedures were calculated for differing sizes of patient populations.

Results

Records were obtained on 4242 cases of primary total hip replacement between 1 April 1994 and 31 March 1997. There were 235 patients who had both of their hips replaced; these patients are recorded as two cases each in the study. Ninety-five cases were excluded, 30 of these because they had received surgery as a result of a fractured neck of femur, 10 because their underlying diagnosis was recurrent dislocation, fractured shaft of femur or a complication of implant, 21 because they lived outside Northern Ireland and 34 because their address was missing or inadequate to allow allocation to an urban or rural ward. One of the private hospitals was unable to locate data on patients receiving surgery during the first 3 months of the study period. Approximately 20 cases may have been missed, based on its final total.

The National Health Service provided surgery for 3791 (89.4 per cent), and 433 (10.2 per cent) of cases received their surgery in the private sector. Eighteen patients (0.4 per cent) received their surgery in hospitals outside Northern Ireland.

There were 4147 cases in the final group for analysis. The incidence of primary total hip replacement was 87.6 per 100 000 population. In the urban population the incidence was 77.6 per 100 000 and in the rural population 101.3 per 100 000 population. The annual incidence for each age group is shown in Table 1. The urban and rural and sex specific rates for each age group are shown in Table 2.

The mean age at operation for males was significantly younger at 68 years (SD 10) than that for females at 70 years (SD 11) (p = 0.001). The rural patients were also significantly younger than the urban ones (p = 0.002). Although 59 per cent of patients were female, after standardization the ratio of the incidence of primary elective total hip replacement between males and females was 1:1 (p = 0.32; 95 per cent CI 0.91–1.03). In urban areas the ratio of the incidence of hip replacement was 1:1.45 (95 per cent CI 1.03–1.93) and in rural areas was 1:1.44 (95 per cent CI 0.96–2.16).

Table 1 Annual age specific rates per 100 000 population for primary elective total hip replacement in Northern Ireland, with 95 per cent CIs

| Age group | Rate per 100 000 population | 95 per cent CI |
|-----------|-----------------------------|---------------|
| 20–24     | 1.06                        | 0.29–2.71     |
| 25–29     | 1.91                        | 0.77–3.93     |
| 30–34     | 4.99                        | 2.90–7.98     |
| 35–39     | 9.70                        | 6.53–14.04    |
| 40–44     | 17.01                       | 12.62–22.45   |
| 45–49     | 30.40                       | 24.17–37.70   |
| 50–54     | 72.94                       | 62.51–85.12   |
| 55–59     | 138.13                      | 123.21–154.84 |
| 60–64     | 277.13                      | 255.51–300.41 |
| 65–69     | 377.28                      | 350.87–405.58 |
| 70–74     | 512.68                      | 477.82–549.59 |
| 75–79     | 598.58                      | 556.68–643.47 |
| 80–84     | 620.70                      | 565.46–681.53 |
| 85–89     | 438.45                      | 374.00–513.86 |
| 90+       | 253.51                      | 176.70–352.38 |

Table 2 Gender specific rate ratios for primary elective total hip replacement in Northern Ireland

| Gender | Rate Ratio | 95 per cent CI |
|--------|------------|---------------|
| M/F    | 0.91       | 0.89–0.93     |
| U/R    | 1.04       | 0.97–1.11     |
replacement between males and females was 1:1.2 (0.83) $(p \leq 0.001; 95\% \text{ CI} 0.75–0.89)$. The reverse pattern was seen in rural areas, with a higher proportion of males receiving surgery, the male to female ratio being 1:0.9 (1.11) $(p \leq 0.001; 95\% \text{ CI} 1.05–1.25)$.

The standardized ratio of urban to rural for the cases studied was 1:1.3 (0.77) and the greater proportion of rural cases was statistically significant $(p \leq 0.001; 95\% \text{ CI} 1.05–1.25)$. The distribution of diagnoses did not differ significantly between urban and rural populations $(p = 0.52)$, with 81 per cent of patients having osteoarthritis, 10 per cent painful hip, 4 per cent rheumatoid arthritis and 5 per cent other diagnoses such as congenital dysplasia and avascular necrosis. Most of the patients diagnosed as ‘painful hip’ (an inappropriate diagnostic code) would probably have had osteoarthritis.

Applying the rates in Table 2 to each general practice population gave the expected annual requirement for primary elective total hip replacements for that practice. Table 3 shows an example of the results for a mainly urban practice, a mainly rural one, a mixed practice and a group of practices working as a total purchasing pilot, with the standard error and 95 per cent CIs.

Because of concerns regarding commissioning risks for small practices with year-to-year fluctuations in activity, demonstrated by the wide confidence intervals, calculations of margins of error for different population sizes were made. Commissioners serving a population of approximately 400 000 people, and allowing a 10 per cent margin of error, would require 400 procedures in 1 year based on the Poisson distribution. Alternatively, commissioning for a population of 130 000 people over a 3 year period would also require 400 procedures with the same margin of error.

**Discussion**

The finding of an increased incidence of primary elective total hip replacements in rural populations is not a new one. Although others outside Northern Ireland would need to determine the actual age, sex, and urban and rural specific rates for their own region, the authors hope that the model described here will be of practical use in the application of local rates in the estimation of the requirement of total hip replacements for their population.

