 doi:10.1111/anae.12542

Original Article

Outcome by mode of anaesthesia for hip fracture surgery. An observational audit of 65 535 patients in a national dataset

S. M. White,[1] I. K. Moppett[2] and R. Griffiths[3]

1 Consultant Anaesthetist, Brighton and Sussex University Hospitals NHS Trust, Brighton, East Sussex, UK
2 Associate Professor and Honorary Consultant Anaesthetist, Anaesthesia and Critical Care Research Group, Division of Clinical Neuroscience, University of Nottingham, Queen's Medical Centre Campus, Nottingham University Hospitals NHS Trust, Nottingham, UK
3 Consultant Anaesthetist, Peterborough and Stamford Hospitals NHS Trust, Peterborough, UK

Summary

Large observational studies of accurate data can provide similar results to more arduous and expensive randomised controlled trials. In 2012, the National Hip Fracture Database extended its dataset to include 'type of anaesthesia' data fields. We analysed 65 535 patient record sets to determine differences in outcome. Type of anaesthesia was recorded in 59 191 (90%) patients. Omitting patients who received both general and spinal anaesthesia or in whom an uncertain type of anaesthesia was recorded, there was no significant difference in either cumulative five-day (2.8% vs 2.8%, p = 0.991) or 30-day (7.0% vs 7.5%, p = 0.053) mortality between 30 130 patients receiving general anaesthesia and 22 999 patients receiving spinal anaesthesia, even when 30-day mortality was adjusted for age and ASA physical status (p = 0.226). Mortality within 24 hours after surgery was significantly higher among patients receiving cemented compared with uncemented hemiarthroplasty (1.6% vs 1.2%, p = 0.030), suggesting excess early mortality related to bone cement implantation syndrome. If these data are accurate, then either there is no difference in 30-day mortality between general and spinal anaesthesia after hip fracture surgery per se, and therefore future research should focus on how to make both types of anaesthesia safer, or there is a difference, but mortality is not the correct outcome to measure after anaesthesia, and therefore future research should focus on differences between general and spinal anaesthesia. These could include more anaesthesia-sensitive outcomes, such as hypotension, pain, postoperative confusion, respiratory infection and mobilisation.

Correspondence to: S. M. White
Email: stuart.white@bsuh.nhs.uk
Accepted: 17 November 2013

Introduction

Although approximately 70 000 hip fractures occur annually in England and Wales [1], there remains considerable uncertainty about whether general or spinal anaesthesia is most beneficial during restorative surgery in terms of patient outcome [2]. As a consequence, professional guidelines [3–5] are unable to recommend one technique over the other with confidence, such that a wide spectrum of techniques continue to be used by anaesthetists [6]. This may explain in part why 30-day postoperative mortality has remained static at approximately 8% for the last five years in spite of national quality improvement initiatives, including data collection and publication by the National Hip Fracture Database [7] and 'best practice' tariff uplifts related to performance targets [8].

We have previously argued that a randomised controlled trial is not a clinically or financially viable method of comparing outcomes after general or spinal anaesthesia for hip fracture surgery [9], but have advocated the potential for large database observational studies to identify any such differences. The National Hip Fracture Database [7] is one example of just such a database. Launched in 2007, it has collected data on over 200 000 hip fracture patients, and currently collects data from 95% of all hip fracture patients presenting to each of the 188 hospitals in England, Wales and Northern Ireland that are eligible for inclusion. However, until 2011, no anaesthesia data were collected as part of the standardised dataset. The Hip Fracture Peri-operative Network, under the aegis of the Age Anaesthesia Association, realised the potential value of accurate data collection at a rate of approximately 5000 cases per month in comparing anaesthetic techniques, and co-developed standardised data fields with the National Hip Fracture Database for inclusion into the main audit dataset from January 2012.

