■ TRAUMA

Low haemoglobin at admission is associated with mortality after hip fractures in elderly patients

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Aims

Low haemoglobin (Hb) at admission has been identified as a risk factor for mortality for elderly patients with hip fractures in some studies. However, this remains controversial. This study aims to analyze the association between Hb level at admission and mortality in elderly patients with hip fracture undergoing surgery.

Patients and Methods

All consecutive patients (prospective database) admitted with hip fracture operated in a tertiary hospital between 2012 and 2016 were analyzed. We collected patient characteristics, time to surgery, duration and type of surgery, comorbidities, Hb at admission, nadir of Hb after surgery, the use and amount of red blood cells (RBCs) transfusion products, postoperative complications, and death. The main outcome measures were mortality at 30 days, 90 days, 180 days, and one year after surgery.

Results

We included 829 patients; the mean age was 81 years (SD 11). Mortality at 30 days, 90 days, 180 days, and one year was 5.7%, 12.3%, 18.1%, and 23.5%, respectively. The highest mortality was observed in patients aged over 80 years (162/557, 29%) and in male patients (85/267, 32%). Survival at 90 days, 180 days, and one year after surgery was significantly lower in patients with a Hb level below 120 g/l at admission. In multivariate analysis, Hb level below 120 g/l at admission was found to be an independent factor associated with mortality (adjusted hazard ratio (aHR) 1.68 (95% confidence interval (CI) 1.22 to 2.31); p = 0.001), along with age (aHR 1.06 (95% CI 1.04 to 1.06); p < 0.001), male sex (aHR 2.19 (95% CI 1.61 to 2.96); p < 0.001), and need for RBC transfusions (aHR 1.10 (95% CI 1.02 to 1.19); p = 0.01).

Conclusion

Our results suggest that low Hb at admission along with age and RBC transfusions is significantly associated with short- and long-term mortality after hip fracture surgery, independently of comorbidity confounders. Further studies should be performed to understand how preoperative Hb could be taken into account in perioperative management.

Cite this article: *Bone Joint J* 2019;101-B:1122–1128.

The reported incidence of hip fractures in elderly people is 1.1% and 1.6% per year in the United States and Europe, respectively.[1,2] With increasing life expectancy and rising numbers of elderly people in all populations of rich countries, the incidence of fragility hip fractures is estimated to reach 6.3 million by the year 2050.[3] Hip fractures due to fragility are considered among the most prognostically poor consequences of age-related osteoporosis owing to their propensity for complications such as reduced mobility, poor quality of life, and mortality. The mortality rates following hip fractures in elderly patients within the first month following hip fracture injuries has been shown to be as high as 13.3%, and range between 14% and 36% within one year of the injury.[4-6] Identifying modifiable or associated risk factors contributing to mortality can, therefore, play a crucial role in reducing it.[7] The older, frailer nursing home population has a prevalence of anaemia of 48%, and a prevalence of 46% was observed in emergency surgical patients with hip fracture.[8-10] Some authors reported a high incidence at admission in individuals with hip fracture depending on definition, varying from 12.3% with haemoglobin (Hb) levels less than 100 g/l[11] to 40.4% with Hb

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doi:10.1302/0301-620X.101B9.BJJ-2019-0526.R1 $2.00

Bone Joint J 2019;101-B:1122–1128.

levels less than 120 g/l.[12] Among preoperative factors, authors recently found that preoperative Hb level at admission (< 100 g/l) was a significant associated factor for mortality.[8,9] However, a large retrospective study in noncardiac surgical patients showed that preoperative anaemia appeared to be associated with baseline diseases that markedly increased early-term postoperative mortality, whereas preoperative anaemia *per se* was a rather weak independent predictor of early-term postoperative mortality.[10] Therefore the Hb level at admission as an associated risk factor for mortality remains controversial.

The aim of our study was to analyze the association between Hb level at admission or nadir of Hb after surgery, with mortality in a cohort of elderly patients with fragility hip fracture undergoing surgery.

