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Is anemia at admission related to short-term outcomes of elderly hip fracture patients?

Research Article

Emilija Dubljanin-Raspopović[1,2*], Ljiljana Marković-Denić[3], Dejan Nikolić[4], Goran Tulić[2,5], Marko Kadija[2,5], Marko Bumbaširević[2,5]

[1] *Clinic for Physical Medicine and Rehabilitation, Clinical Center of Serbia, Belgrade, Serbia*

[2] *Faculty of Medicine, University of Belgrade, Belgrade, Serbia*

[3] *Institute of Epidemiology, Faculty of Medicine, University of Belgrade, Belgrade, Serbia*

[4] *University Childrens Hospital, Belgrade, Serbia*

[5] *Institute for Orthopedic Surgery and Traumatology, Clinical Center of Serbia, Belgrade, Serbia*

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Abstract: Hip fracture in elderly people is associated with high morbidity and mortality. Therefore, it is important to identify risk factors that potentially influence outcomes after hip surgery. The main purpose of this study was to evaluate the relationship of anemia at admission and short-term outcomes after hip fracture. We studied 343 community-dwelling patients who underwent surgery for hip fracture from March 2009 to March 2010. Functional mobility at discharge, postoperative complications, hospital length of stay and in-hospital mortality were analyzed in respect to presence and severity of anemia at admission. Anemia (defined as hemoglobin levels < 13.0 g/dl for men and < 12.0g/dl for women) was present in 185 (53.9%) patients, of whom 54 (29.2%) were severely anemic (defined as hemoglobin level 10.0g/dl or below). In multivariate analysis anemia was associated with age, gender (female), type of fracture (intertrochanteric) and American Society of Anesthesiologists (ASA) classification (3 or 4), while severity of anemia was associated with recovery of ambulatory ability at discharge. There was no difference in the incidence of postoperative complication, in-hospital mortality and length of hospital stay between the groups at discharge. Overall anemia at admission is an indicator of poor general health status. Ambulatory recovery in hip fracture patients is independently related to severity of anemia at admission.

Keywords: *Hemoglobin • Rehabilitation • Functional recovery*

1. Introduction

The population of elderly people, which counted 600 million in 2000, is expected to increase twofold by 2025 and more than threefold by 2050 [1]. The fastest growing age group in the world is the “oldest-old” (85 years and older), which is expected to account for one fifth of older persons by the middle of the century [2]. This demographic change consequently impacts the rising incidence of hip fractures [3,4]. In older people they are associated with a high morbidity and mortality, as well as enormous Medicare costs [5,6]. Because of the severity of the problem it becomes of ultimate importance to recognize medical problems in older people, which are potentially related to functional recovery after hip fracture, especially those that can be modified. It is well recognized that hemoglobin levels are lower in older people compared to young ones [7]. However, it remains undecided whether lower hemoglobin levels in older people are necessarily an indicator of underlying

* *E-mail: edubljaninraspopovic@gmail.com*

comorbidities, or just an aspect of natural aging [7]. A large number of research has been done to investigate the impact of different variables on recovery after hip fracture surgery [8-10]. The effect of perioperative anemia on surgical mortality and morbidity in hip fracture patients has also been addressed in literature [11-14]. However, a limited number of studies have investigated the relationship between admission hemoglobin level and hip fracture outcome [15-17]. Distinguishing the role of admission hemoglobin is of major importance, since hemoglobin values at different time points of the perioperative period may indicate different problems, and have consequently different clinical implications. Knowing the risks of blood transfusion it is of even more importance to recognize if and at which level hemoglobin at admission is related to outcome, as to decide when transfusion becomes justifiable [18-20].

We presume that anemia at admission might be associated with short-term hip fracture recovery. Thus, the aim of this prospective study was to evaluate the relationship of hemoglobin level at admission with functional and clinical outcomes of older hip fracture patients at discharge from an acute setting.

2. Material and Methods

Three hundred and forty three patients (274 females; 79.9%) with median age of 78.1±7.4 (from 65-96 years) who presented with acute hip fracture from March 2009 to March 2010 at the Clinics for Orthopedic Surgery and Traumatology (COST), Clinical Center Serbia, Serbia were prospectively enrolled in the study. At the COST, hip fracture patients are evaluated and treated with a multidisciplinary approach by orthopedic surgeons and physical medicine and rehabilitation specialists. Exclusion criteria were: age < 65 years, undisplaced femoral neck fracture (Garden I and II), subtrochanteric fracture, pathologic fracture, major concomitant injuries, multiple trauma such as a vehicle accident, imminent death due to an end-stage disease, and non ability to walk prior to fracture. Patients with high surgical risk due to comorbidities, who were treated non-operatively, were also excluded from the study. The study was conducted according to the Helsinki Declaration [21], and approved by the Ethics Committee of the Medical Faculty at Belgrade University in Serbia.

