RESEARCH ARTICLE

# Pre-operative Anemia and Hyponatremia Increase the Risk of Mortality in Elderly Hip Fractures

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## Abstract

**Objectives:** Pre-operative assessment is routinely performed for all hip fractures, and include a thorough clinical examination and multiple pre-operative tests. While abnormalities are often detected in many tests, they have varied effect on mortality. The purpose of the study was to assess the prevalence and impact of these abnormal tests and comorbidities.

**Methods:** This was a prospective study of 283 consecutive hip fracture patients aged above 50 years admitted in a major trauma hospital from February 2019 to December 2019. The prevalence of abnormalities in the following tests were assessed: chest x-ray, electrocardiogram, complete blood count, serum electrolytes, renal function test, prothrombin time/international normalized ratio, and serum bilirubin. Also, presence of comorbidities were recorded. Mortality within 90 days of admission was assessed.

**Results:** 91.5% (N= 259/283) of the patients had at least one abnormal investigation. The most common abnormal investigation was anemia (70.3%, N= 199/283), followed by deranged sodium (36.4%, N= 103/283). 17.7% (N= 50/283) of the patients had at least one new comorbidity diagnosed after admission. The most common newly diagnosed comorbidity was hypertension (10.6%, N= 30/283). Anemia (p=0.044), deranged sodium (p=0.002), raised urea (p=0.018), raised creatinine (p=0.002), renal disease (p=0.015), neurological diseases (p=0.024), and charlson comorbidity index (p=0.004) were associated with increased mortality in multivariate analysis.

**Conclusion:** Pre-operative hemoglobin, sodium, urea, and creatinine were the most important tests influencing mortality, and derangements of these should therefore be carefully evaluated and managed. Hip fracture care pathways should focus on correction of these abnormalities.

**Level of evidence:** II

**Keywords:** Comorbidities, Hip fracture, Mortality, Preoperative tests

## Introduction

About 50-70% of the elderly patients suffering from hip fractures have at least one comorbidity.[1,2] Unfortunately, many comorbidities in the elderly population are not diagnosed in a timely manner and are inappropriately managed as many of these illnesses can be silent.[3,4] Also, about one in six of the elderly population in the world experience psychological abuse.[5] This can hinder appropriate management of their comorbidities, especially in low-income countries where they have to depend on the younger earning members of the family for regular physician visits.[6,7] Hip fracture is an acute debilitating event, and patients invariably seek medical attention. As surgery is the preferred treatment for these patients, they undergo a detailed medical evaluation involving a number of pre-operative tests which often reveal many abnormalities.[8] In addition to the already known comorbidities, such newly detected medical ailments might have an effect on the outcomes of these patients.[9–11]

The one-year mortality after hip fractures is estimated to be about 30%.[12–14] Medical comorbidities and frailty of these patients are thought to be primarily responsible for such a high mortality.[2,15] As there is a general tendency to operate hip fractures on an urgent basis, there are concerns on the utility of the various pre-operative tests which may

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delay surgery, and may not actually alter the treatment plan.[16] Therefore, it is important to identify the extent to which abnormalities are detected in the pre-operative tests, and to understand whether they have an impact on mortality. Also, all comorbidities and abnormal lab results may not have the same effect on outcomes. Understanding the medical conditions responsible for higher mortality will help in identifying the high-risk patients at the time of admission who may require a different care pathway.

Therefore, the current study was conducted to assess: 1) the prevalence of abnormal results in routine pre-operative tests, and the prevalence of comorbidities among elderly Indian hip fractures; and 2) the impact of the various abnormal test results and comorbidities on 90-day mortality.

## Materials and Methods

The study was commenced after obtaining approval from the Institution Ethical Committee. Patients were included in the study after written informed consent. This was a prospective observational study of consecutive elderly hip fracture patients admitted at a single tertiary level trauma center from February, 2019 to December, 2019. Data was collected by in-person interview of the patient and/or relatives at the time of admission along with review of their medical records.