Patients and Methods

Study design and patients. We retrospectively analyzed all consecutive patients operated with fragility hip fracture between 1 January 2012 and 20 December 2016 in a tertiary hospital in Brussels, Belgium. In 2012, a multidisciplinary team was dedicated to the management of elderly hip fracture, thus a database was created to collected all demographic details (age, ethnicity, sex) and clinical characteristics, laboratory investigations (C-reactive protein, Hb, neutrophil to lymphocyte ratio (NLR)), comorbidities, delay of surgery, type of surgery and anaesthesia, complications (cardiac, thromboembolic, anaemia, transfusions), and outcome (length of stay, mortality) of all the patients with frailty hip fracture undergoing surgery. For this study, all the patients were identified from this prospective database, which included a total of 1029 patients with a diagnosis of low energy or fragility hip fracture. Patients with missing data concerning comorbidities and with pathological (metastatic) hip fracture (n = 200) were excluded from the study. All patients included were treated following the same early surgical care protocol (864/1029, 84%) operated within the first 48 hours). Postoperative follow-up was performed by our multidisciplinary medical team consisting of orthopaedic surgeons, anaesthetists, geriatricians, and internal medicine specialists dedicated to perioperative medicine, as well as physiotherapists.

Data collection. All medical records coming from our hip fracture database and our institutional records documented on the platform Medical Explorer (V8v9; CUSL, Brussels, Belgium) were evaluated for the following content: patient characteristics (age, sex), fracture type, type of fracture fixation, duration of surgery, time or delay to surgery, comorbidities, Hb at admission, nadir of Hb after surgery, the use and extent of red blood cell (RBC) transfusion products during the postoperative/perioperative period (96 hours), postoperative complications, and death. The included comorbidities were defined as follows: presence on admission of cardiovascular disease (pre-existing ischaemic cardiomyopathy, history of coronary bypass surgery, documented heart failure, chronic arrythmia), arterial hypertension, cerebrovascular disease (history of stroke or transient ischaemic attack), chronic respiratory diseases (chronic obstructive pulmonary disease or asthma), renal insufficiency, diabetes, cirrhosis, cognitive disorders, and documented osteoporosis. Mortality was recorded at 30 days, 90 days, 180 days, and one year after surgery. Mortality data were obtained from the Belgian national registry, in accordance with the national laws, permitting a complete high-quality follow-up. The causes of mortality were not recorded. Low level of Hb at admission was defined as Hb level under 120 g/l. We selected this threshold in part because the World Health Organization (WHO) defined anaemia as Hb levels < 120 g/l in women and < 130 g/l in men, and partly because fragility hip fracture is more frequent in women.[1,2] A conservative approach strategy for transfusion was used. This meant that a patient with Hb level under 70 g/l was transfused and a patient with Hb level between 70 g/l and 100 g/l was transfused only if he/she was symptomatic. All elderly patients with cardiac diseases with Hb level under 80 g/l were also transfused.

Table I. Patient demographics and baseline characteristics

Characteristic	Value (n = 829)
Mean age, yrs (SD)	81 (11)
Female, n (%)	562 (*68*)
Comorbidity, n (%)	
Congestive heart failure	63 (*8*)
Ischaemic heart disease	83 (*10*)
Chronic heart arrythmia	180 (*22*)
Coronary bypass surgery	42 (*5*)
Arterial hypertension	433 (*52*)
Chronic obstructive disease/asthma	94 (*11*)
Diabetes mellitus	95 (*11.5*)
Chronic renal insufficiency	86 (*10*)
Cerebrovascular disease	106 (*13*)
Dementia	125 (*16*)
Chronic anaemia	39 (*5*)
Cirrhosis	25 (*3*)

We included 829 patients, 562 of whom (68%) were women, and the mean age was 81 years (SD 11). Demographic and clinical characteristics including comorbidities are summarized in Table I.

Statistical analysis. Continuous variables were expressed as means with standard deviations and categorical variables were expressed as counts and percentages. Categorical variables were analyzed using chi-squared test or Fisher's exact test. Differences between means or medians were compared using unpaired Student's *t*-test or Mann–Whitney U test, according to the distribution. The Kaplan–Meier method was used and survival curves were compared by the log-rank test. In order to investigate factors influencing survival, a Cox proportional hazards model was built. Variables with a p-value < 0.20 in univariable analysis were entered into a backward stepwise selection procedure based on the likelihood ratio, after checking the log-linearity and the proportional hazard assumption for each variable using the graphical 'log-log' plots method and the Schoenfeld residuals test on the time-varying coefficients. Results were displayed as hazard ratio or adjusted hazard ratio (aHR) with 95% confidence interval (CI).