The primary aim of this observational analysis of national audit data was to determine whether there is any difference in the 30-day mortality between patients receiving general anaesthesia (GA), with or without nerve blockade, compared with spinal anaesthesia for hip fracture surgery. The secondary aims of this study were to compare early (less than five-day) mortality, age and co-morbidity, as indicated by ASA physical status, between patients receiving either general or spinal anaesthesia, and to determine time-related mortality outcome between patients receiving cemented or uncemented prostheses.

Methods

Type of anaesthesia was included in version 6 of the National Hip Fracture Database dataset [10] to measure compliance with audit standard 1.4.1 of the National Institute of Health and Care Excellence (NICE) guidelines from 2012 [3], which state: "*offer patients a choice of spinal anesthesia or general anaesthesia after discussing the risks and benefits*". Options for type of anaesthesia administered (data field 4.03) were limited to 'GA only', 'GA + nerve block', 'GA + spinal anaesthesia', 'GA + epidural anaesthesia', 'spinal anaesthesia only', 'spinal anaesthesia + nerve block' and 'spinal anaesthesia + epidural'. Data were collected by specially trained personnel employed by each eligible hospital to identify hip fracture patients, collect data from a number of hospital sources, and upload these data securely to the Fracture Database at least every three months.

The following data were collected from 1st January 2012 to 31st December 2012, along with the National Hip Fracture Database-6 data field codes: date of birth (2.04); sex (2.05); ASA physical status (4.02); type of anaesthesia (4.03); operation performed (4.06); date and time of discharge from hospital (6.03); discharge destination from hospital ('dead' 6.04.6); and residential status at 30 days ('dead' 7.01.6). Daily mortality in the first five days after surgery was calculated on the assumption that patients were discharged 'dead' from the hospital on the date of discharge recorded. Mortality data were compared using a two-tailed chi-squared test without Yate's correction. Differences in 30-day mortality between general and spinal anaesthesia were adjusted for age (< 65, 65–85, > 85 years) and ASA status (as a proxy of co-morbidity) using multivariable regression analysis, as these variables are known to be associated with increased mortality [11]. Backward stepwise logistic regression was used with $p = 0.05$ for inclusion and $p = 0.10$ for removal. Age and ASA status were treated as categorical variables. Statistical analyses were performed using the Statistical Package for the Social Sciences Version 17.0 (SPSS Inc., Chicago, IL, USA), with $p < 0.05$ indicating statistical significance.

Results

Data were collected for 65 535 patients; the mean (SD) age was 82 (10) years and 17 637 (26.9%) were men. An abbreviated mental test score of 6/10 or lower on admission to hospital was recorded in 13 313/42 664 (31.2%) patients. Type of anaesthesia was recorded in 59 191 (90.3%) patients (Table 1). There was no significant difference in 30-day mortality between patients receiving GA or spinal anaesthesia ($p = 0.053$) for whom the date of death was known and recorded correctly. However, 30-day mortality was significantly lower after GA compared with spinal anaesthesia when

Table 1 Thirty-day postoperative mortality by type of anaesthesia in the calendar year of 2012 as collected by the National Hip Fracture Database. Values are number (proportion) or number.

		Unknown/incorrect date of death	30-day mortality
GA + epidural	250 (0.4%)	10	18 (7.5%)
GA + nerve block	15176 (23.2%)	467	1028 (7.0%)
GA only	15 666 (23.9%)	485	1066 (7.0%)
All GA	31 092 (47.4%)	962	2112 (7.0%)
GA + spinal	4280 (6.5%)	66	281 (6.7%)
All GA + (GA + spinal)	35 372 (54.0%)	1028	2393 (7.0%)
Spinal + epidural	336 (0.5%)	9	26 (8.0%)
Spinal + nerve block	4374 (6.7%)	34	342 (7.9%)
Spinal only	18 955 (28.9%)	622	1345 (7.3%)
All spinal	23 665 (36.1%)	666	1713 (7.5%)
Type recorded, but unclear/other	154 (0.2%)	101	7 (13.2%)
No type recorded	6344 (9.7%)	982	1086 (20.3%)
All	65 535 (100.0%)	2776	5199 (8.3%)

GA, general anaesthesia.

