

CLINICAL PRACTICE

# Nottingham Hip Fracture Score as a predictor of one year mortality in patients undergoing surgical repair of fractured neck of femur

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## Editor's key points

- Mortality following surgical repair of hip fracture is high.
- Criteria for identifying high risk patients would facilitate clinical care.
- The ability of the Nottingham Hip Fracture Score to predict one year mortality was assessed retrospectively in 6202 patients.
- This scoring system allowed accurate identification of low- and high-risk groups with significant differences in one year survival.

**Background.** Surgical repair of hip fractures is associated with high postoperative mortality. The identification of high-risk patients might be of value in aiding clinical management decisions and resource allocation. The Nottingham Hip Fracture Score (NHFS) is a scoring system validated for the prediction of 30 day mortality after hip fracture surgery. It is made up of seven independent predictors of mortality that have been incorporated into a risk score: age (66–85 and  $\geq 86$  yr); sex (male); number of co-morbidities ( $\geq 2$ ), admission mini-mental test score ( $\leq 6$  out of 10), admission haemoglobin concentration ( $\leq 10$  g dl<sup>-1</sup>), living in an institution; and the presence of malignancy. We investigated whether the NHFS was a predictor of 1 yr mortality in patients undergoing surgical repair of fractured neck of femur.

**Methods.** NHFS was retrospectively calculated for 6202 patients who had undergone hip fracture surgery between 1999 and 2009. One year and 30 day postoperative mortality data were collected both from hospital statistics and the Office of National Statistics.

**Results.** Overall mortality was 8.3% at 30 days and 29.3% at 1 yr. An NHFS of  $\leq 4$  was considered low risk and a score of  $\geq 5$  high risk. Survival was greater in the low-risk group at 30 days [96.5% vs 86.3% ( $P < 0.001$ )] and at 1 yr [84.1% vs 54.5% ( $P < 0.001$ )].

**Conclusions.** NHFS can be used to stratify the risk of 1 yr mortality after hip fracture surgery.

**Keywords:** complications, death; risk; surgery, orthopaedic; trauma

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More than 68 000 patients in the UK sustained a fracture of their proximal femur in 2008/09.<sup>1</sup> It is currently predicted that by 2033, 23% of the UK population will be aged over 65.<sup>2</sup> Thus, the incidence of proximal femoral fracture will continue to increase, despite interventions targeted at primary and secondary prevention. Hip fractures place a huge economic burden on the health service with a median stay of 15 days and over 1.1 million total inpatient bed days.<sup>1</sup> Hip fractures also cause substantial morbidity and mortality. Postoperative mortality is 5–10% at 30 days and 19–33% at 1 yr.<sup>3–5</sup> Around 20% of the patients require institutional care at hospital discharge.<sup>6</sup>

Preoperative identification of those patients at high risk of adverse outcomes would be beneficial for a number of reasons: optimal timing of surgery; critical care admission before or after operation; and appropriate informed consent. The Nottingham Hip Fracture Score (NHFS) is a

scoring system that reliably predicts 30 day mortality for patients after hip fracture.<sup>7</sup> It is made up of seven independent predictors of 30 day postoperative mortality that have been incorporated into a risk score: age (66–85 and  $\geq 86$  yr); sex (male); number of co-morbidities ( $\geq 2$ ), admission mini-mental test score ( $\leq 6$  out of 10), admission haemoglobin concentration ( $\leq 10$  g dl<sup>-1</sup>), living in an institution; and the presence of malignant disease.

Previous work has demonstrated that late mortality after hip fracture is high.<sup>8</sup> This might partly be a consequence of the ageing process itself and therefore largely unaffected by hip fracture *per se*. Data suggest that at 2 yr, survivors after hip fracture have the same mortality risk as the non-fracture population.<sup>9</sup> Postoperative complications have been shown in other cohorts to increase long-term mortality.<sup>10</sup> Longer term mortality might therefore be a function of postoperative course. Since it is possible to predict early

postoperative mortality, which is associated with early complications, we hypothesized that the NHFS could predict later mortality after hip fracture surgery.

## Methods

Guidance from the Integrated Research Application Service (IRAS) classified the project as service evaluation, meaning that formal ethical approval was unnecessary. Local approval was gained from our institution's audit committee.

From May 1999 to April 2009, all patients admitted with a fractured femoral neck to the Queen's Medical Centre campus of the Nottingham University Hospitals had prospective collection of physiological and operative data in order to allow local departmental audit. One year and 30 day postoperative mortality was collected and cross-checked both from hospital statistics and the Office of National Statistics. Data were collected prospectively by dedicated audit officers and the accuracy of the data was verified with internal cross-checking demonstrating an error rate of <3%. The database is fully compliant with Caldicott principles<sup>11</sup> and patient anonymity and confidentiality is strictly maintained.