All tests were two-sided, with significance set at the 0.05 probability level. All analyses were conducted using SPSS v.21 software (IBM Corp., Armonk, New York) and R. version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria). Graphs were drawn using GraphPad Prism 7.0 (GraphPad Software, La Jolla, California).

Table II. Timing of surgery and surgical characteristics

Characteristic	Value (n = 829)
Mean time to surgery, days (SD)	0.8 (1.09)
Time to surgery, n (%)	
< 24 hrs	408 (*49*)
24 to 48 hrs	289 (*35*)
48 to 72 hrs	73 (*9*)
≥ 72 hrs	58 (*7*)
Mean haemoglobin level at admission, g/l (SD)	126 (19)
Mean nadir of haemoglobin after surgery, g/l (SD)	94 (17)
Mean number of red blood cell transfusions during surgery (SD)	0.9 (1.5)
Mean duration of surgery, mins (SD)	132 (63)
Type of surgery, n (%)	
Sliding hip screw osteosynthesis	65 (*8*)
Triple screw method	79 (*9.5*)
Intramedullary device (proximal femoral nail)	388 (*47*)
Hip hemiarthroplasty	159 (*19*)
Bipolar hemiarthroplasty	26 (*3*)
Total hip arthroplasty	98 (*12*)
Cerclage wires	1 (*1.1*)
Others	12 (*1.5*)
Type of anaesthesia, n (%)	
General anaesthesia	640 (*77*)
General anaesthesia and spinal anaesthesia	135 (*16*)
Spinal anaesthesia alone	54 (*7*)

Table III. Mortality after hip surgery

Mortality	Value (n = 829)
Overall mortality, n (%)	
30 days	45 (*5.7*)
90 days	102 (*12.3*)
180 days	150 (*18.1*)
1 yr	195 (*23.5*)
1-yr mortality classified by age, n (%)	
< 50 years (n = 12)	0 (*0*)
50 to 60 yrs (n = 36)	5 (*14*)
60 to 70 yrs (n = 71)	9 (*13*)
70 to 80 yrs (n = 152)	19 (*13*)
> 80 yrs (n = 557)	162 (*29*)
1-yr mortality classified by sex, n (%)	
Male (n = 267)	85 (*32*)
Female (n = 562)	110 (*19*)

Results

The mean Hb level at admission was 126 g/l (SD 19), the mean nadir of Hb after surgery was 94 g/l (SD 17), and the mean number of RBC transfusions in the perioperative period was 0.9 units (SD 1.5; Table II). The mean time to surgery, the mean duration of surgery, type of surgery, and anaesthesia are summarized in Table II. Intramedullary device (proximal femoral nail) was the most frequent type of surgery performed (348, 47%) and general anaesthesia (GA) was performed in 77% of cases. The overall mortality rates at 30 days, 90 days, 180 days, and one year were 5.7%, 12.3%, 18.1%, and 23.5%, respectively (Table III). The higher mortality was observed in patients with age greater than 80 years (162/557, 29%) and in male patients (85/276, 32%; Table III). Anaemia requiring transfusion (230, 28%), delirium (94, 11.3%), and acute renal failure (57, 7%) were the three most prevalent complications. There were 119 cardiopulmonary complications (14.4%) (Table IV).

Table IV. Postoperative complications for the 829 patients undergoing hip surgery