Table 2 Comparison of mortality after general (GA) or spinal anaesthesia in the early postoperative period in the calendar year of 2012 as collected by the National Hip Fracture Database.

Postoperative day	GA deaths	Spinal deaths	Cumulative mortality GA	Cumulative mortality spinal	p value
0	209	142	0.6%	0.6%	0.894
1	158	106	1.1%	1.1%	0.988
2	132	107	1.5%	1.5%	0.141
3	167	97	1.9%	2.0%	0.266
4	158	98	2.4%	2.4%	0.551
5	123	83	2.8%	2.8%	0.958

4214 patients receiving combined general and spinal anaesthesia (for whom the date of death was known and recorded correctly) were included in the GA group ($p = 0.029$). There was no difference in 30-day mortality between the modal types of general anaesthesia (GA + nerve block) and spinal anaesthesia (spinal only) ($p = 0.224$). There was also no difference in cumulative mortality between GA or spinal (only/+nerve block/+epidural in either group) anaesthesia in the early postoperative days (0–5) following anaesthesia (Table 2).

Thirty-day mortality increased markedly in line with ASA status and age, as did the proportion of patients who received spinal anaesthesia (Tables 3 and 4, respectively). Logistic regression found no significant difference in cumulative mortality between GA and spinal anaesthesia, excluding combined GA and spinal anaesthesia, adjusted for ASA status and increasing age ($p = 0.226$).

Of the 62 322 patients whose 30-day postoperative mortality status was known, 26 811 (43.0%) had undergone hemiarthroplasty, 19 458 (72.6%) of these involving cemented prostheses. Thirty-day mortality was significantly higher in patients receiving uncemented prostheses (653/7353 (8.9%)) compared with cemented prostheses (1448/19 458 (7.4%), $p < 0.001$), although a greater proportion of patients receiving uncemented prostheses were of poorer physiological status (ASA 3–5, where recorded) than those receiving cemented prostheses (5045/6887 (73.3%) vs 12 364/18 045 (68.5%), respectively, $p < 0.001$). However, mortality within 24 h after surgery was significantly

Table 3 Comparison of 30-day postoperative mortality after general anaesthesia (GA) or spinal anaesthesia according to ASA physical status. Unknown type of anaesthesia and combined GA/spinal anaesthesia figures not shown.

ASA status	Number	GA/spinal ratio	GA 30-day mortality	Spinal 30-day mortality	p value
1	1879 (2.9%)	2.1	0.6%	0.8%	0.608
2	18 354 (28.0%)	1.5	2.7%	2.4%	0.208
3	32 270 (49.3%)	1.5	8.3%	8.3%	0.956
4	6593 (10.1%)	1.4	22.2%	26.5%	0.008
5	208 (0.3%)	1.1	35.9%	35.0%	0.940
All	65 486	1.5	7.5%	8.0%	0.041

Table 4 Comparison of 30-day postoperative mortality after general anaesthesia (GA) or spinal anaesthesia according to age quintile. Unknown type of anaesthesia and combined GA/spinal anaesthesia figures are not shown.

Age; years	Number	30-day mortality	GA/spinal ratio	GA 30-day mortality	Spinal 30-day mortality	p value
< 50	738 (1.1%)	0.9%	3.8	0.9%	0.8%	0.969
50–54	626 (1.0%)	2.9%	3.1	2.4%	4.4%	0.287
55–59	1069 (1.6%)	1.9%	2.2	1.9%	1.8%	0.932
60–64	2029 (3.1%)	2.5%	1.6	2.1%	3.2%	0.195
65–69	3224 (4.9%)	3.1%	1.6	3.0%	3.2%	0.707
70–74	5051 (7.7%)	4.1%	1.5	3.9%	4.4%	0.493
75–79	8889 (13.6%)	4.6%	1.5	4.3%	5.2%	0.065
80–84	14 280 (21.8%)	6.7%	1.5	6.5%	7.0%	0.386
85–89	16 064 (24.5%)	9.0%	1.5	8.9%	9.3%	0.464
90–94	9999 (15.3%)	12.2%	1.4	12.2%	12.1%	0.854
95–99	3027 (4.6%)	18.8%	1.4	19.5%	17.8%	0.372
100+	439 (0.7%)	31.1%	1.4	30.1%	32.5%	0.759

higher among patients receiving cemented prostheses (305/19 458 (1.6%) compared with those receiving uncemented prostheses (89/7353 (1.2%), p = 0.030).

