

Original Research Article

Prevalence of hyponatraemia in geriatric hip fracture patients in rural India: a one-year retrospective observational cohort study

Yogesh Dilip Narkhede*, Sarika Nair, Jaiwardhan Bhosale

Department of orthopedics, SMCW, Pune, Maharashtra, India

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*Correspondence:

Dr. Yogesh Dilip Narkhede,

E-mail: dr.yogeshdn@gmail.com

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ABSTRACT

Background: Hip fractures are a major cause of morbidity, functional decline and healthcare burden in older adults. Hyponatraemia is common in hospitalized older patients and has been associated with falls, fractures and adverse perioperative outcomes. Evidence from rural Indian hip-fracture cohorts is limited. Differences in access to care, timing of presentation, comorbidity burden and continuity of follow-up may influence the burden of hyponatraemia and early outcomes in such settings. The aim is to determine the prevalence of admission hyponatraemia among patients aged ≥ 60 years with radiologically confirmed hip fractures treated at a rural tertiary care teaching hospital in Maharashtra, India, and to assess its association with postoperative complications, length of hospital stay and 30-day readmission.

Methods: This retrospective observational cohort study included 150 eligible patients aged 60 years or older with radiologically confirmed hip fractures and an admission serum sodium result during January-December 2024. Admission sodium was classified as normal (≥ 135 mmol/l) or hyponatraemic (< 135 mmol/l); severity was described as mild (130-134 mmol/l), moderate (125-129 mmol/l) or severe (< 125 mmol/l). Categorical variables were compared using Pearson chi-square or Fisher exact tests, and length of stay was compared using the Mann-Whitney U test. Effect estimates are unadjusted; 95% confidence intervals are reported where applicable.

Results: Admission hyponatraemia was present in 44/150 patients (29.3%; 95% CI 22.6%-37.1%) using the biochemical threshold of serum sodium < 135 mmol/l. Among these 44 patients, 28 (63.6%) had mild, 12 (27.3%) moderate and 4 (9.1%) severe hyponatraemia. Postoperative complications were recorded in 16/44 (36.4%) patients with hyponatraemia and 20/106 (18.9%) with normal sodium (unadjusted RR 1.93, 95% CI 1.11-3.36; $p=0.022$). Median hospital stay was 9.0 versus 8.0 days (Mann-Whitney $U=1522.5$; $p<0.001$). Thirty-day readmission was recorded in 6/44 (13.6%) versus 11/106 (10.4%) (unadjusted RR 1.31, 95% CI 0.52-3.33; Fisher exact $p=0.579$). Diabetes mellitus was more frequent in the hyponatraemic group. Three records with sodium exactly 135 mmol/l were coded as mild in the source severity field; they were classified as normonatraemic for this analysis, consistent with the prespecified threshold < 135 mmol/l.

Conclusions: Admission hyponatraemia was present in 29.3% of this single-centre rural/peri-urban Indian geriatric hip-fracture cohort when defined as serum sodium < 135 mmol/l. In unadjusted analyses, it was associated with more recorded postoperative complications and longer hospital stay; 30-day readmission did not differ significantly. Because the study was retrospective and no multivariable adjustment was performed, these findings do not establish independent effects or causality. The results should be interpreted within the cohort eligibility criteria and data limitations.

Keywords: Hyponatraemia, Geriatric, Hip fracture, Rural India, Perioperative outcomes, Serum sodium, Retrospective observational study

INTRODUCTION

Hip fractures are among the most clinically consequential injuries affecting older adults and are associated with substantial morbidity, functional decline, prolonged hospitalisation and healthcare burden.¹⁻⁵ In India, the burden is amplified by an ageing population, osteoporosis, nutritional vulnerability and disparities in access to specialist orthopaedic and perioperative care, particularly outside major urban centres.³⁻⁵

Hyponatraemia, defined as a serum sodium concentration <135 mmol/l, is a common electrolyte disorder in hospitalised patients and is particularly frequent in older adults.^{6,7} Age-related impairment of renal water handling, altered thirst, increased antidiuretic hormone sensitivity, comorbidity and medication exposure may all predispose older patients to dysnatremia.^{6,7} Even apparently mild hyponatraemia has been associated with impaired attention, gait instability and falls.⁸⁻¹⁰

The association between hyponatraemia and hip fracture is biologically plausible in both directions. Chronic hyponatraemia may impair attention, postural stability and neuromuscular coordination, increasing susceptibility to falls.^{8,9,11} Experimental and clinical data also suggest effects on bone remodelling, including increased osteoclastic activity and reduced bone mineral density.¹¹⁻¹³ More marked hyponatraemia can produce neurological manifestations, while acute illness, perioperative stress, fluid shifts and comorbidity may further disturb sodium homeostasis.^{14,15} These mechanisms are biologically plausible explanations rather than variables directly measured in the present study.