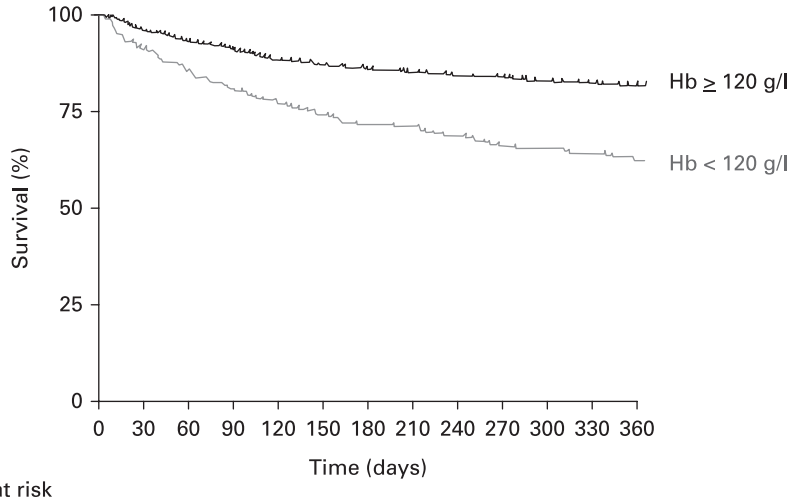
Postoperative complications	n (%)
Pneumonia	40 (*4.8*)
Hypoxaemia (probable atelectasis)	15 (*1.8*)
Urinary tract infection	24 (*2.9*)
Acute cardiac decompensation	14 (*1.7*)
Acute coronary syndrome	13 (*1.6*)
Pulmonary oedema	13 (*1.6*)
Pulmonary embolism and deep venous thrombosis	8 (*1*)
Wound infection	1 (*0.1*)
Delirium	94 (*11.3*)
Atrial fibrillation	16 (*1.9*)
Urinary retention	45 (*5.4*)
Acute renal failure	57 (*6.9*)
Medical emergency team call	20 (*2.4*)
Alcohol weaning	14 (*1.7*)
Prolonged postoperative ileus	40 (*3.8*)
Revision surgery	3 (*0.8*)
Anaemia requiring transfusion	230 (*28*)

Table V. Haemoglobin values, transfusions, and survival

Survival	Survivors	Nonsurvivors	p-value
30 days			
Total, n	782	47	N/A
Mean Hb level at admission, g/l (SD)	12.6 (1.9)	12 (2)	0.06
Mean nadir Hb after surgery, g/l (SD)	9.5 (1.8)	9 (1.8)	0.56
Mean RBC transfusions, units (SD)	0.9 (1.5)	1.4 (2.3)	0.09
Hb < 120 g/l, n (%)	208 (*29*)	20 (*42*)	0.02*
Hb < 80 g/l after surgery, n (%)	249 (*32*)	20 (*42*)	0.13
90 days			
Total, n	727	102	N/A
Mean Hb level at admission, g/l (SD)	127 (19)	118 (20)	< 0.001*
Mean nadir Hb after surgery, g/l (SD)	95 (18)	91 (16)	0.17
Mean RBC transfusions, units (SD)	0.9 (1.4)	1.2 (1.8)	0.01*
Hb < 120 g/l, n (%)	184 (*25*)	44 (*43*)	< 0.001*
Hb < 80 g/l after surgery, n (%)	236 (*32*)	33 (*32*)	0.97
180 days			
Total, n	679	150	N/A
Mean Hb level at admission, g/l (SD)	128 (18)	119 (20)	< 0.001*
Mean nadir Hb after surgery, g/l (SD)	95 (18)	90 (17)	0.004*
Mean RBC transfusions, units (SD)	0.8 (1.4)	1.4 (1.8)	< 0.001*
Hb < 120 g/l, n (%)	164 (*24*)	64 (*42*)	< 0.001*
Hb < 80 g/l after surgery, n (%)	211 (*31*)	58 (*39*)	0.074
1 yr			
Total, n	634	195	N/A
Mean Hb level at admission, g/l (SD)	129 (18)	118 (20)	< 0.001*
Mean nadir Hb after surgery, g/l (SD)	96 (18)	90 (17)	0.002*
Mean RBC transfusions, units (SD)	0.8 (1.4)	1.3 (1.7)	< 0.001*
Hb < 120 g/l, n (%)	143 (*22*)	85 (*43*)	< 0.001*
Hb < 80 g/l after surgery, n (%)	195 (*30*)	74 (*38*)	0.063

*Statistically significant

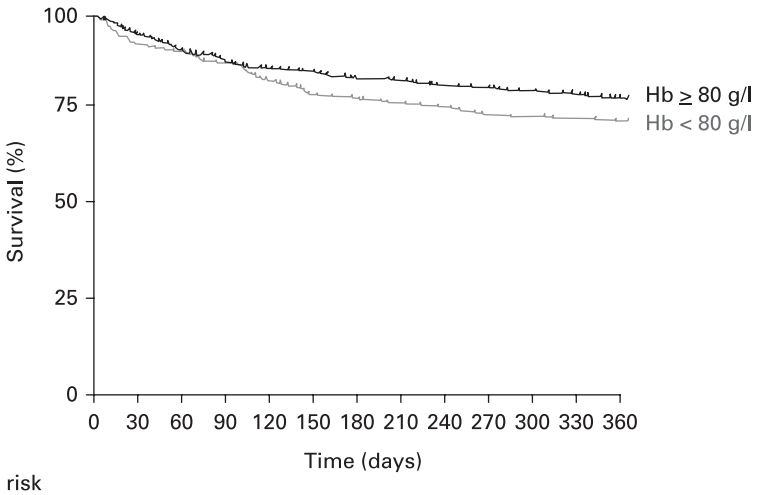
N/A, not applicable; Hb, haemoglobin; RBC, red blood cell