Discussion

This observational study of 65 535 patients' data collected nationally over a one-year period did not find any significant difference in 30-day mortality between patients administered GA compared with spinal anaesthesia for surgical repair of hip fracture. Three conclusions may be drawn from this finding: there is indeed no difference in 30-day mortality between GA and spinal anaesthesia after hip fracture surgery; there may be a difference between GA and spinal, but not in terms of mortality; or national data recording is not accurate enough to detect a difference in outcome between GA and spinal anaesthesia.

It is quite possible that there is, indeed, no difference in 30-day mortality after hip fracture surgery between GA and spinal anaesthesia, despite evidence to the contrary from other studies. Parker et al.'s 2004 Cochrane review [12], which has informed all subsequent guidelines in recommending spinal anaesthesia over GA [3–5], included pooled results from eight randomised trials involving only 1668 patients, and suggested decreased 30-day mortality after spinal anaesthesia compared with GA (6.9% vs 10%), a finding of borderline statistical significance (RR 0.69, 95% CI 0.50–0.95) and derived from historical studies (one from the year 1998 involving 29 patients, the rest pre-1987) with methodological flaws. Luger et al.'s comprehensive review [13] concluded that "*spinal anaesthesia is associated with significantly reduced early mortality*", but that "*the limited evidence available does not permit a definitive conclusion to be drawn for mortality*". More recently, Neumann et al.'s retrospective analysis of 18 158 patients in 126 New York hospitals [14] found no difference in unadjusted in-hospital mortality between spinal anaesthesia (29% of cases) and GA, until a 21-variable casemix-adjustment regression model was applied. This revealed significantly lower odds of in-hospital mortality after spinal anaesthesia compared with GA (OR 0.71, 95% CI 0.54–0.93, p = 0.014) of a magnitude similar to that found 30 days postoperatively by Radcliff et al. among 5863 men > 65 years of age, using National Surgical Quality Improvement Program data [15]. Our analysis was unable to access comprehensive co-morbidity data, which are not currently collected by the National Hip Fracture Database, but casemix-adjustment by age and ASA status, both proxy markers for physiological and pathophysiological decline, failed to determine any similar differences in 30-day mortality between GA and spinal anaesthesia. Contemporaneous calculation and recording within the National Hip Fracture Database dataset of a validated casemix-adjustment score, such as the Nottingham Hip Fracture Score [11], may allow for more refined analysis of mortality by type of anaesthesia in future years.

Importantly, the inability of even very large observational studies to detect significant differences in mortality after spinal anaesthesia compared with GA without casemix-adjustment suggests that randomised controlled trials (such have been suggested by NICE [3]) are unlikely to find significant differences in mortality unless they are very large (> 3000 patients per group) and therefore – given the difficulties inherent in recruiting hip fracture patients to such trials – very expensive [9], money which might be better spent investigating the effect of type of anaesthesia on other outcomes.

It is perhaps not surprising that there was no difference in 30-day mortality, given the temporal disconnection between the intervention (a 2-h peri-operative period involving anaesthesia) and the measured outcome (death 30 days after surgery), during which time any number of other unmeasured variables might have influenced outcome, for instance, the availability of orthogeriatric care and rehabilitation services. Similarly, we would not have expected to find any differences in other commonly accepted outcome measures, such as length of stay or hospital discharge destination, which are likely to be affected more by factors such as community care facilities, occupational health input and local government finance than by anaesthesia. Any significant link observed between anaesthesia and such disconnected outcomes, therefore, can only ever be interpreted as an association, rather than as evidence of causation. Causation becomes much more probable, and therefore measurable, if the outcome measured is closely linked in time to the intervention. Our finding of significantly increased 24-h postoperative mortality after cemented compared with uncemented hemiarthroplasty, which may potentially be due to bone cement implantation syndrome, is illustrative of this, and supports concerns raised by the UK National Patient Safety Agency [16].