Most published hip-fracture hyponatraemia studies have arisen from Europe, North America, East Asia or other urban settings. Indian evidence remains limited, and rural referral populations are underrepresented.¹⁶⁻¹⁹ Indian hospital-based research has described the clinical and etiological profile of hyponatraemia in older adults, but it does not directly estimate prevalence in a hip-fracture cohort.²⁰

This cohort was chosen because a rural tertiary referral environment may have a distinct case mix, including delayed presentation, different patterns of chronic disease, limited pre-admission laboratory testing and barriers to post-discharge follow-up. The contribution of this study is therefore setting-specific: it quantifies admission hyponatraemia and examines its early postoperative associations in a rural Indian referral population, rather than claiming novelty of the hyponatraemia-hip-fracture association itself.

The primary objective of this study was to determine the prevalence of hyponatraemia at admission among geriatric patients with hip fractures treated at a rural tertiary care teaching hospital in Maharashtra, India. Secondary objectives were to compare postoperative complications;

length of hospital stay and 30-day readmission between hyponatraemic and normonatremic patients. Hyponatraemia severity was described using predefined sodium categories; no severity-stratified outcome inference was planned because of the small subgroup sizes.

METHODS

Study design

This retrospective observational cohort study was conducted at Symbiosis University Hospital and Research Centre (SUHRC), Lavale, Pune, Maharashtra, India, a tertiary-care teaching hospital serving a rural and peri-urban referral population. Medical records of eligible admissions from January to December 2024 were reviewed. A total of 150 patients aged 60 years or older with radiologically confirmed hip fracture and an admission serum sodium result were included.

Duration and setting

The study period was January-December 2024 (12 months). The hospital is located at Lavale, Pune, and provides orthopaedic trauma care to rural and urban communities. The study setting is described as rural/peri-urban based on the protocol; this single-centre cohort should not be assumed to represent all rural Indian populations.

Ethical approval

The study was approved by the Institutional Ethics Committee (BIHR), Symbiosis International (Deemed University), Pune, India (Reference/Proposal No. SIU/IEC/641).

Study population

Medical records of patients aged 60 years and above admitted with hip fractures during the study period were reviewed. A total of 150 patients met the eligibility criteria and were included in the analytic cohort.

Inclusion criteria

The age ≥ 60 years; radiologically confirmed femoral neck, intertrochanteric or subtrochanteric fracture; serum sodium documented within 24 hours of admission; and complete inpatient records sufficient for outcome assessment.

Exclusion criteria

Exclusion criteria were documented chronic hyponatraemia before admission, pathological fracture due to malignancy, incomplete medical records, or missing admission sodium. Medication exposure was not used as an exclusion criterion in the analysed dataset. Diuretic,

ACE-inhibitor and antidepressant exposure was recorded as a baseline variable. The exclusion of patients with documented chronic hyponatraemia narrows the target population and may affect the observed prevalence; this estimate therefore applies to the eligible cohort defined above.

Data collection

Data were extracted from electronic medical records and physical inpatient case files by two investigators using a predefined extraction form. Variables included age, sex, age group (60-69, 70-79, ≥ 80 years), fracture type, admission serum sodium, diabetes mellitus, hypertension, heart disease, chronic kidney disease, recorded medication exposure (diuretics, ACE inhibitors and antidepressants), length of stay, postoperative complications and 30-day readmission. Fractures were classified as intracapsular or extracapsular. The complete 30-day readmission follow-up was calculated as per patients who did get admitted from our study cohort.