We have previously developed and validated the NHFS.<sup>7</sup> In brief, this is a weighted score of seven independent admission variables which reliably predicts 30 day mortality. Total NHFS scores range between 0 and 14, with a median of 4. We retrospectively calculated the NHFS of every patient who underwent a surgical repair of a fractured femoral neck and compared this prospectively with their outcome data.

Previous analysis of survival curves for a given NHFS suggested a divergence at scores >4. Therefore, for the purposes of this study, the cohort was therefore divided into two cohorts with NHFS ≤4 and >4, respectively (low and high risk). In order to distinguish the effect of early mortality, cumulative survival to 1 yr was assessed for two groups of patients. The complete data set was analysed for difference in 1 yr mortality. The subset of patients who survived to 30 days was also examined separately.

The effect of operative delay on 1 yr mortality was examined for the whole population and for the groups stratified as low and high risk. We classified 'early' surgery as that performed up to and including 48 h from admission, and 'late' surgery as that performed >48 h from admission. This time scale was chosen on the basis of a large systematic review that demonstrated that surgery delayed by >48 h was associated with increases in 30 day and 1 yr postoperative mortality.<sup>12</sup> A target of <48 h until surgery has also recently been set by the British Orthopaedic Association and the British Geriatrics Society.<sup>13</sup>

All data were entered into a Microsoft Office 2007 Excel spreadsheet (Microsoft Corporation, Redmond, VA, USA). Statistical analyses were performed using SigmaStat 3.1 software (Systat Software, Richmond, CA, USA). A log-rank test was used to compare the Kaplan–Meier curves with  $P < 0.05$  considered statistically significant.

## Results

During the 10 yr study period, 7483 patients underwent operative management of a fractured femoral neck, and 1281 patients were excluded [347 were admitted from an acute hospital ward and represent a different patient cohort; 261 had no date of surgery recorded; 33 had no discharge date recorded; NHFS could not be calculated for 640 patients due to missing data (admission mini-mental test score 465 patients, admission haemoglobin 174 patients, date of birth 1 patient)]. This left 6202 patients for analysis. The characteristics of the patients are shown in Table 1.

The overall postoperative mortality was 8.3% at 30 days and 29.3% at 1 yr. A Kaplan–Meier curve was constructed for 30 day and 1 yr mortality (Fig. 1). Survival was significantly greater in the low-risk group at 30 days [96.5% compared with 86.3% ( $P < 0.001$ )] and at 1 yr [84.1% compared with 54.5% ( $P < 0.001$ )]. One year survival in those patients who survived beyond 30 days was also significantly greater in the low-risk group compared with the high-risk group [87.1% compared with 63.1% ( $P < 0.001$ )] (Fig. 2).

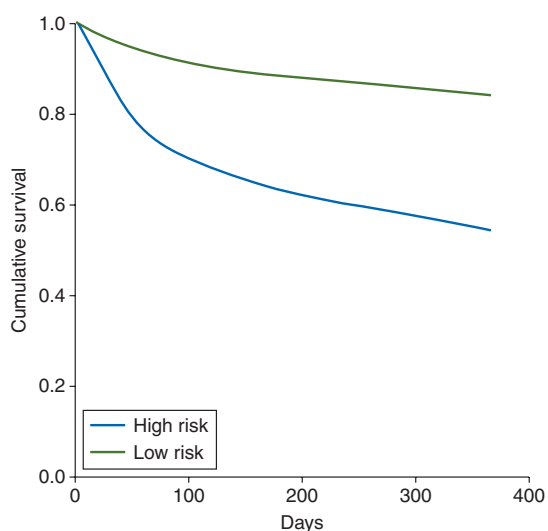
The effect of delay in surgery on 1 yr mortality is shown in Table 2. A delay in surgery of >48 h was associated with an increased mortality at 1 yr (31% compared with 26%,  $P < 0.001$ ). After adjusting for time to surgery, the high-risk cohort still had a greater mortality than the low-risk cohort [43.4% compared with 13.2% in the early surgery group ( $P < 0.001$ ) and 46.4% compared with 17.5% in the late surgery group ( $P < 0.001$ )].