All hip fractures (proximal femur fractures: neck, intertrochanteric, or subtrochanteric) above 50 years were included in the study. During the study period, there were 377 hip fracture admissions of which 93 were under the age of 50. One patient did not give consent, and was not included, Therefore, a total of 283 patients who were included in the study. The mean age of the cohort was 70±12 years, and there were 152 (54%) females. Intertrochanteric fractures were the most common fracture type (N=182, 64%) followed by neck of femur (N=77, 27%), and subtrochanteric fractures (N=24, 9%). All patients presented to the emergency department, and were attended by an orthopedic surgeon. Pre-operative assessment was conducted by the anesthetic team which included an appropriate medical examination and review of the following routine tests: chest x-ray (CXR), electrocardiogram (ECG), complete blood count, serum electrolytes, renal function test, prothrombin time/international normalized ratio (INR) and serum bilirubin. Surgery was planned for the earliest available slot provided the patient was fit for surgery based on the anesthetist's assessment. Patients who needed pre-operative optimization (such as correction of anemia, correction of serum electrolytes, control of blood sugars or blood pressure, etc.) were accordingly managed by interdisciplinary team involving orthopedic surgeons, geriatric physicians, and other specialists as required. After surgery (fixation or replacement), patients were mobilized on day 1 and were discharged by day 2 or 3 if the wound was healthy.

Comorbidities included in the charlson comorbidity index (CCI) were assessed.[17] These included history of myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, peptic ulcer disease, liver disease (mild, moderate or severe), diabetes (uncomplicated or with end organ damage), hemiplegia, renal disease (moderate or severe), tumor, lymphoma, leukemia, metastasis, and AIDS.[17] Based on these comorbidities, both CCI (score ranging from 0 to 33) and age-adjusted CCI (score ranging from 0 to 37) were calculated. Additionally, the following comorbidities which were not a part of CCI were assessed: hypertension, hypothyroidism, other neurological disease, psychoses, depression, cardiac arrythmia, and valvular disorders. The presence of any of these comorbidities at admission was obtained through history from patients or relatives, or using their previous medical records or during evaluation after admission by the orthopedic/anesthetic team and/or other specialists.

The lab tests performed at the time of admission were recorded. For the purposes of study, the results of ECG and CXR as interpreted by the anesthetist (or cardiologist or pulmonologist when available) were recorded as normal or abnormal. Anemia was defined based on the world health organization (WHO) definition as hemoglobin (Hb) <13 g/dL in men and Hb <12 g/dL in women.[18] Severe anemia was defined as Hb < 8 g/dL.[18] Thrombocytopenia was defined as platelet count < 150,000 per µL. The normal ranges for total leukocyte count (TLC) and INR were taken as 4000-11000 per µL and 0.9-1.1 respectively, with anything beyond this range considered as abnormal. Raised urea, creatinine, and bilirubin were defined using the following cut-offs respectively: >48 mg/dL, > 1.2 mg/dL, and > 1.2 mg/dL. The normal ranges used for sodium and potassium were 135-145 mEq/L and 3.5-5.1 mEq/L respectively.

All patients were followed up to assess all-cause mortality within 90 days of the admission. Patients who were not operated or died before surgery were also included in this study. Surgery was performed in 96.8% (N=274/283) patients (total hip arthroplasty=8 [all uncemented], hemiarthroplasty=49 [22-cemented], fixation=215 [cephalomedulary nail=196, cannulated cancellous screw=14, dynamic hip screw=4, blade plate =1); 2 patients decided to get operated outside our institution and the details were not available). The choice of fixation was based on surgeon's choice. The post-operative DVT prophylaxis at our hospital consisted of mechanical prophylaxis and tablet Aspirin 75 mg once a day for 28 days. Four patients died before surgery (1-pneumonia, 1-renal failure, 1- arrythmia, 1- stroke), two refused surgery and left against medical advice, and the remaining three were managed conservatively in view of poor health. Data regarding the death was obtained through medical records (during admission or re-admission) or by telephone interview of the patients' relatives.

