

## Web references

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## Methods

[posted as supplied by author]

### 1. General HES data processing

The Dr Foster case note is based on analysis of Hospital Episode Statistics (HES). These are data that are routinely collected within the health service for administrative purposes and not specifically for clinical audit. There may be issues regarding coverage, completeness and accuracy that need to be considered when interpreting the results. In addition, the capacity to adjust for confounding factors is in general limited to the information available in the data, although where appropriate, we are able to adjust by area-level socio-economic deprivation using the postcode of residence.

The data are in the form of consultant episodes (the continuous period during which the patient is under the care of one consultant), which need to be linked into admissions (or “spells”). About 10% of spells comprise more than one episode. From 2000/1 we have been given *HESID*, derived by the Department of Health by comparing date of birth, sex, postcode, NHS number and local patient ID, and have been using this as a patient identifier. Only ages within the ranges 1-120 and 7001-7007 (special values to indicate age in months for children under 1 year) are considered valid. Duplicate records (those with the same combination of provider, date of birth, sex, postcode, date of admission and episode number (*PROCEDURE*, *DOB*, *SEX*, *HOMEADD*, *EPISTART*, *EPIEND*, *EPIORDER*) and unfinished episodes are excluded. Some spells have the same date of admission (*ADMIDATE*) but different dates of discharge (*DISDATE*). This is not valid unless the patient was discharged and readmitted on the same day: if not, the spell with the earliest *ADMIDATE* was arbitrarily taken to be the valid one. Episodes relating to the invalid spell are excluded at this stage. Remaining episodes are sorted by provider, date of birth, sex, postcode, date of admission, date of discharge and episode number (*PROCEDURE*, *DOB*, *SEX*, *HOMEADD*, *ADMIDATE*, *DISDATE*, *EPIORDER*). Episodes are not required to be in strict sequence, only in chronological order. For example, if the first one had *EPIORDER*=01, the second one had *EPIORDER*=03 and the last one of the same spell had *EPIORDER*=99, then the three episodes are treated just the same as if they were numbered 01, 02 and 03 (as most multi-episode spells are). The dataset is then split into the first and last episodes of each spell (which are often the same, as most spells comprise only one episode). The primary diagnosis (*DIAG1*) is taken from the first episode if it is not a symptom and signs code (‘R code’), when *DIAG1* is taken from the second episode, unless it too contains an R code, when the first episode is used. Outcome variables are taken from the last

episode (*DISMETH* (method of discharge), *DISDEST* (destination on discharge), *DISDATE*). *DISMETH*='4' is used to indicate death (it does not always coincide with *DISDEST*='79' but it is used by the DH). The length of stay is defined as *DISDATE* minus *ADMIDATE*; spells with missing or negative lengths of stay are excluded.

Spells ending in transfer to another NHS hospital are linked together, allowing for a difference between discharge from the first trust and admission to the next trust of up to two days, using *DISDEST*, *ADMIMETH* and *ADMISORC* values of 49, 50, 51, 52 and 53 (which refer to NHS units). Deaths occurring post transfer are allocated to the first trust.

As hospitals merge and services reorganised, provider codes (*PROCODE*) may change from one HES year to the next. In order to track hospitals over time, the provider codes need to be unified, i.e. just one code needs to identify each trust throughout. To date, codes have been unified as of the trust status at April 1<sup>st</sup> 2005.

The new Super Output Areas and the Department of the Environment, Transport and the Regions index of multiple deprivation score (IMD2004) are then added to the data by matching on the patient's postcode using the All Fields Postcode Directory from the Office for National Statistics.

## 2. Specific processing for "Readmission and length of stay" Case Notes

We examined all live inpatient discharges for elective surgery in the Hospital Episode Statistics (HES) database in 2003/4 for acute NHS trusts only. Patients who were readmitted to hospital as emergencies within 28 days of discharge were defined as being the readmissions. Emergency transfers between hospitals were not counted as being readmissions. Length of stay was calculated as the number of days between the dates of the end and the start of each admission; if both dates were the same then the length of stay was 0 days.

We plotted scatter graphs for length of stay in days against the proportion of readmission for admissions.

We used a logistic regression model to test for the association of the likelihood of emergency readmission with length of stay. The models incorporated factors known to be associated with emergency readmission and other factors we thought were likely to be associated including age, sex, socio-economic deprivation quintile, elective or emergency admission, proportion of admissions within the trust which were for day case surgery and number of coded co-morbid conditions.<sup>4 5 6</sup> In addition, analyses were stratified by procedures grouped into similar expected length of stays based on their trim points published with the 2005/6 HRG tariffs.<sup>7</sup>

Finally, the following common major procedures were examined separately.