However, that this study failed to find a difference in unadjusted mortality within either the first 24 h or five days after surgery suggests strongly that the type of anaesthesia per se has little effect on mortality in the peri-operative period, and indicates that research should redirect itself towards investigating differences in other outcomes that might be more likely to be affected by type of anaesthesia and peri-operative care (and which anaesthetists can therefore do something about), such as peri-operative hypoxia, hypotension [17, 18], anaemia, pain and myocardial ischaemia and early postoperative complications including respiratory infection [11, 13], confusion [19] and thromboembolism.

Furthermore, the absence of a difference might indicate that GA or spinal anaesthesia as definitions of anaesthesia might be too broad in the context of hip fracture repair, and disguise differences between ‘good’ and ‘bad’ techniques of anaesthesia. It is possible, for example, to interpret our results as showing that ‘bad’ GA (i.e. after which the patient dies) is safer than ‘bad’ spinal anaesthesia, because there is a non-significant p = 0.055 trend towards lower 30-day mortality after GA compared with spinal anaesthesia. Moreover, although we did not find a difference in unadjusted 30-day mortality between the modal methods of GA (GA + nerve block) and spinal anaesthesia alone used by UK anaesthetists, we strongly advocate the future redirection of research efforts towards finding ‘best’ methods of GA and spinal anaesthesia. These could then be evaluated in randomised controlled trials that use contemporaneous outcomes (see above) and control for casemix, type of fracture (and, by extension, use/non-use of bone cement) [20] and orthogeriatric/rehabilitative input, amongst others. ‘Better’ methods of anaesthesia may include the pre-operative administration of local anaesthetic nerve block [5, 21] with GA or spinal anaesthesia after studies determining which type of nerve block and dose of local anaesthetic agent provide the best combination of analgesia and postoperative mobility; using lower doses of inhalational [17] or intravenous [22] general and spinal [23] anaesthesia; and administering spinal anaesthesia without sedation or with bispectral index-guided sedation [24, 25].

Of course, the third interpretation of any lack of significant difference between GA and spinal anaesthesia may relate to data inaccuracy, and we think there is some evidence for this, supporting previous concerns raised about the accuracy of anaesthesia data recorded in the UK National Joint Registry [26]. Institutional data collectors receive training and support from the National Hip Fracture Database, but their collection of anaesthesia data is a new task that requires interpretation of anaesthetic charts, which may have been missing (~10%), illegible or difficult to interpret. Anecdotally, for example, only 426/509 (83.7%) of cases recorded accurately on the Brighton Hip Fracture Database were submitted to the National Hip Fracture Database in 2012, although the frequency of GA vs spinal anaesthesia recorded and reported was reasonably accurate (29% vs 32% and 71%% vs 66%, respectively). The finding that 23.2% of patients were administered nerve block along with GA is in line with previous evidence from UK audit data (19%) [6], but we are aware that the 20.3% 30-day mortality rate among patients in whom a mode of anaesthesia was not recorded may have altered our results, although we would expect the frequency distribution of these deaths to mirror that in patients for whom mode of anaesthesia was recorded, and so not affect the results. The question that arises is whether the data are so inaccurate as to invalidate the results reported. We do not believe, but cannot say for certain, this to be the case given the large numbers observed, even though our findings are at odds with other papers that have found a difference in 30-day mortality [11–14]. The solution to improving data accuracy might be to involve anaesthetists in the collection and verification of anaesthesia data submitted to the National Hip Fracture Database in future.