Categorical variables were compared using a Chi-squared or Fisher Exact test. Students t-test sum was used to compare continuous variables. A univariate logistic regression was used to assess the factors associated with mortality. A multivariate logistic regression model was used to study the association between individual variables and mortality after adjusting for age, gender, and type of fracture. As the number of newly diagnosed comorbidities were low, both newly diagnosed and previously diagnosed comorbidities were considered together when studying the association between each of these comorbidities and mortality. The level of significance for rest of the analysis

was also set at $p < 0.05$. Statistical analysis was completed using Stata statistical software, version 12 (StataCorp, College Station, TX).

## Results

91.5% (N= 259/283) of the patients had at least one abnormal investigation. The most common abnormal investigation was anemia (70.3%, N= 199/283), followed by deranged sodium (36.4%, N= 103/283) [Table 1]. Overall, 68.9% (N=195/283) of the patients had at least one comorbidity with the most common one being hypertension (45.9%, N= 130/283) followed by uncomplicated diabetes (19.8%, N= 56/283) [Table 2]. The mean CCI score was 0.75 ± 1.07 (range, 0 to 6) while the age adjusted CCI score was 3.14 ±.1.53 (range, 0 to 8). The CCI score was higher, but not statistically significant in those with a new comorbidity (1.00 ± 1.2 vs 0.70 ± 1.06, p=0.074), as was age adjusted CCI score (3.67 ± 1.35 vs 3.01 ± 1.56, p=0.079).

**Table 1. Prevalence of abnormal investigation reports**

| Investigation | Number (%) |
|---|---|
| Any abnormal investigation | 259 (91.5%) |
| Anemia (<12 g/dl in females, <13 g/dl males) | 199 (70.32%) |
| Severe anemia (< 8 g/dl) | 22 (7.77%) |
| Abnormal TLC (<4000 per µL,>11000 per µL) | 47 (16.61%) |
| Thrombocytopenia (<150 per µL) | 77 (27.21%) |
| Abnormal INR (<0.9,>1.1) | 62 (21.91%) |
| Deranged sodium (<135 mEq/L, >145 mEq/L) | 103 (36.4%) |
| Deranged potassium (<3.5 mEq/L, >5.1 mEq/L) | 35 (12.37%) |
| Raised Urea (>48 mg/dL) | 60 (21.2%) |
| Raised Creatinine (>1.2 mg/dL) | 37 (13.07%) |
| Raised Bilirubin (>1.2 mg/dL) | 35 (12.37%) |
| Abnormal ECG | 91 (32.16%) |
| Abnormal CXR | 46 (16.25%) |

**Table 2. Prevalence of comorbidities**

| Comorbidity | N (%) |
|---|---|
| Hypertension | 130 (45.94%) |
| Uncomplicated diabetes | 56 (19.79%) |
| Chronic lung disease | 32 (11.31%) |
| Cerebrovascular accident | 22 (7.77%) |
| Hypothyroidism | 13 (4.59%) |
| Other neurological diseases | 10 (3.53%) |
| Complicated Diabetes | 9 (3.18%) |
| Tumor | 9 (3.18%) |
| Dementia | 8 (2.83%) |
| Moderate or severe renal disease | 8 (2.83%) |
| Cardiac arrhythmia | 8 (2.83%) |
| Congestive Heart Failure | 6 (2.12%) |
| Connective tissue disease | 6 (2.12%) |
| Myocardial infarction | 5 (1.77%) |
| Hemiplegia | 4 (1.41%) |
| Psychoses | 3 (1.06%) |
| Depression | 3 (1.06%) |
| Peptic ulcer disease | 2 (0.71%) |
| Metastasis | 2 (0.71%) |
| Valvular disease | 2 (0.71%) |
| Chronic liver disease | 2 (0.71%) |