Classification of hyponatraemia

Serum sodium was classified with reference to the European Clinical Practice Guideline on diagnosis and treatment of hyponatraemia.¹⁵ Hyponatraemia was defined as serum sodium <135 mmol/l; mild 130-134 mmol/l; moderate 125-129 mmol/l; and severe <125 mmol/l. Normal admission sodium was defined as ≥ 135 mmol/l.

Statistical analysis

Data were entered in Microsoft Excel and analysed using SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as counts and percentages. Length of stay was summarised using the median and interquartile range (IQR) and compared with the Mann-Whitney U test because it was non-normally distributed. Categorical variables were compared using Pearson's chi-square test, with Fisher's exact test used when expected cell counts were small.

Tests were two-sided, with $p < 0.05$ considered statistically significant. Prevalence and effect estimates are reported with 95% confidence intervals where applicable. No multivariable regression model was performed; thus, all comparisons are unadjusted and should not be interpreted as independent effects.

RESULTS

Baseline demographics

A total of 150 eligible patients were included. Mean age was 74.8 ± 8.6 years (range 60-94 years), and 99 (66.0%) were women. Forty-two patients (28.0%) were aged 60-69 years, 68 (45.3%) were aged 70-79 years, and 40 (26.7%) were aged ≥ 80 years. Extracapsular fractures accounted for 96 patients (64.0%), including one subtrochanteric

fracture; 54 (36.0%) fractures were intracapsular. Recorded comorbidities included hypertension in 65 (43.3%), diabetes mellitus in 35 (23.3%), heart disease in 22 (14.7%) and chronic kidney disease in 10 (6.7%).

Prevalence and severity of hyponatraemia

Hyponatraemia was present in 44/150 patients (29.3%; 95% CI 22.6%-37.1%) and normal admission sodium in 106/150 (70.7%). Among the 44 hyponatraemic patients, 28 (63.6%) had mild, 12 (27.3%) moderate and 4 (9.1%) severe hyponatraemia. Mean serum sodium was 129.5 ± 5.0 mmol/l in the hyponatraemic group and 140.2 ± 2.9 mmol/l in the normonatraemic group.

Comparison of baseline characteristics between groups

There were no statistically significant differences in mean age (75.3 ± 8.5 vs 74.6 ± 8.7 years; Mann-Whitney $p = 0.71$), age group ($p = 0.64$), sex ($p = 0.46$) or fracture type ($p = 0.12$). Diabetes mellitus was more frequent in the hyponatraemic group (36.4% vs 17.9%, $p = 0.015$). Chronic kidney disease was numerically more frequent (13.6% vs 3.8%) but did not reach statistical significance using Fisher exact testing ($p = 0.064$) (Table 1).

Hypertension and heart disease were not significantly different between groups. Diuretic, ACE-inhibitor and antidepressant use were not significantly associated with the sodium group in unadjusted comparisons ($p = 0.195$, $p = 0.695$ and $p = 0.234$, respectively).

Clinical outcomes

Length of hospital stay was longer in patients with hyponatraemia: median 9.0 days (IQR 8.0-10.0) versus 8.0 days (IQR 6.0-9.0) in patients with normal sodium (Mann-Whitney $U = 1522.5$, $p < 0.001$). The U statistic is reported as the smaller of the two complementary Mann-Whitney statistics (Table 2).

Postoperative complications were recorded in 16/44 (36.4%) patients with hyponatraemia versus 20/106 (18.9%) with normal sodium (Pearson chi-square = 5.22, $p = 0.022$), corresponding to an unadjusted relative risk of 1.93 (95% CI 1.11-3.36). The masterchart contains only a binary complication indicator; complication-specific categories and the precise observation window were not sufficiently documented for subtype analysis. Thirty-day readmission was recorded in 6/44 (13.6%) patients with hyponatraemia and 11/106 (10.4%) with normal sodium.

The Pearson chi-square statistic was 0.33; because one expected cell count was below 5, Fisher exact testing was used for the p-value ($p = 0.579$). The unadjusted relative risk was 1.31 (95% CI 0.52-3.33). The difference was not statistically significant, and the wide confidence interval is compatible with both a clinically relevant increase and no difference.

Table 1: Baseline characteristics of hyponatraemic and normonatraemic patients.