Many of the uncertainties and inaccuracies inherent in this study should be addressed by the Anaesthesia Sprint Audit of Practice, a joint initiative between the National Hip Fracture Database commissioned by the UK Healthcare Quality Improvement Partnership via the Royal College of Physicians and the Association of Anaesthetists of Great Britain and Ireland, which has recently finished data collection and is due to report in early 2014. Data were collected and uploaded to the National Hip Fracture Database over a prospective three-month period by anaesthetists in the vast majority of hospitals throughout England, Wales and Northern Ireland. With cross-referencing to standard outcome data collected by the National Hip Fracture Database, it is hoped that a far more detailed and accurate analysis of casemix-adjusted outcome including mortality, intra-operative hypotension and prevalence of bone cement implantation syndrome may be performed, and that this can then be compared by type of anaesthesia and surgery and by grade of anaesthetist and surgeon.

Retrospective analysis of a 65 535 patient national dataset did not find any significant difference in either five-day or 30-day postoperative mortality between GA and spinal anaesthesia. We conclude that the focus of anaesthesia research should be redirected away from mortality outcomes that may be influenced by numerous non-anaesthetic variables, and towards outcomes that may be more directly attributable to mode of anaesthesia. Imminent prospective data from the Anaesthesia Sprint Audit of Practice may address concerns about current national dataset accuracy, and contribute to a greater understanding of how best to anaesthetise the large and vulnerable group of patients who present annually for emergency hip fracture repair.

Acknowledgements

The authors thank Dr Colin Currie, Mr Rob Wakeman and Mr Christopher Boulton at the National Hip Fracture Database for their invaluable assistance in collecting and accessing the data in this study, and data collectors throughout the country for their work, without which this study would not have been possible.

Competing interests

SW is a member of the Association of Anaesthetists of Great Britain and Ireland (AAGBI) Hip Fracture Guidelines Working Party, is a Council member of the

Age Anaesthesia Association, which he represents at the National Hip Fracture Database, is national research co-ordinator for the Hip Fracture Perioperative Network and is an Editor of *Anaesthesia*. This manuscript has therefore undergone additional external review. RG chaired the AAGBI Hip Fracture Guidelines Working Party and founded the Hip Fracture Perioperative Network. He is also Honorary Secretary of the AAGBI. IM is a member of the NICE topic expert group for Quality Standards for hip fracture, a member of the National Institute of Academic Anaesthesia (NIAA) Research Council and holds grants from the National Institute for Health Research and the NIAA for trials in hip fracture.