Follow-up was available for 97.2% (N=275/283) patients at 90-days. Out of these, 9.8% (N=27/275) patients died. The in-hospital mortality was 2.5% (7/283). Seven (2.5%) patients had a re-operation (3- implant failure, 2-infection, 1- dislocation, 1- periprosthetic fracture), Mortality among patients with re-operation was 14.3% (N=1/7) while it was 9.7% (N=26/268) among those without reoperation, p=0.519. Among the abnormal investigations, anemia (p=0.017), severe anemia (p=0.042), deranged sodium (p=0.017), raised urea (p=0.003) and raised creatinine (p<0.001) were associated with increased mortality. Anemia (p=0.044), deranged sodium (p=0.002), raised urea (p=0.018) and raised creatinine (p=0.002) were also associated with increased mortality in multivariate analysis [Table 3]. All patients who died had at least one abnormal investigation, and hence, odds ratio was not calculated. On univariate analysis, presence of any comorbidity (p=0.016), CCI score (p=0.006) and age adjusted CCI (p=0.037) were associated with increased mortality [Table 4]. Individually, moderate or severe renal disease (p=0.018) and other neurological diseases (p=0.043) were associated with increased mortality. On multivariate analysis, presence of any comorbidity (p=0.026), CCI score (p=0.004), age adjusted CCI (p=0.043), moderate or severe renal disease (p=0.015) and other neurological diseases (p=0.024) were associated with increased mortality [Table 4]. The odds ratio for the following comorbidities were not calculated due to lack of events (mortality) in either of the groups (comorbidity present/absent): myocardial infarction, connective tissue disease, peptic ulcer disease, chronic liver disease, hypothyroidism, psychoses and valvular diseases.

**Table 3. Influence of abnormal investigations on 90-day mortality**

| Investigation | Odds ratio (95% CI) | P-value | Adjusted odds ratio (95% CI) | P-value |
|---|---|---|---|---|
| Anemia | 5.95 (1.38-25.75) | 0.017 | 4.60 (1.04-20.38) | 0.044 |
| Severe anemia | 3.09 (1.04-9.17) | 0.042 | 2.67 (0.86-8.26) | 0.089 |
| Abnormal TLC | 0.36 (0.08-1.58) | 0.176 | 0.34(0.07-1.51) | 0.155 |
| Thrombocytopenia | 0.93(0.37-2.29) | 0.869 | 1.05 (0.41-2.66) | 0.922 |
| Abnormal INR | 1.26(0.51-3.13) | 0.623 | 1.27(0.50-3.25) | 0.613 |
| Deranged sodium | 4.72 (1.98-11.23) | <0.001 | 3.98 (1.64-9.68) | 0.002 |
| Deranged potassium | 1.22(0.39-3.76) | 0.732 | 1.13(0.35-3.63) | 0.841 |
| Raised Urea | 3.51 (1.54-8.01) | 0.003 | 2.90(1.20-7.00) | 0.018 |
| Raised Creatinine | 4.81 (2.00-11.57) | <0.001 | 4.94(1.84-13.27) | 0.002 |
| Raised Bilirubin | 0.25 (0.03-1.90) | 0.182 | 0.33 (0.04-2.60) | 0.294 |
| Abnormal ECG | 1.50(0.66-3.38) | 0.330 | 1.15(0.49-2.71) | 0.744 |
| Abnormal CXR | 2.40 (0.98-5.89) | 0.056 | 2.27(0.89-5.82) | 0.087 |

CI- Confidence Interval, TLC- Total Leukocyte Count, INR- International Normalized Ration, ECG-electrocardiogram, CXR- Chest X-ray

**Table 4. Influence of comorbidities on 90-day mortality**

| Comorbidity | Odds ratio (95% CI) | P-value | Adjusted odds ratio (95% CI) | P-value |
|---|---|---|---|---|
| Any comorbidity | 6.06 (1.40-26.22) | 0.016 | 5.45 (1.22-24.02) | 0.026 |
| CCI score | 1.50(1.13-2.01) | 0.006 | 1.61 (1.16-2.21) | 0.004 |
| Age-adjusted CCI* | 1.71(1.03-2.84) | 0.037 | 1.68 (1.02-2.78) | 0.043 |
| Number of comorbidities | | | | |
| 0 | Ref | | Ref | |
| 1 | 5.37 (1.15-24.97) | 0.032 | 4.86 (1.01-23-34) | 0.048 |
| 2 | 7.10 (1.50-33.66) | 0.013 | 6.41(1.31-31.33) | 0.022 |
| >2 | 5.99 (1.04-34.60) | 0.045 | 5.21 (0.87-31.14) | 0.070 |
| Hypertension | 1.49(0.67-3.32) | 0.325 | 1.27(0.55-2.93) | 0.575 |
| Uncomplicated diabetes | 1.19(0.45-3.11) | 0.722 | 1.25(0.46-3.39) | 0.667 |
| Chronic lung disease | 1.94 (0.68-5.55) | 0.217 | 1.87(0.63-5.57) | 0.263 |
| Cerebrovascular accident | 1.59 (0.44-5.81) | 0.478 | 1.37 (0.35-5.34) | 0.648 |
| Other neurological diseases | 4.30 (1.04-17.73) | 0.043 | 5.84(1.26-27.13) | 0.024 |
| Complicated Diabetes | 2.75 (0.54-13.98) | 0.222 | 3.14 (0.58-16.98) | 0.184 |
| Tumour | 1.15 (0.14-9.60) | 0.895 | 1.16 (0.13-10.28) | 0.893 |