Number at risk

Hb < 120 g/l	228	208	184	164	143
Hb ≥ 120 g/l	601	574	543	515	491

Fig. 1a



Number at risk

Hb < 80 g/l	269	249	236	211	195
Hb ≥ 80 g/l	560	532	490	467	438

Fig. 1b

Kaplan–Meier survival estimation according to the haemoglobin (Hb) value at: a) admission; and b) after surgery. a) Hb level at admission (log-rank test, $p < 0.001$); b) nadir of Hb after surgery (log-rank test, $p < 0.001$).

Haemoglobin values, transfusions, and survival. Those patients who had died by 90 days, 180 days, and one year exhibited lower Hb level at admission in comparison with survivors while the nadir of Hb < 80 g/l after surgery was not statistically different between both groups (Table V). The proportion of patients with less than 120 g/l was higher in the nonsurvivors group (Table V). In contrast, the nadir of Hb in postoperative period did not have any association with the mortality. The proportion of patients exhibiting a level below 80 g/l in postoperative period did not differ between survivors and nonsurvivors.

In the same way, using the Kaplan–Meier method, there was a significant association between increase in mortality and a Hb level below 120 g/l at admission (Fig. 1a), whereas there was no difference between groups according to the nadir of Hb below 80 g/l after surgery (Fig. 1b).

Identification of risk factors for mortality. In the univariable analysis (Table VI), age, male sex, Hb at admission < 120 g/l, the use of RBC transfusions, thromboembolic diseases, and chronic renal insufficiency were identified as significant risk factors associated with shorter time to death at one year. Types of surgical procedures were not found to be associated risk factors. In the multivariable model (Fig. 2), it was revealed that Hb level below 120 g/l at admission was an independent associated risk factor associated with mortality (aHR 1.68 (95% CI 1.22 to 2.31); $p = 0.001$). Other variables associated with one-year

Table VI. Univariable Cox regression model predicting hazard ratio for one-year mortality

Variable	Unadjusted hazard ratio (95% CI)	p-value
Age	1.05 (1.03 to 1.07)	< 0.001*
Sex (male)	1.74 (1.32 to 2.32)	< 0.001*
Time before surgery	1.08 (0.95 to 1.22)	0.25
Haemoglobin level at admission < 120 g/l	2.34 (1.70 to 3.10)	< 0.001*
Haemoglobin nadir < 80 g/l	1.32 (0.98 to 1.76)	0.063
Red blood cell transfusion	1.17 (1.09 to 1.25)	< 0.001*
Surgery duration	1.00 (0.99 to 1.01)	0.93
Arterial hypertension	1.06 (0.80 to 1.40)	0.70
Ischaemic cardiopathy	1.42 (0.94 to 2.14)	0.10
Cerebrovascular disease	1.38 (0.94 to 2.01)	0.90
Heart failure	1.31 (0.81 to 2.10)	0.27
Chronic arrythmia	1.27 (0.92 to 1.75)	0.15
COPD/asthma	0.67 (0.40 to 1.10)	0.11
Thromboembolic disease	2.05 (1.05 to 3.99)	0.036*
Diabetes	0.97 (0.62 to 1.51)	0.89
Chronic renal insufficiency	1.61 (1.08 to 2.39)	0.018*
Osteoporosis	0.94 (0.57 to 1.54)	0.80
Chronic anaemia	1.34 (0.74 to 2.39)	0.33
Cirrhosis	0.62 (0.23 to 1.68)	0.35
Dementia	0.93 (0.62 to 1.39)	0.72
Type of surgery		
Sliding hip screw osteosynthesis	Reference	N/A
Triple screw method	0.78 (0.38 to 1.58)	0.49
Intramedullary device (proximal femoral nail)	1.01 (0.59 to 1.70)	0.98
Hip hemiarthroplasty	1.18 (0.66 to 2.10)	0.56
Bipolar hemiarthroplasty	1.44 (0.62 to 3.38)	0.39
Total hip arthroplasty	0.65 (0.32 to 1.31)	0.23
Cerclage	0.001 (0 to undetermined)	0.96
Others	1.56 (0.52 to 4.66)	0.42