There are well-recognized problems with routine health

| Table 2 | Annual age, sex, and urban and rural specific rates per 100 000 population for primary elective total hip replacement for Northern Ireland |
|---|---|---|---|---|
| Age group | Urban females | Urban males | Rural females | Rural males |
| 20–24 | 0.00 | 0.00 | 3.88 | 1.18 |
| 25–29 | 2.75 | 0.98 | 0.00 | 3.76 |
| 30–34 | 6.07 | 4.34 | 8.05 | 1.33 |
| 35–39 | 12.15 | 2.54 | 10.54 | 14.31 |
| 40–44 | 22.04 | 10.38 | 21.10 | 14.50 |
| 45–49 | 23.59 | 28.93 | 39.99 | 31.23 |
| 50–54 | 43.15 | 55.02 | 96.74 | 111.26 |
| 55–59 | 148.95 | 110.29 | 150.02 | 146.40 |
| 60–64 | 252.86 | 236.63 | 283.14 | 364.19 |
| 65–69 | 363.60 | 271.73 | 384.08 | 530.06 |
| 70–74 | 522.50 | 342.41 | 563.89 | 634.33 |
| 75–79 | 533.58 | 532.36 | 679.16 | 705.12 |
| 80–84 | 584.68 | 498.54 | 682.80 | 758.17 |
| 85–89 | 463.46 | 448.87 | 401.36 | 415.51 |
| 90+ | 302.90 | 342.94 | 199.45 | 71.23 |
| All ages | 83.6 | 69.3 | 95.3 | 108.2 |

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There are well-recognized problems with routine health

| Table 3 | Expected numbers of primary elective total hip replacements (THR) by practice with standardized ratios, standard error and 95 per cent CIs |
|---|---|---|---|---|
| Practice A | Practice B | Practice C | Practice D |
| List size (20+ years) | 5857 | 5862 | 5775 | 31 608 |
| Expected THR | 5857 | 5862 | 5775 | 31 608 |
| Urban females | 0.08 | 3.44 | 2.67 | 16.07 |
| Rural females | 3.51 | 1.01 | 1.36 | 6.84 |
| Urban males | 0.54 | 2.09 | 1.79 | 10.07 |
| Rural males | 3.28 | 0.97 | 1.11 | 6.13 |
| Total THRs required | 8.21 | 7.51 | 6.93 | 39.11 |
| Standardized THR ratio | 1.22 | 0.67 | 0.82 | 0.76 |
| Standard error | 0.39 | 0.30 | 0.34 | 0.14 |
| 95% confidence limits | 0.46, 1.98 | 0.08, 1.26 | 0.15, 1.49 | 0.49, 1.03 |

Practice A, mainly rural population; practice B, mainly urban population; practice C, evenly split urban–rural population; practice D, group of fundholding practices working as a total purchasing pilot.
service data systems and therefore the potential for inaccuracy must be considered. Most of the data for this study came from a specially designed system for the main orthopaedic provider. It gives more detail than routine hospital information systems and we are confident that only primary elective procedures were included. The private patients were identified through theatre registers, which are recognized as being an accurate record of surgical events in a hospital.

Other studies on this topic have excluded fractured neck of femur, so for comparability this category was excluded from the present study also. As revision surgery for total hip replacements is likely to increase in the future, it is important to ascertain rates for elective surgery, and an allowance for revisions can be added as and when they change over time.\textsuperscript{2}

The incidence rates reported here are slightly higher than reports elsewhere.\textsuperscript{4,6} In the 5–10 years between data collection for these studies and the present one, a wider group of patients are being accepted for surgery. Differences may also be due to the fact that all private surgery has been included and some previous studies have not had access to private cases. This could have significant implications, as the estimated proportion of hip replacements carried out in the private sector was 28 per cent for England and Wales.\textsuperscript{7} However, the proportion is less in Northern Ireland, at 10 per cent. Also, in other studies, cases may have been missed if patients received surgery outside their own region. Northern Ireland is ideal in this respect as very few patients leave the region for routine medical treatment.

Experience has shown the futility of attacking waiting lists in a one-off manner without other changes allowing the demand to be tailored to the available supply.\textsuperscript{8} Using the rates calculated in this study an indicative figure produced for each practice, or group of practices, represents the number of procedures required for their population per year. The existing waiting list of patients before the introduction of the new system would be reviewed and cleared through a commitment of the Trust to treat extra cases, and the GPs agreeing to defer surgery for some patients. Having agreed a contract for a number of procedures, the number of patients referred would equate to the number of slots available.

Referrals would be based on the agreed guidelines in the proforma developed jointly between GPs and orthopaedic surgeons. Patients would be referred to a dedicated clinic for pre-operative assessment and arrangements made for surgery within a defined period. If a patient was referred and did not receive a total hip replacement they would not use up a surgical slot. Practices would come on line with the new system in a phased manner because of the workload involved in clearing the existing waiting list. The numbers of contracted procedures would be reviewed annually to ascertain if the calculations were in keeping with the GPs’ perceived need.

One critical element of the process is the size of population for whom this commissioning process takes place. The wide confidence intervals seen for the smaller practices highlight that, to be effective, commissioning for this procedure needs to be based on larger numbers. It also underscores the necessity for groups of practices to come together and agree an acceptable margin of error, ideally over a 3 year cycle. The practices must then agree and tailor their protocols to ensure that managed demand meets capacity. The move towards primary care groups may well facilitate the joint commissioning required.

Now that this approach has been developed, and after it has been tested in practice, it could be expanded to include other procedures provided there is a recognized and acceptable level of need.

The observed variation between urban and rural communities is an important one and research is required to explore some of the possible etiological factors underlying these differences. It is not known what proportion of the observed difference is due to a true increased incidence of disease in rural populations and what part higher functional requirements and greater perceived disability play in referral and acceptance for surgery.

Waiting lists, specifically those for primary total hip replacement, have been a major issue for successive Governments, commissioners and trust managers. Undoubtedly, a solution will be found only when commissioners and providers work together in trying to achieve it.

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