**Table 4. Continued**

| | | | | |
|---|---|---|---|---|
| Dementia | 1.32 (0.16-11.19) | 0.796 | 1.02(0.11-9.21) | 0.984 |
| Moderate or severe renal disease | 6.08(1.37-26.99) | 0.018 | 7.74(1.48-40.39) | 0.015 |
| Cardiac arrythmia | 3.23(0.62-16.84) | 0.165 | 2.83(0.46-17.41) | 0.261 |
| Congestive Heart Failure | 1.87(0.21-16.61) | 0.575 | 2.58(0.27-24.82) | 0.411 |
| Hemiplegia | 3.14 (0.32-31.29) | 0.329 | 3.64(0.31-42.31) | 0.303 |
| Depression | 4.73(0.41-53.96) | 0.211 | 4.21(0.33-53.64) | 0.269 |
| Metastasis | 9.5 (0.57-156.39) | 0.115 | 13.82 (0.74-258.67) | 0.079 |

*For age-adjusted CCI, age was not included in the multivariate analysis reporting adjusted odds ratio. CI- Confidence Interval, CCI- Charlson Comorbidity Index

## Discussion

Surgery is the preferred treatment for hip fractures, and all patients undergo a pre-operative medical assessment which often reveals multiple abnormalities. In this study, we assessed the prevalence of abnormal lab investigations and comorbidities in a consecutive series of hip fractures. Our study found that 92% of the hip fracture patients had at least one abnormality in the routine lab investigations. Overall, 69% of the patients had at least one comorbidity. Anemia was the most commonly detected lab abnormality while hypertension was most commonly diagnosed comorbidity. Our study also found that anemia, deranged sodium, raised urea, and raised creatinine were associated with increased mortality. Although composite measures of comorbidity like CCI and the presence of comorbidities in general increased the risk of mortality, commonly detected comorbidities such as hypertension and diabetes were not associated with a higher risk of mortality.

The vast majority of the patients had at least one abnormality in the routinely performed tests. Anemia was the most commonly detected lab abnormality followed by deranged sodium level, and both of these were associated with higher mortality. Other studies have also found a strong relationship between anemia and mortality after hip fractures.[10,19,20] Interestingly, though severe anemia was found to be associated with increased mortality in univariate analysis, it was not associated with mortality after adjusting for confounders suggesting that severe anemia may not have a strong association as anemia. This might be because, patients with severe anemia are often closely monitored and almost always receive transfusions pre-operatively which lead to an improvement in the Hb.[18] This suggests that patients at borderline anemia might be at higher risk of mortality as their anemia may not always be adequately addressed. The in-hospital and 90-day mortalities in our studies were 2.5% and 9.8% respectively, which were comparable to other studies.[11,21] The prevalence of deranged sodium (36%) in the study was slightly larger than that reported in other studies (20-25%),[9,21–24] though other studies also reported consistently higher mortality with deranged sodium.[9,21,23,24] As some studies have shown that hyponatremia is associated with increased risk of hip fractures, independent of bone mineral density, it is possible that many of the hip fracture patients may have had derangements in blood sodium even before the injury.[25,26] Although severe hyponatremia is usually corrected, orthopaedic surgeons should also be aware about mild abnormalities which can easily be overlooked.[23]