Primary assessment included the hemoglobin level at admission. Additionally, pre-fracture living conditions, pre-fracture functional status with regard to the activities of daily living, pre-fracture walking ability, and health related quality of life data were assessed from patient/proxy interview at the time of admission. Medical charts were reviewed during the hospital stay and before discharge to ascertain comorbidities, laboratory values, fracture type, and presence of complication during the hospital course.

In order to obtain uniform data all assessments were carried out by the coordinator of the study (EDR), except for the American Society of Anesthesia's (ASA) classification, and the type of fracture, which were categorized by the attending anesthesiologist, and responsible surgeon, respectively. Three treatment modalities were used: 200 (58.3%) patients underwent hemiarthroplasty (bipolar prothesis), 129 (37.6%) underwent closed reduction internal fixation (dynamic hip screw), and 14 patients (4.1%) had total hip replacement (THR). Bone cement was used in all patients with arthroplasty. In all patients, depending on overall postoperative health status, early mobilization was encouraged on the first postoperative day with weight-bearing as tolerated. Restricted weight-bearing in patients treated surgically for intertrochanteric fractures has little biomechanic justification, and has not be proven to decrease complication rates following fixation of intertrochanteric fractures [22].

Pre-fracture living conditions were recorded as either independent or institutionalized. Pre-injury walking ability was classified as able to walk outdoors or only indoors. Independence in activities of daily living (bathing, dressing, toilet use, transferring, urine and bowel continence, eating) was assessed with the Katz Index of Independence in Activities of Daily Activities (ADL) [23]. The total number of activities of daily living performed independently in the month prior to fracture was documented. The American Society of Anesthesia's rating of operative risk was used to group patients' physical status into one of 5 categories, ranging from 1 (healthy) to 5 (moribund) [24]. No patient in our study was graded moribund. For the purpose of this study two rating categories were used: Grade 1 or 2 and Grade 3 or 4. This approach has been previously used in trials on patients with hip fracture [25-27]. Health related quality of life during the last week before fracture was rated with use of EuroQol-5D (EQ-5D) index. An EQ-5D index score of 0 indicates the worst possible health state, and a value of 1 indicates full health [28].

The outcomes in the study included functional mobility one day prior to discharge, the incidence of postoperative medical complications, length of hospital stay, and intra-hospital mortality rate. Functional mobility was measured using the locomotion subscale of the Functional Independence Measure (FIM is a trademark and UDSMR is a service mark of the Uniform Data System for Medical Rehabilitation, a division of

Table 1. Baseline Data in Relation to Hemoglobin level at Admission.

	Patients with hemoglobin level < 12.0 or < 13 g/dl	Patients with hemoglobin level ≥12.0 or 13 g/dl	P value
Number of patients 343	185 (53.9%)	158 (46.1%)	
Gender ‡			
Male	27(14.6%)	42(26.6%)	0.006
Female	158 (85.4%)	116 (73.4%)	
Age (y.) †	79.3±7.0	76.8±7.7	0.004
Age groups (y.)			0.268
60-84	142 (76.7%)	29 (81.6%)	
≥ 85	43 (23.3%)	129 (18.4%)	
Preinjury residence ‡			0.858
Home	180 (97.8%)	155 (98.0%)	
Institution	4 (2.2%)	3 (1.9%)	
Type of fracture ‡			0.020*
Femoral Neck	105 (56.8%)	109 (68.9%)	
Intertrochanteric	80 (43.2%)	49 (31.1%)	
Operative risk‡			0.014
ASA 1,2	8 (4.3%)	18 (11.4%)	
ASA 3,4	177 (95.7%)	140 (46,49%)	
Preinjury walking ability ‡			0.699
Community ambulators	23 (12.9%)	18 (11.5%)	
Household ambulators	156 (87.2%)	139 (88.5%)	
ADL†	5.0±1.2	5.2±1.2	0.010
EQ5D†	0.6±0.3	0.7±0.3	0.005

†The values are given as the mean with the standard deviation in parentheses.
‡The values are given as the number of patients with the percentage in parentheses.

UB Foundation Activities Inc.), that rates the patient independence in walking 150 feet without assistive devices, and going up and down 12 to 14 stairs indoors in a safe manner from 1 (total assistance) to 7 (complete independence) [29].