Coronary bypass (E04)

Inguinal, umbilical or femoral hernia repairs (F73 & F74)

Cholecystectomy (G13 & G14)

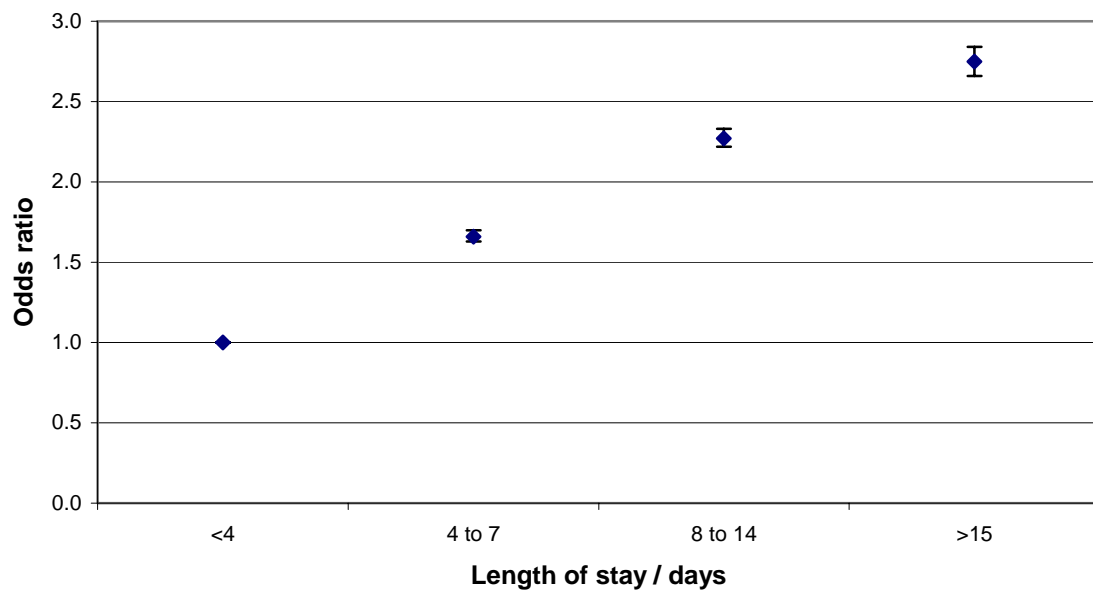
Primary knee replacement (H04)

Primary hip replacement (H80 & H81)

Mastectomy – partial / total / subtotal (J46, J47, J48 & J49)

Prostate transurethral resection procedure (L27 & L28)

Figure 1 – Length of stay and odds ratio for emergency readmissions within 28 days for selected elective surgical inpatient admissions to acute NHS trusts in England 2003/4\*



\* All odds ratios are versus a length of stay of less than 4 days and are adjusted for age, sex, deprivation, elective admission, proportion of total admissions to the admitting trust which were day cases and number of coded co-

Table 1 – Odds ratios (95% CI) of emergency readmission for elective surgical admissions grouped by HRG trim point

| HRG trimpoint / days | LOS / days |                           |                           |                           |
|----------------------|------------|---------------------------|---------------------------|---------------------------|
|                      | <4         | 4 to 7                    | 8 to 14                   | >15                       |
| 1                    | 1.0        | 1.82<br>(1.60 to 2.17) ** | 3.11<br>(2.49 to 3.87) ** | 3.27<br>(2.52 to 4.25) ** |
| 2                    | 1.0        | 1.83<br>(1.63 to 2.02) ** | 3.23<br>(2.75 to 3.79) ** | 2.98<br>(2.38 to 3.73) ** |
| 3                    | 1.0        | 1.64<br>(1.48 to 1.81) ** | 2.22<br>(1.90 to 2.59) ** | 2.94<br>(2.40 to 3.61) ** |
| 4 to 7               | 1.0        | 1.73<br>(1.64 to 1.81) ** | 2.52<br>(2.33 to 2.72) ** | 2.99<br>(2.69 to 3.32) ** |
| 8 to 14              | 1.0        | 1.21<br>(1.16 to 1.26) ** | 1.80<br>(1.70 to 1.90) ** | 2.00<br>(1.83 to 2.18) ** |
| >15                  | 1.0        | 1.20<br>(1.11 to 1.29) ** | 1.50<br>(1.40 to 1.61) ** | 1.91<br>(1.77 to 2.06) ** |
| All admissions       | 1.0        | 1.66<br>(1.63 to 1.70) ** | 2.27<br>(2.22 to 2.33) ** | 2.75<br>(2.66 to 2.84) ** |