Overall, hypertension was the most prevalent comorbidity (46%). Hypertension was also the most prevalent comorbidity in the studies by Penrod et al.,[27] Dhibar et al.[28] and, Reig et al.[11] conducted in United States, India, and Spain respectively. But hypertension which was not found to be associated with mortality similar to other studies.[29,30] Also, hypertension is not a part of the commonly used CCI which has been shown to be a better predictor for poor outcomes in various studies.[31-33] Elevations in either urea or creatinine were associated with increased mortality in our study similar to the findings by Jonsson et al.[19] and Seyedi et al.[34] Elevated serum creatinine may pre-dispose patients to acute kidney injury in the peri-operative period which has been shown to increase mortality.[35,36] Raised urea may be a sign of poor hydration suggesting that these patients might need better management and monitoring of their fluid intake and output.[37] Although we did not classify patients based on severity, diabetes was not associated with increased mortality suggesting that unnecessary delay in surgery awaiting optimization of sugars maybe avoided.

The study has a number of limitations. The sample size is only moderately sized, and a number of comorbidities which failed to show an association with mortality might have been significantly associated with mortality if the sample size was larger. However, this study included a consecutive series of hip fractures, and thus also included patients who did not underwent a surgery due to medical reasons, resulting in a more accurate estimation of the prevalence of abnormal tests and comorbidities. The present study only assessed those investigations which were routinely performed at our institution as part of the pre-operative assessment. However, other lab parameters might also have an influence on outcomes, and some of them might be routinely performed at other centres. Also, the abnormal results were based on ranges used in our laboratory, and there might be some variations in the normal ranges depending on the country and laboratory, although these changes are unlikely to affect the conclusions of the study. Also multiple other medical conditions such as obesity, drug abuse, smoking, etc which are not part of the Charlson Comorbidity Index were not included in the study and may influence mortality.[17]

## Conclusion

In summary, about nine out of every ten hip fracture patients had an abnormal investigation with the most frequently detected abnormalities being anemia and deranged sodium. Pre-operative Hb, sodium, urea and creatinine were the most important tests influencing mortality, and derangements of these should therefore be carefully evaluated and managed. In general, presence of comorbidities increased the risk of mortality though different comorbidities had varied effects. Presence of a renal disease or neurological disease were associated with higher risk of mortality while common comorbidities such as hypertension and diabetes did not show an association with mortality. The findings of our study is helpful in developing hip fracture care pathways aimed at correction of abnormalities which have a substantial effect on mortality.