## Discussion

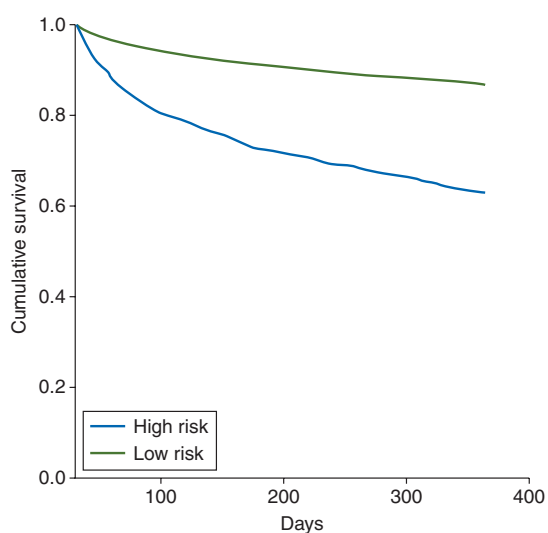
We have shown that the NHFS can stratify patients undergoing surgical fixation of a fractured femoral neck into

**Table 1** Characteristics of patients in the Nottingham Hip Fracture database (IQR, inter-quartile range)

	Total	Low risk (NHFS ≤4)	High risk (NHFS >4)
Number of cases	6202	3405	2797
Age [median (IQR)]	82 (76–88)	79 (72–84)	87 (82–91)
Sex [n (%), males]	1347 (22)	507 (15)	840 (30)
Nottingham Hip Fracture score [median (IQR)]	4 (3–5)	3 (3–4)	5 (5–6)
Number of days from admission until time of surgery [median (IQR)]	2 (1–3)	2 (1–3)	2 (1–3)
Death within 30 days [n (%)]	500 (8.1)	118 (3.5)	382 (13.7)
Death within 90 days [n (%)]	1098 (17.7)	287 (8.4)	811 (29.0)
Death within 1 yr [n (%)]	1816 (29.3)	543 (15.9)	1273 (45.5)



**Fig 1** The Kaplan–Meier curve showing 1 yr postoperative mortality after hip fracture surgery. Low- and high-risk groups have an NHFS of  $\leq 4$  and  $> 4$ , respectively.



**Fig 2** The Kaplan–Meier curve showing 1 yr postoperative mortality in patients who survived 30 days after hip fracture surgery. Low- and high-risk groups have an NHFS of  $\leq 4$  and  $> 4$ , respectively.

high- and low-risk groups, which demonstrated significant differences in mortality at 30 days and 1 yr after operation. This difference persists even when those patients who die early are excluded, suggesting that preoperative factors are associated with continuing mortality risk after hip fracture repair. The identification of the high-risk patient using the NHFS is also unaffected by potentially confounding factors such as delays in time to surgery.

Patients with an NHFS of  $\geq 5$  have an almost 30% greater mortality at 1 yr than those with a score of  $\leq 4$ . The

**Table 2** Effect of time to surgery for a fractured femoral neck on 1 yr mortality, risk stratified using the NHFS. \* $P < 0.001$  early vs late surgery; † $P = 0.102$  early vs late surgery

	Early surgery ( $\leq 48$ h from admission)	Late surgery ( $> 48$ h from admission)
Number of cases	2098	4104
Death within 1 yr [n (%)]	540 (25.7)	1276 (31.1)*
Death within 1 yr for low-risk cohort (NHFS $\leq 4$ ) [n (%)]	162 (13.2)	381 (17.5)*
Death within 1 yr for high-risk cohort (NHFS $> 5$ ) [n (%)]	378 (43.4)	895 (46.4)†

preoperative identification of the high-risk patient will be of great use to the multidisciplinary team involved in the care of patients with hip fractures. The high-risk patient might benefit from aggressive optimization of co-existent medical problems, expeditious surgery involving senior surgeons and anaesthetists, monitoring such as invasive arterial pressure and cardiac output monitoring, and pre- or post-operative observation or optimization in a critical care environment. As yet, there is no evidence demonstrating that such interventions in a high-risk patient group alter outcome, but risk stratification could be of value in guiding future research, allowing the identification of individuals who might benefit most from intervention. A greater understanding of the level of risk that a patient faces also allows informed discussions with both patients and relatives regarding the likely outcome. The NHFS stratification could also be of value in risk-adjusting outcome comparisons, allowing an accurate comparison of postoperative mortality to be made between different units, in addition to providing a benchmark for internal audits. One advantage of the NHFS is its simplicity. The NHFS uses data that are easily and routinely collected from all patients presenting with hip fractures. The NHFS can be calculated on admission to hospital allowing risk stratification to start in the Emergency Department. This is in contrast to those scoring systems which require surgical and anaesthetic data such as POSSUM<sup>14</sup> or Donati score.<sup>15</sup> POSSUM scoring has been shown to over-predict mortality in patients with hip fractures,<sup>16</sup> and the Donati score shows a poor concordance when a range of risks is considered.<sup>7</sup> A Japanese group has recently shown a good correlation between the Estimation of Physiologic Ability and Surgical Stress (E-PASS) score and mortality after hip fracture surgery.<sup>17</sup> However, the applicability of this to UK practice is limited by a postoperative mortality of only 1% at 30 days. Of note, the patients in that cohort were selected low-risk patients without early complications.