\* p<0.050

\*\* p<0.00

Table 2 – Number of admissions and readmission rate for selected procedures

| <b>HRG groups</b>   | <b>Total number of admissions</b> | <b>Number of readmissions (%)</b> |
|---|-----------------------------------|-----------------------------------|
| Coronary bypass (E04)   | 14,650                            | 1,478 (10.1%)                     |
| Inguinal, umbilical or femoral hernia repairs (F73 & F74)     | 42,566                            | 1,346 (3.2%)                      |
| Cholecystectomy (G13 & G14)                                   | 38,396                            | 1,982 (5.2%)                      |
| Primary knee replacement (H04)                                | 46,492                            | 2,602 (5.6%)                      |
| Primary hip replacement (H80 & H81)                           | 42,074                            | 2,507 (6.0%)                      |
| Mastectomy – partial / total / subtotal (J46, J47, J48 & J49) | 29,009                            | 1,168 (4.0%)                      |
| Prostate transurethral resection procedure (L27 & L28)        | 24,489                            | 1,655 (6.8%)                      |

Table 3 – Odds ratios of emergency readmission within 28 days for variables used in regression model

| <b>Variable</b>   | <b>OR (95% CI)</b>  | <b>P value</b> |
|---|---------------------|----------------|
| <b>Age group (years)*:</b>  |                     |                |
| 0-4   | 1.0                 |                |
| 5 to 9  | 0.75 (0.69 to 0.81) | <0.001         |
| 65 to 69  | 0.60 (0.57 to 0.64) | <0.001         |
| 75 to 79  | 0.63 (0.60 to 0.67) | <0.001         |
| 80 to 84  | 0.68 (0.64 to 0.73) | <0.001         |
| 85+   | 0.79 (0.74 to 0.85) | <0.001         |
| <b>Sex:</b>   |                     |                |
| Male  | 1.0                 |                |
| Female  | 0.87 (0.86 to 8.88) | <0.001         |
| <b>Deprivation quintile (1=least deprived, 5= most deprived):</b> |                     |                |
| 1   | 1.0                 |                |
| 2   | 1.03 (1.00 to 1.06) | 0.071          |
| 3   | 1.05 (1.02 to 1.08) | <0.001         |
| 4   | 1.07 (1.04 to 1.10) | <0.001         |
| 5   | 1.14 (1.11 to 1.17) | <0.001         |
| <b>Proportion of admissions to trust which were daycases:</b>     |                     |                |
| <20%  | 1.0                 |                |
| 20-29%  | 0.16 (0.09 to 0.31) | <0.001         |
| 30-39%  | 0.23 (0.13 to 0.43) | <0.001         |
| 40-49%  | 0.37 (0.21 to 0.67) | <0.001         |
| >49%  | 0.36 (0.20 to 0.64) | <0.001         |
| <b>Number of co-morbidities*:</b>                                 |                     |                |
| 0   | 1.0                 |                |
| 1   | 1.13 (1.10 to 1.15) | <0.001         |
| 2   | 1.32 (1.28 to 1.35) | <0.001         |
| 3   | 1.52 (1.47 to 1.57) | <0.001         |
| 4   | 1.67 (1.60 to 1.74) | <0.001         |
| 5   | 1.89 (1.78 to 2.00) | <0.001         |
| >5  | 2.01 (1.89 to 2.14) | <0.001         |

\*Some subgroups have been omitted for brevity

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<sup>4</sup> Smith DM, Giobbie-Hurder A, Weinburger M, Oddone EZ, Henderson WG, Asch DA, Ashton CM, Feussner JR, Ginier P, Huey JM, Hynes DM, Loo L, Mengel CE. *Predicting non-elective hospital readmissions: A multi-site study*. Journal of Clinical Epidemiology 2000; 53: 1113-1118.

<sup>5</sup> Lyratzopoulos G, Havelly D, Gemmell I, Cook GA. *Factors influencing emergency medical readmission risk in a UK district general hospital: A prospective study*. BMC Emergency Medicine 2005; 5, 1

<sup>6</sup> Halfon P, Egli Y, Melle G, Chevalier J, Wasserfallen J-B, Burnand B. *Mesuring potentially avoidable hospital readmissions*. Journal of Clinical Epidemiology 2002; 55: 573-587.

<sup>7</sup> Department of Health National tariff 2005-06 URL available at <http://www.dh.gov.uk/assetRoot/04/09/15/32/04091532.xls>