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## References

1. Meyer AC, Ek S, Drefahl S, Ahlbom A, Hedström M, Modig K. Trends in Hip Fracture Incidence, Recurrence, and Survival by Education and Comorbidity: A Swedish Register-based Study. Epidemiology. 2021; 32(3):425-433. doi:10.1097/EDE.0000000000001321.
2. Kristensen PK, Hjelholt TJ, Madsen M, Pedersen AB. Current Trends in Comorbidity Prevalence and Associated Mortality in a Population-Based Cohort of Hip Fracture Patients in Denmark. Clin Epidemiol. 2023; 15:839-853. doi:10.2147/CLEP.S410055.
3. Frost M, Wraae K, Gudex C, et al. Chronic diseases in elderly men: Underreporting and underdiagnosis. Age Ageing. 2012; 41(2):177-183. doi:10.1093/ageing/afr153.
4. van Dongen SI, van Straaten B, Wolf JRLM, et al. Self-reported health, healthcare service use and health-related needs: A comparison of older and younger homeless people. Heal Soc Care Community. 2019; 27(4):e379-e388. doi:10.1111/hsc.12739
5. Yon Y, Mikton CR, Gassoumis ZD, Wilber KH. Elder abuse prevalence in community settings: a systematic review and meta-analysis. Lancet Glob Heal. 2017; 5(2):e147-e156. doi:10.1016/S2214-109X(17)30006-2.
6. Bhan N, Madhira P, Muralidharan A, et al. Health needs, access to healthcare, and perceptions of ageing in an urbanizing community in India: A qualitative study. BMC Geriatr. 2017; 17(1). doi:10.1186/s12877-017-0544-y.
7. Yon Y, Mikton CR, Gassoumis ZD, Wilber KH. Elder abuse prevalence in community settings: a systematic review and meta-analysis. Lancet Glob Heal. 2017; 5(2):e147-e156. doi:10.1016/S2214-109X(17)30006-2.
8. George J, Sharma V, Farooque K, Mittal S, Trikha V, Malhotra R. Injury Mechanisms of Hip Fractures in India. Hip pelvis. 2021; 33(2):62-70. doi:10.5371/HP.2021.33.2.62.
9. Madsen CM, Jantzen C, Lauritzen JB, Abrahamsen B, Jorgensen HL. Hyponatremia and hypernatremia are
method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;
associated with increased 30-day mortality in hip fracture patients. Osteoporos Int. 2016; 27(1):397-404. doi:10.1007/s00198-015-3423-4.
10. Zhang L, Yin P, Lv H, et al. Anemia on admission is an independent predictor of long-term mortality in hip fracture population a prospective study with 2-year follow-up. Medicine (Baltimore). 2016; 95(5). doi:10.1097/MD.0000000000002469.
11. Sanz-Reig J, Salvador Marín J, Ferrández Martínez J, Orozco Beltrán D, Martínez López JF, Quesada Rico JA. Prognostic factors and predictive model for in-hospital mortality following hip fractures in the elderly. Chinese J Traumatol - English Ed. 2018; 21(3):163-169. doi:10.1016/j.cjtee.2017.10.006.
12. Paruk F, Matthews G, Gregson CL, Cassim B. Hip fractures in South Africa: mortality outcomes over 12 months post-fracture. Arch Osteoporos. 2020; 15(1):76. doi:10.1007/s11657-020-00741-4.
13. Li S, Sun T, Liu Z. Excess mortality of 1 year in elderly hip fracture patients compared with the general population in Beijing, China. Arch Osteoporos. 2016; 11(1):35. doi:10.1007/s11657-016-0289-9.
14. George J, Sharma V, Farooque K, Mittal S, Trikha V, Malhotra R. Factors associated with delayed surgery in elderly hip fractures in India. Arch Osteoporos. 2021; 16(1). doi:10.1007/S11657-020-00858-6.
15. Groff H, Kheir MM, George J, Azboy I, Higuera CA, Parvizi J. Causes of in-hospital mortality after hip fractures in the elderly. Hip Int. 2020; 30(2):204-209. doi:10.1177/1120700019835160.
16. Bernstein J, Roberts FO, Wiesel BB, Ahn J. Preoperative testing for hip fracture patient's delays surgery, prolongs hospital stays, and rarely dictates care. J Orthop Trauma. 2016; 30(2):78-80. doi:10.1097/BOT.0000000000000444.
17. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new 40(5):373-383. doi:10.1016/0021-9681(87)90171-8.
18. WHO. Haemoglobin concentrations for the diagnosis of