*Statistically significant

CI, confidence interval; COPD, chronic obstructive pulmonary disease; N/A, not applicable

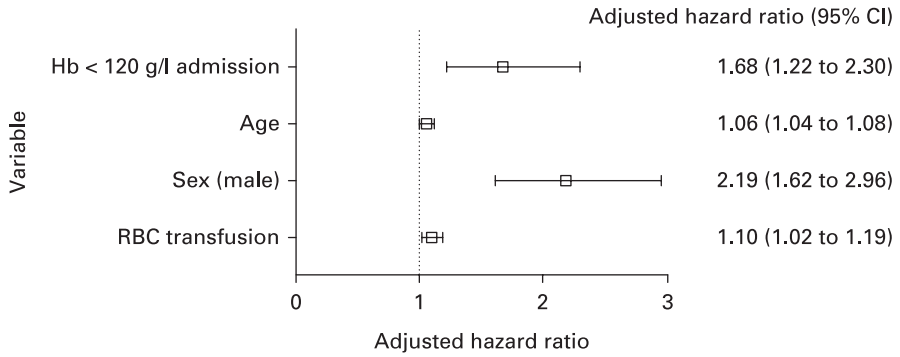


Fig. 2

Multivariate Cox regression model predicting hazard ratio for one-year mortality. CI, confidence interval; Hb, haemoglobin; RBC, red blood cell.

mortality in the multivariable analysis were male sex (aHR 2.19 (95% CI1.62 to 2.96); p < 0.001), age (aHR 1.68 (95% CI1.04 to 1.08); p < 0.001), and RBC transfusions (aHR 1.10 (95% CI 1.02 to 1.19); p = 0.013).

Discussion

The most interesting finding of our study was that low level of Hb (anaemia) at admission (< 120 g/l) and need for RBC transfusions, along with age greater than 80 years and male sex,

were independently associated risk factors of early and one-year mortality in elderly fragility hip fracture patients. There was no association of nadir of Hb < 80 g/l in the postoperative period, type of anaesthesia, type of fracture fixation, and time to surgery with mortality in our cohort study.

Preoperative anaemia is common in elderly adults.[11] Its incidence at admission in individuals with hip fracture is high, depending on definition, varying from 12.3% with Hb levels less than 100 g/l[11] to 40.4% with Hb levels less than 120 g/l.[12] Pooled results of previous studies examining the same association between anaemia and mortality in patients with hip fracture show excess mortality in patients with low Hb.[13] However, those studies had a relatively low number of patients. In addition, the cut-off values are not uniform, ranging from 100 g/l to 130 g/l, and thus limiting then the validity of pooling the results.[13] A recent meta-analysis found that anaemia on admission was associated with greater risk of 30-day, 90-day, and one-year mortality.[14] However, only five of the eight studies included in the meta-analysis reported that anaemia was not independently associated with death after adjustment for major confounders.[14] In a larger study, Praetorius et al[15] showed that 30-day mortality was associated with low levels of Hb at admission. However, when adjusting for age, type of fracture or fixation, sex, and comorbidities (Charlson score),[16] the estimated risk was slightly attenuated (hazard ratio (HR) 1.66 *vs* 1.21). In our study, low Hb level at admission (< 120 g/l) remained an independent associated risk factor for mortality after adjusting for comorbidities and complications. There is a debate on the cut-off of Hb level at admission, which can be associated with high mortality after hip fracture. Some authors used the cut-off of less than 100 g/l to define preoperative low Hb level at admission,[8,9] while other studies used a level of less than 120 g/l, as we did, to define anaemia before hip fracture, but not adjusted for sex differences.[17,18] Nevertheless, all those studies found that anaemia was an independent associated risk factor for mortality.[17,18] In a large study of 3595 patients using the WHO criteria for anaemia to respect sex differences in anaemia definition, Kovar et al[19] found an association between short-term mortality (less than three months) and Hb levels at admission, adjusted for age and sex. However, most known factors affecting the postoperative death of elderly patients undergoing hip fracture surgery (such as the American Society of Anethesiologists (ASA) physical status classification,[20] preoperative comorbidities, serum albumin levels, perioperative cardiac medications, preoperative functional status, types of hip fracture surgery, operative time, and surgical complications) were not included in general data of patients for statistical analysis and adjustment. That was not the case in our study, since we included most of these confounders.