Variables	Total (n=150)	Hyponatraemia (n=44)	Normal sodium (n=106)	p value
Age (years), Mean $\pm$ SD	74.8 $\pm$ 8.6	75.3 $\pm$ 8.5	74.6 $\pm$ 8.7	0.71†
Age Group, N (%)				0.64*
60–69 years	42 (28.0%)	11 (25.0%)	31 (29.2%)	
70–79 years	68 (45.3%)	19 (43.2%)	49 (46.2%)	
$\geq$ 80 years	40 (26.7%)	14 (31.8%)	26 (24.5%)	
Gender, N (%)				0.46*
Female	99 (66.0%)	31 (70.5%)	68 (64.2%)	
Male	51 (34.0%)	13 (29.5%)	38 (35.8%)	
Fracture type, N (%)				0.12*
Intracapsular	54 (36.0%)	20 (45.5%)	34 (32.1%)	
Extracapsular (including 1 subtrochanteric)	96 (64.0%)	24 (54.5%)	72 (67.9%)	
Comorbidities, N (%)				
Diabetes mellitus	35 (23.3%)	16 (36.4%)	19 (17.9%)	0.015*
Hypertension	65 (43.3%)	21 (47.7%)	44 (41.5%)	0.48*
Heart disease	22 (14.7%)	5 (11.4%)	17 (16.0%)	0.46*
Chronic kidney disease	10 (6.7%)	6 (13.6%)	4 (3.8%)	0.064‡
Medications, N (%)				
Diuretics	34 (22.7%)	13 (29.5%)	21 (19.8%)	0.195*
ACE inhibitors	41 (27.3%)	13 (29.5%)	28 (26.4%)	0.695*
Antidepressants	8 (5.3%)	4 (9.1%)	4 (3.8%)	0.234‡
Serum sodium (mmol/l), Mean $\pm$ SD	137.0 $\pm$ 6.1	129.5 $\pm$ 5.0	140.2 $\pm$ 2.9	—

* Pearson chi-square test; † Mann-Whitney U test; ‡ Fisher exact test. SD=standard deviation. Percentages are column percentages within sodium-status groups.

Table 2. Clinical outcomes in hyponatraemic and normonatraemic patients.

Outcome	Hyponatraemia (n=44)	Normal sodium (n=106)	Test statistic	P value	Effect estimate (95% CI)
Postoperative complications, N (%)	16 (36.4%)	20 (18.9%)	$\chi^2=5.22$	0.022	RR 1.93 (1.11–3.36)
Length of stay, median days (IQR)	9.0 (8.0–10.0)	8.0 (6.0–9.0)	U=1522.5	<0.001	—
30-day readmission, N (%)	6 (13.6%)	11 (10.4%)	$\chi^2=0.33$; Fisher exact test	0.579	RR 1.31 (0.52–3.33)

Pearson's chi-square test was used for categorical outcomes and the Mann-Whitney U test for length of stay; Fisher's exact test was used when any expected cell count was below 5. IQR=interquartile range.

Relative risks are unadjusted. Mortality was not retained as an analytical outcome because mortality counts were inconsistent between source patient-level fields and the masterchart summary, and the number of events was small.

DISCUSSION

The principal finding was that admission hyponatraemia, defined biochemically as serum sodium <135 mmol/l, was present in 29.3% of this eligible rural/peri-urban Indian geriatric hip-fracture cohort. This estimate is within the broad range reported in published hip-fracture and fragility-fracture series, although comparisons are limited by differences in eligibility criteria, sodium thresholds, measurement timing and the inclusion of chronic or incident hyponatraemia.^{14,16-19}

The analysis used measured sodium values rather than the source-derived severity label because three records with sodium of 135 mmol/l were incorrectly labelled mild. The present study contributes setting-specific data; it does not establish that this prevalence represents all rural Indian patients with hip fractures.

Diabetes mellitus was more frequent in the hyponatraemic group (36.4% vs 17.9%, $p=0.015$), whereas chronic kidney disease was numerically more frequent but did not reach statistical significance on Fisher exact testing ($p=0.064$). These findings are clinically plausible because metabolic disease, renal dysfunction, impaired water excretion and multimorbidity may accompany abnormal sodium homeostasis.^{6,7} However, all comparisons were unadjusted and were not designed to determine whether either comorbidity independently predicts hyponatraemia. The small number of patients with chronic kidney disease also limits precision.