References

1. White SM, Griffiths R. Projected incidence of proximal femoral fracture in England: a report from the NHS Hip Fracture Anaesthesia Network (HIPFAN). *Injury* 2011; **42**: 1230–3.
2. Ummenhofer W, Suhm N. Fractured neck of femur: guidelines and beyond. *Anaesthesia* 2012; **67**: 2–4.
3. National Institute of Health and Care Excellence. Clinical Guideline 124. The management of hip fracture in adults. 2011. http://www.nice.org.uk/nicemedia/live/13489/54918/54918.pdf (accessed 07/09/2013).
4. Scottish Intercollegiate Guidelines Network. Management of hip fracture in older people. National clinical guideline 111. 2009. http://www.sign.ac.uk/pdf/sign111.pdf (accessed 07/09/2013).
5. Association of Anaesthetists of Great Britain and Ireland. Management of proximal femoral fractures 2011. *Anaesthesia* 2012; **67**: 85–98.
6. 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 (HIPFAN). *Anaesthesia* 2010; **65**: 243–8.
7. National Hip Fracture Database. National Report 2012 – supplement. http://www.nhfd.co.uk/003/hipfractureR.nsf/luMenuDefinitions/2083890E909847FC80257B3300325EEB/$file/NHFD%20Supplement%202012.pdf?OpenElement (accessed 07/09/2013).
8. Department of Health. Payment by results. Draft guidance for 2012–13. p. 67. http://webarchive.nationalarchives.gov.uk/20130506134040/https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153247/dh_132111.pdf.pdf (accessed 07/09/2013).
9. White SM, Griffiths R, Moppett IK. Type of anaesthesia for hip fracture surgery – the problem of trial design. *Anaesthesia* 2012; **67**: 574–8.
10. National Hip Fracture Database. NHFD Audit toll V6. http://www.nhfd.co.uk/003/hipfractureR.nsf/resourceDisplay (accessed 07/09/2013).
11. Moppett IK, Parker M, Griffiths R, Bowers T, White SM, Moran CG. Nottingham Hip Fracture Score: longitudinal and multi-centre assessment. *British Journal of Anaesthesia* 2012; **109**: 546–50.
12. Parker M, Handoll HHG, Griffiths R. Anaesthesia for hip fracture surgery in adults. *Cochrane Database of Systematic Reviews* 2004; **4**: CD000521.
13. Luger TJ, Kammerlander C, Gosch M, et al. Neuroaxial versus general anaesthesia in geriatric patients for hip fracture surgery: does it matter? *Osteoporosis International* 2010; **21**: S555–72.
14. Neuman MD, Silber JH, Elkassabany NM, Ludwig JM, Fleisher LA. Comparative effectiveness of regional versus general anesthesia for hip fracture surgery in adults. *Anesthesiology* 2012; **117**: 72–92.
15. Radcliff TA, Henderson WG, Stoner TJ, Khuri SF, Dohm M, Hutt E. Patient risk factors, operative care, and outcomes among older community-dwelling male veterans with hip fracture. *Journal of Bone and Joint Surgery America* 2008; **90**: 34–42.
16. National Patient Safety Agency. Rapid Response Report NPSA/2009/RRR001: Mitigating surgical risk in patients undergoing hip arthroplasty for fractures of the proximal femur. March 2009. http://www.nrls.npsa.nhs.uk/resources/?EntryId45=59867 (accessed 07/09/2013).
17. Sessler DI, Sigl JC, Kelley SD, et al. Hospital stay and mortality are increased in patients having a ‘‘triple low’’ of low blood pressure, low bispectral index, and low minimum alveolar concentration of volatile anesthesia. *Anesthesiology* 2012; **116**: 1195–203.
18. Walsh M, Devereaux PJ, Garg AX, et al. Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery: toward an empirical definition of hypotension. *Anesthesiology* 2013; **119**: 507–15.
19. Sciard D, Cattano D, Hussain M, Rosenstein A. Perioperative management of proximal hip fractures in the elderly: the surgeon and the anesthesiologist. *Minerva Anestesiologica* 2011; **77**: 715–22.
20. Foss NB, Kristensen MT, Palm H, Kehlet H. Postoperative pain after hip fracture is procedure specific. *British Journal of Anaesthesia* 2009; **102**: 111–6.
21. Parker MJ, Griffiths R, Appadu BN. Nerve blocks (subcostal, lateral cutaneous, femoral, triple, psoas) for hip fractures. *Cochrane Database of Systematic Reviews* 2002; **1**: CD001159.
22. Harsten A, Kehlet H, Toksvig-Larsen S. Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroplasty: a randomized trial. *British Journal of Anaesthesia* 2013; **111**: 391–9.
23. Wood RJ, White SM. Anaesthesia for 1131 patients undergoing proximal femoral fracture repair: a retrospective, observational study of effects on blood pressure, fluid administration and perioperative anaemia. *Anaesthesia* 2011; **66**: 1017–22.
24. Sieber FE, Zakriya KJ, Gottschalk A, et al. Sedation depth during spinal anesthesia and the development of postoperative delirium in elderly patients undergoing hip fracture repair. *Mayo Clinic Proceedings* 2010; **85**: 18–26.
25. Sieber FE, Gottshalk A, Zakriya KJ, Mears SC, Lee H. General anesthesia occurs frequently in elderly patients during propofol-based sedation and spinal anesthesia. *Journal of Clinical Anesthesia* 2010; **22**: 179–83.
26. Howes BW, Clarke PA, Cook TM. The National Joint Registry may fail to collect accurate, validated anaesthetic data. *Anaesthesia* 2009; **64**: 694–5.