Observed postoperative medical complications were congestive heart failure, arrhythmia, pneumonia, cerebrovascular event, myocardial infarction, pulmonary embolism, urinary tract infection, deep wound infection and pressure sores. Regarding the number of complications we compared two groups of patients (0 complications versus ≥ 1 complications).

The investigated subjects were classified as anemic according to the World Health Organization Criteria when the hemoglobin level at admission was below 13.0 g/dl for males and below 12.0 g/dl for females [30]. Further sub-classification of anemic patients was into severe (admission hemoglobin level 10.0 g/dl or below) and mild anemia (admission hemoglobin level between 10.0 and 11.9 g/dl for women, and between 10.0 and 12.9 g/dl for men) [15]. We used these criteria to compare the outcome for patients with anemia with the outcome of patients without anemia at admission. Outcome was also compared for patients with severe with those with mild anemia at admission. All analyses used two-tailed significance level of $p<0.05$. Scale variables (conveyed as mean ± standard deviation) in independent groups were tested by the Mann-Whitney U test. Chi-square test was used to test categorical variables that were expressed as numbers and percentages of patients. Only variables that showed statistically significant association were included in the multivariate logistic regression analysis as independent variables, while anemia status at admission was the dependent variable. The relative importance of various outcome variables in respect to hemoglobin level is presented as the odds ration (OR) with 95% confidence interval. Data were analyzed using SPSS software, version 15.0 (SPSS Inc, Chicago IL, USA).

Table 2. Association between anemia at admission and other factors identified by multivariate analysis.

Variables	OR (95%CI)	P
Age	1.038 (1.006-1.071)	0.018
Gender (female)	1.904 (1.091-3.323)	0.023
Type of fracture (trochanteric)	1.795 (1.124-2.866)	0.014
Operative risk (ASA 3,4)	2.782 (1.135-6.818)	0.025

a – dependent variable: anemia at admission

3. Results

3.1. Baseline data

Baseline characteristics of the hip fracture patients followed in this study are summarized in Table 1. At admission anemia was identified in 185 (53.9%) of 343 patients with acute hip fracture. Of these, 54 (29.2%) had severe anemia. The mean age in the group of patients with anemia at admission was significantly higher with a higher proportion of female patients. In the group with anemia, patients have sustained an intertrochanteric fracture more often. Further, they were with higher operative risk compared to the non-anemic population (ASA 3,4), had a lower score for health-related quality of life and activities of daily living performed independently prior to fracture. No other significant differences were noted between the patients with and without anemia. Severely anemic groups had a higher proportions of patients > 85 years (p=0.037), and a significantly lower preoperative health related quality of life (p=0.048). All the other baseline characteristics were evenly distributed between the groups.

3.2. Outcomes

Out of 343 patients 31 patients (9.0%), of whom 19 (5.5%) were anemic, died during their hospital stay. The average length of stay was 30.8 ± 15.2 days. Comparing the outcomes between the anemic and non-anemic group there was no difference in length of hospital stay, in hospital mortality, and number of complications. However, patients with anemia had worse functional outcomes compared to patients without anemia at admission, as demonstrated by a highly significant lower average FIM locomotion score at discharge (p=0.002).

Then, multivariate analysis was conducted using seven variables (age, gender, type of fracture, ASA score, ADL score, EQ-5D index, and FIM locomotion score). As shown in Table 2, advanced age, female gender, trochanteric type of fracture and higher ASA score were independently related to the status of anemia at admission.

In respect to severity of anemia, patients with lower levels of hemoglobin achieved significantly poorer recovery of locomotion with an average FIM locomotion score of 4.3± 2.3 at discharge (p=0.022). Multivariate analysis revealed that a significant relationship between severity of anemia at admission and FIM locomotion score at discharge (OR=1.260, 95% CI 1.019-1.320, p=0.025).

4. Discussion

The percentage of anemic patients in our group was 53.9%, that is similar to the percentage of anemic patients with hip fractures reported in other studies [15,16]. We found no significant association between anemia at admission and increased length of hospital stay compared with non-anemic group. Gruson et al. [15], however, reported that anemia at admission was significantly related to length of hospital stay. Similarly, Halm et al. [16] also reported that higher hemoglobin level at admission in hip fracture patients were associated with shorter hospital length of stay. We believe that the length of hospital stay is not necessarily an objective outcome measure in our setting because most of our patients are directly discharged to rehabilitation hospitals, whereby the time of discharge is often dependent on the capacity of the facilities. This might explain the fact that our study shows no significant association between anemia and increased length of hospital stay.