Median hospital stay was one day longer in patients with hyponatraemia (9 vs 8 days; $p<0.001$), and recorded postoperative complications were more frequent (36.4% vs 18.9%; RR 1.93, 95% CI 1.11-3.36). Similar associations between hyponatraemia and prolonged hospitalisation or adverse perioperative outcomes have been reported in fragility-fracture and hip-fracture populations.^{16,19} Possible explanations include impaired attention and mobility, greater medical complexity, altered fluid balance and the possibility that hyponatraemia acts as a marker of frailty or systemic illness rather than a direct causal mechanism.

Thirty-day readmission did not differ significantly between groups (13.6% vs 10.4%; Fisher exact $p=0.579$). The corresponding RR of 1.31 had a wide 95% CI (0.52-3.33), so the study cannot exclude either a clinically important increase or no difference. This non-significant result should therefore be presented as uncertainty rather than as evidence of equivalence, and must be interpreted after confirming the completeness of follow-up.

Mechanistically, hyponatraemia may affect hip-fracture vulnerability and recovery through several overlapping pathways. Mild chronic hyponatraemia has been linked to attention deficits, gait instability and falls, which may increase pre-fracture vulnerability and can plausibly impair early mobilisation after fracture.^{8,9} Experimental data indicate increased osteoclastic activity and adverse effects on bone mineral density with chronic hyponatraemia, providing a plausible pathway for impaired bone quality.¹¹⁻¹³ More marked hyponatraemia can produce neurological symptoms, while perioperative fluid shifts and concurrent illness may aggravate sodium disturbances.^{14,15} These mechanisms are hypotheses that may help explain observed associations; they were not directly measured in this retrospective dataset.

A data-validation check also found three records with sodium exactly 135 mmol/l that were labelled “Mild”

despite the study definition of <135 mmol/l; these were reclassified as normonatraemic for analysis. Medication exposure was recorded rather than used as an exclusion criterion, but the observational design cannot separate medication-related from disease-related hyponatraemia. Frailty and nutritional status were not standardised variables.

The available masterchart records only a binary complication indicator, without reliable complication subtypes or a clearly documented complication observation window. The 30-day readmission outcome also requires confirmation of complete follow-up and ascertainment methods. There was no non-fracture control group and longer-term prognosis was not assessed. Finally, one rural/peri-urban referral centre cannot represent all rural Indian populations.

Limitations

This was a retrospective, single-centre study with a modest sample size. All comparisons were unadjusted and may be confounded by age, frailty, nutritional status, comorbidity, timing of surgery, illness severity, medication exposure and other factors. Only admission sodium was assessed; chronicity, subsequent correction and postoperative sodium trajectories were unavailable. The aetiology of hyponatraemia was not systematically characterised. Patients with documented chronic hyponatraemia were excluded, limiting generalisability and potentially affecting the prevalence estimate.

Clinical implications should be cautious. Admission sodium is inexpensive and routinely available and may help identify patients who warrant closer perioperative review. These observational analyses do not establish that correcting hyponatraemia reduces complications or length of stay. Prospective multicentre studies with serial sodium measurements, clearly defined complication outcomes and readmission ascertainment, systematic assessment of aetiology, frailty and nutritional status, and appropriate multivariable adjustment are needed before treatment effects can be inferred.

CONCLUSION

Admission hyponatraemia, defined as serum sodium <135 mmol/l, was present in 44/150 (29.3%) eligible geriatric hip-fracture patients treated at this centre. In unadjusted analyses, it was associated with more recorded postoperative complications and longer hospital stay; 30-day readmission did not differ significantly. The prevalence estimate applies to the defined cohort, including exclusion of patients with documented chronic hyponatraemia. Three sodium values of exactly 135 mmol/l were reclassified as normonatraemic because the source severity field incorrectly labelled them mild. As this retrospective single-centre analysis did not adjust for confounders and has limitations in complication characterisation and documented readmission

ascertainment, causal or independent-effect conclusions cannot be drawn. Prospective multicentre research with robust follow-up and adjustment for frailty, nutrition, comorbidity and perioperative factors is warranted.

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