anaemia and assessment of severity. Available at:https://www.who.int/vmnis/indicators/haemoglobin.pdf. Published 2011. Accessed October 9, 2020.
19. Ryan G, Nowak L, Melo L, et al. Anemia at Presentation Predicts Acute Mortality and Need for Readmission Following Geriatric Hip Fracture. JB JS open access. 2020; 5(3). doi:10.2106/JBJS.OA.20.00048
20. Guerra MTE, Viana RD, Feil L, Feron ET, Maboni J, Vargas AS-G. One-year mortality of elderly patients with hip fracture surgically treated at a hospital in Southern Brazil. Rev Bras Ortop. 2017; 52(1):17-23. doi:10.1016/j.rboe.2016.11.006.
21. Ayus JC, Fuentes N, Go AS, et al. Chronicity of Uncorrected Hyponatremia and Clinical Outcomes in Older Patients Undergoing Hip Fracture Repair. Front Med. 2020; 7:263. doi:10.3389/fmed.2020.00263.
22. Aicale R, Tarantino D, Maffulli N. Prevalence of Hyponatremia in Elderly Patients with Hip Fractures: A Two-Year Study. Med Princ Pract. 2017; 26(5):451-455. doi:10.1159/000480294.
23. Kuo SCH, Kuo P-J, Rau C-S, Wu S-C, Hsu S-Y, Hsieh C-H. Hyponatremia Is Associated with Worse Outcomes from Fall Injuries in the Elderly. Int J Environ Res Public Health. 2017; 14(5). doi:10.3390/ijerph14050460.
24. Hagino T, Ochiai S, Watanabe Y, et al. Hyponatremia at admission is associated with in-hospital death in patients with hip fracture. Arch Orthop Trauma Surg. 2013; 133(4):507-511. doi:10.1007/s00402-013-1693-x.
25. Nigwekar SU, Negri AL, Bajpai D, et al. Chronic prolonged hyponatremia and risk of hip fracture in elderly patients with chronic kidney disease. Bone. 2019; 127:556-562. doi:10.1016/j.bone.2019.07.029.
26. Jamal SA, Arampatzis S, Harrison SL, et al. Hyponatremia and fractures: Findings from the MrOS study. J Bone Miner Res. 2015; 30(6):970-975. doi:10.1002/jbmr.2383.
27. Penrod JD, Litke A, Hawkes WG, et al. The association of race, gender, and comorbidity with mortality and function after hip fracture. J Gerontol A Biol Sci Med Sci. 2008; 63(8):867-872. doi:10.1093/gerona/63.8.867.
28. Dhibar D, Gogate Y, Aggarwal S, Garg S, Bhansali A, Bhadada S. Predictors and outcome of fragility hip fracture: A prospective study from North India. Indian J Endocrinol Metab. 2019; 23(3):282. doi:10.4103/ijem.ijem_648_18.
29. Henderson CY, Ryan JP. Predicting mortality following hip fracture: an analysis of comorbidities and complications. Ir J Med Sci. 2015; 184(3):667-671. doi:10.1007/s11845-015-1271-z.
30. Härstedt M, Rogmark C, Sutton R, Melander O, Fedorowski A. Impact of comorbidity on 6-month hospital readmission and mortality after hip fracture surgery. Injury. 2015; 46(4):713-718. doi:10.1016/j.injury.2014.12.024.
31. Jiang L, Chou ACC, Nadkarni N, et al. Charlson Comorbidity Index Predicts 5-Year Survivorship of Surgically Treated Hip Fracture Patients. Geriatr Orthop Surg Rehabil. 2018; 9:2151459318806442. doi:10.1177/2151459318806442.
32. Tang PL, Lin HS, Hsu CJ. Predicting in-hospital mortality for dementia patients after hip fracture surgery – A comparison between the Charlson Comorbidity Index (CCI) and the Elixhauser Comorbidity Index. J Orthop Sci. 2021; 26(3):396-402. doi:10.1016/j.jos.2020.04.005.
33. Toson B, Harvey LA, Close JCT. The ICD-10 Charlson Comorbidity Index predicted mortality but not resource utilization following hip fracture. J Clin Epidemiol. 2015; 68(1):44-51. doi:10.1016/j.jclinepi.2014.09.017.
34. Seyedi HR, Mahdian M, Khosravi G, et al. Prediction of mortality in hip fracture patients: Role of routine blood tests. Arch Bone Jt Surg. 2015; 3(1):51-55. doi:10.22038/abjs.2015.3793.
35. Porter CJ, Moppett IK, Juurlink I, Nightingale J, Moran CG, Devonald MAJ. Acute and chronic kidney disease in elderly patients with hip fracture: Prevalence, risk factors and outcome with development and validation of a risk prediction model for acute kidney injury. BMC Nephrol. 2017; 18(1). doi:10.1186/s12882-017-0437-5.
36. Rantalaiho I, Gunn J, Kukkonen J, Kaipia A. Acute kidney injury following hip fracture. Injury. 2019; 50(12):2268-2271. doi:10.1016/j.injury.2019.10.008.
37. Zanetti M, De Colle P, Omiciuolo C, et al. Postoperative Dehydration Is Associated with Frailty and Decreased Survival in Older Patients with Hip Fracture. Nutrients. 2022; 14(4). doi:10.3390/nu14040820.