We found a significant relationship between anemia at admission and recovery of locomotion at discharge. However, this variable was not independently related to the hemoglobin level at admission. Our results are consistent with other investigators. Hagino et al. [17] reported that hemoglobin level at admission, as an indicator of the general status of the patient before injury, is a predictor of ambulation status at discharge. Contrary with above mentioned, in the study of Halm et al. [16], who used a modified version of the locomotion subscale of FIM to access ambulation 60 days after hospital discharge no association between admission hemoglobin level and functional ability was found. Gruson et al. [15], who investigated recovery of ambulatory activity at earliest after 3 months, found no

significant difference in recovery between anemic and nonanemic patients.

Beside those findings, we found a significant association between the severity of anemia and hip fracture outcome. In contrast to our findings, Hagino et al. [17], who compared the outcome of patients with mild and severe anemia, reported no significant difference in ambulatory status at discharge between the two groups of patients. The study of Hagino et al. [17] did not exclude patients who were non-ambulatory prior to fracture as well as patients treated non-operatively. The potential confounding effect of the heterogeneous nature of the population group [17] needs to be taken into account when comparing the results of this study. Our results imply that that the capacity of functional recovery is independently related to the degree of anemia. One possible explanation might be the premise that decreases in muscular strength occur in the presence of anemia [31], especially in patients with severe anemia at admission.

In our study we did not find an association between anemia at admission and in-hospital mortality, and between anemia and postoperative medical complications. Gruson et al. [15] similarly reported that anemic patients were no more likely to develop postoperative medical complications, including intrahospital mortality compared to non-anemic patients. The authors [15] believe that this result is probably due to the small number of in-hospital deaths in the anemic and non-anemic population, which is also the case in our study (5.5% and 3.5%, respectively). Similarly to Gruson, Halm et al. [16] found that anemia before surgery was a strong predictor of death and readmission within 60 days of the surgical repair.

As it is shown from our study, patients with anemia were more likely to be older, female, and have a higher operative risk as rated with the ASA score. Similarly, Gruson et al. [16] found that anemic patients were more often of worse physical health as graded with the ASA score. Halm et al. [16] explained that anemia on admission might be a poor prognostic factor because it is a physiologic indicator of underlying comorbid illness burden.

Anemic patients in our study revealed to sustain more often an intertrochanteric fracture, which is consistent with the findings of previous studies [15,17]. The reason for this could possibly be explained in two ways. First, anemia on admission might be a reflection of excessive prehospital bleeding. In addition, many elderly patients might be dehydrated on admission, and initial fluid hydration may decrease hemoglobin levels [32]. In our study, patients were admitted to hospital, and blood test were done, a short period after hip injury. Therefore, fluid hydration is not the cause of anemia at admission in our study. It remains to be answered if bleeding as a result of a sustained intertrochanteric fractures can be the single cause of anemia even in those patients where blood tests are taken a short period after injury. Second, the increased incidence in both anemia and trochanteric fractures with advanced age has been acknowledged [33]. Also, elderly patients with anemia are at increased risk for falls [34]. It remains to be investigated if elderly patients with low hemoglobin levels may be at increased risk to sustain a trochanteric fracture when falling.

Beside the limitation of the study that included the fact that we observed only short-term outcome in the setting of acute cure, there are several aspects contributing to the strength of the study. Concerning pre-fracture ambulation and pre-fracture institutionalization the population group was rather homogenous. All patients followed a similar postoperative rehabilitation protocol, which excluded the confounding effects of different postoperative approaches. We also investigated the relationship between anemia at admission and a wide range of variables. Justification for short-term methodological approach can be found in the lack of the data in literature regarding observed parameters. Additionally, Duke and Keating [35] have shown that the acute period is the most critical part of rehabilitation predicting long term outcome, indicating the necessity of short-term follow-up introduction in the evaluation of hip fracture patients.

Further investigation should be conducted in three directions. First, it seems a challenge to define in what way functional recovery is dependent on severity of anemia. Second, the relationship between anemia at admission and type of fracture should be further investigated. Third, since the degree of anemia is potentially a modifiable risk factor these findings could raise appropriate clinical attention. In light of this, further research should be conducted to investigate whether correction of severe anemia is the mean of improving early functional recovery in hip fracture patients.

5. Conclusion

In conclusion, anemia at admission is an indicator of poor general health status. Short-term functional outcome after hip fracture surgery is independently related to the degree of anemia at admission. There is a clear relation between type of fracture, and anemia at admission, which needs to be investigated further. Additional research in revealing factors associated with hip fracture outcome might be promising in improving rehabilitation results.

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