This study has two major limitations. The results reflect the working practices and patient population of a single hospital. We feel that our practice is representative of normal UK trauma care (our institution runs two dedicated trauma

theatres, staffed by consultants and senior trainees, with operating lists taking place 7 days a week), but we recognize that some aspects of our care differ from other units. Future work is needed to examine how applicable the NHFS is in other trauma centres. The 30 day and 1 yr postoperative mortality of our institution is in line with national statistics and other published data.<sup>3 4 18</sup> Owing to missing data, we had to exclude 12% of the patients within our database from analysis. These exclusions were spread evenly over the 9 yr of data and we do not believe that they have made a material difference to the results.

The use of the NHFS to stratify patients in future research studies could be of value. We have shown large differences in mortality within this population, and future research studies might benefit from stratified randomized techniques using the NHFS to avoid potentially confounding factors. The NHFS will also allow orthopaedic units to measure their own performance adjusted for risk. The National Hip Fracture Database is now collecting data from all hospitals in England, Wales, and Northern Ireland. The NHFS may allow institutions to make an accurate, case-mix-adjusted comparison of their mortality figures.

In conclusion, we have demonstrated that the NHFS is an accurate predictor of 1 yr mortality after hip fracture surgery. We believe that it is a valuable tool for all medical professions involved in the care of this high-risk population.

## Conflict of interest

None declared.

## References

- 1 The Information Centre for Health and Social Care. Hospital episode statistics. Available from <http://www.hesonline.nhs.uk> (accessed 19 April 2010)
- 2 UK Statistics Authority. Office for National Statistics. Available from <http://www.ons.gov.uk> (accessed 19 April 2010)
- 3 Brauer CA, Coca-Perrillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. *J Am Med Assoc* 2009; **302**: 1573–9
- 4 Roche JJW, Wenn RT, Sahota O, Moran CG. Effect of comorbidities and postoperative complications on mortality after hip fracture in elderly people: prospective observational cohort study. *Br Med J* 2005; **33**: 1374
- 5 Wehren LE, Hawkes WG, Orwig DL, Hebel JR, Zimmerman SI, Magaziner J. Gender differences in mortality after hip fracture: the role of infection. *J Bone Miner Res* 2003; **18**: 2231–7
- 6 Roberts HC, Pickering RM, Onslow E, et al. The effectiveness of implementing a care pathway for femoral neck fracture in older people: a prospective controlled before and after study. *Age Ageing* 2004; **33**: 178–84
- 7 Maxwell MJ, Moran CG, Moppett IK. Development and validation of a preoperative scoring system to predict 30 day mortality in patients undergoing hip fracture surgery. *Br J Anaesth* 2008; **101**: 511–7
- 8 Pande I, Scott DL, O'Neill TW, Pritchard C, Woolf AD, Davis MJ. Quality of life, morbidity, and mortality after low trauma hip fracture in men. *Ann Rheum Dis* 2006; **65**: 87–92
- 9 White B, Fisher W, Laurin C. Rate of mortality for elderly patients after fracture of the hip in the 1980's. *J Bone Joint Surg Am* 1987; **69**: 1335–40
- 10 Khuri SF, Henderson WG, DePalma RG, Mosca C, Healey NA, Kumbhani DJ. Determinants of long-term survival after major surgery and the adverse effect of postoperative complications. *Ann Surg* 2005; **242**: 326–41
- 11 Department of Health. *The Caldicott Committee. Report on the Review of Patient-Identifiable Information*. London: Department of Health, 1997
- 12 Shiga T, Wajima Zi, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. *Can J Anaesth* 2008; **55**: 146–54
- 13 British Orthopaedic Association. *The Care of Patients with Fragility Fracture*. London: British Orthopaedic Association, 2007
- 14 Copeland GP, Jones D, Walters M. POSSUM: a scoring system for surgical audit. *Br J Surg* 1991; **78**: 355–60
- 15 Donati A, Ruzzi M, Adrario E, et al. A new and feasible model for predicting operative risk. *Br J Anaesth* 2004; **93**: 393–9
- 16 Ramanathan TS, Moppett IK, Wenn R, Moran CG. POSSUM scoring for patients with fractured neck of femur. *Br J Anaesth* 2005; **94**: 430–3
- 17 Hirose J, Mizuta H, Ide J, Nomura K. Evaluation of estimation of physiologic ability and surgical stress (E-PASS) to predict the postoperative risk for hip fracture in elder patients. *Arch Orthop Trauma Surg* 2008; **128**: 1447–52
- 18 White SM, Griffiths R, Holloway J, Shannon A. Anaesthesia for proximal femoral fracture in the UK: first report from the NHS Hip Fracture Anaesthesia Network. *Anaesthesia* 2010; **65**: 243–8