Perioperative anaemia is mostly corrected by RBC transfusions in order to prevent the postoperative morbidity and mortality. However, there are conflicting data concerning the effect of RBC transfusions on these outcomes in patients with fragility hip fractures. Engoren et al[21] found that allogeneic RBC transfusions are associated with an increased long-term mortality after hip fracture surgery. In addition, increased risk of postoperative complications has been reported in transfused patients.[22] Besides, several studies suggest that RBC transfusions improve short-term functional outcomes[18,23] and prevent delirium in the frail elderly population.[24] Nevertheless, other data did not demonstrate any relationship between RBC transfusions and mortality.[14]

In contrast, our study shows that RBC transfusion was associated with mortality after adjusting for confounders. One may argue that our restrictive policy of transfusion could explain this result as shown by other studies demonstrating that a restrictive transfusion policy leads to increased cardiovascular events and increased mortality rates.[25] However, the Transfusion Requirements In Frail Elderly (TRIFE) trial showed comparable findings between liberal and restrictive blood transfusion protocols after hip fracture surgery,[26] but subgroup analyses for frail elderly people in nursing homes showed that this group could benefit from a more liberal transfusion.[24] Furthermore, *post hoc* analyses showed a reduced risk of postoperative delirium for the liberal transfusion group.[24] It is worth noting that risk factors for RBC transfusions after hip fracture surgery are multifactorial and interdepending, and drawing a definitive conclusion remains challenging.

Our study showed other variables associated with one-year mortality in the multivariable analysis such as male sex and being older than 80 years. This relationship was shown by other authors.[27,28] The excess mortality in men has been a consistent finding in multiple studies.[29,30] It seems that although hip fracture incidence in men is substantially lower compared with women, mortality after hip fracture is higher in men even after controlling for chronic comorbidities and medications.[30] Men did not exhibit more cardiovascular diseases or renal insufficiency in our cohort (results not shown).

In our study, there is no association between the type of anaesthesia and mortality rate. This was in line with a recent Cochrane review that found no differences in mortality due to anaesthetic technique.[31]

No difference was found in mortality in regard to type of fixation in our study. An extensive meta-analysis completed by Huang et al[32] has shown that proximal femoral nailing and sliding hip screw operations had comparable operation time, blood transfusion, hospital stay, wound complications, reoperation, and mortality rate.

Our study has some limitations. First it is a retrospective analysis, although data have been collected prospectively. Despite our methodical statistical analyses, it is not possible to completely exclude bias. We did not analyze functional data in our study. Indeed, prior to fracture mobility, independence in basic or instrumental activities of daily living, and cognitive or nutritional status were not systematically collected. Studies have shown that delay for surgery was an independent associated risk factor for mortality and surgery after 48 hours increases the risk of mortality.[7-9] In our study, the mean delay for surgery was 0.8 days so that the association between the delay and mortality could not be proven. Other factors such as duration of hypotension during surgery are difficult to be take into account. It has been shown that one-year mortality risk increases when the duration of intraoperative hypotension becomes long enough in the elderly patients undergoing noncardiac surgery.[33] Finally, causes of mortality were not collected.

In conclusion, our results suggest that low Hb at admission (< 120 g/l), along with RBC transfusions, age above 80 years, and male sex, were significantly associated with short- and long-term mortality after fragility hip fracture surgery, independently of comorbidity confounders. This finding strengthens

the importance of preoperative medical assessment of frailty in such types of population. Further studies should be performed to understand why a low level of preoperative Hb is associated with high mortality, and how this low level of Hb could be taken into account in perioperative management of elderly hip fracture patients undergoing surgery.



Take home message

- In the current study, haemoglobin lower than 120 g/l at admission is associated with one-year mortality.
- Although haemoglobin after surgery was not identified as a risk factor associated with mortality, red blood cell transfusions was associated with a higher one-year mortality.
- Among other factors associated with survival, male sex and age (older than 80 years) were identified as risk factors.

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Funding statement:

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Ethical review statement:

Institutional ethical committee approval was granted for this study, and the committee approved and gave its authorization (N° CEHF n°2010/23DEC/406).

This article was primary edited by G. Scott.