Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Postoperative ICU Vasopressor Requirement Is an Independent Marker of 30-Day and 1-Year Mortality After Geriatric Hip Fracture Surgery: A Retrospective Cohort Study

Nele Wagener

Nele.Wagener@nyulangone.org

NYU Langone Health

Braden Saba

NYU Langone Health

Ran Schwarzkopf

NYU Langone Health

Jean Shanaa

NYU Langone Health

Sanjit Konda

NYU Langone Health

Abhishek Ganta

NYU Langone Health

Kenneth A. Egol

NYU Langone Health

Diren Arsoy

NYU Langone Health

Research Article

Keywords: geriatric hip fracture, vasopressors, intensive care unit, postoperative hypotension, mortality, discharge disposition, postoperative complications

Posted Date: November 1st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10986120/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Geriatric hip fracture patients requiring postoperative intensive care unit (ICU) admission represent a high-risk surgical subgroup. This study evaluated whether postoperative ICU vasopressor support was independently associated with mortality and discharge outcomes after adjustment for measured comorbidity and procedure category.

Methods

After institutional review board approval, we retrospectively reviewed 4,012 consecutive patients aged 65 years or older who underwent surgery for low-energy native hip fracture at three hospitals within one academic medical center between September 2015 and January 2025. Patients requiring postoperative ICU admission were stratified by postoperative vasopressor support. Group comparisons used chi-square or Fisher exact tests and t-tests with Welch sensitivity analysis when appropriate. Multivariable logistic regression adjusted for age, sex, smoking status, American Society of Anesthesiologists class, Charlson Comorbidity Index, body mass index, anesthesia type, and procedure category. Kaplan-Meier estimates were used for survival analysis.

Results

Of 4,012 patients screened, 243 (6.1%) required postoperative ICU admission; 91 (37.4%) received vasopressors. Thirty-day mortality was 28.6% with vasopressors versus 4.6% without vasopressors (absolute risk difference, 24.0 percentage points; 95% confidence interval [CI], 14.1–33.8). One-year mortality was 38.5% versus 13.2% (absolute risk difference, 25.3 percentage points; 95% CI, 14.0–36.7). Vasopressor support remained associated with 30-day mortality (adjusted odds ratio, 10.07; 95% CI, 4.09–28.22; P<0.001) and one-year mortality (adjusted odds ratio, 3.98; 95% CI, 2.06–7.90; P<0.001). Ninety-day readmission and reoperation rates were not significantly different. Length of stay was numerically longer among vasopressor recipients (269 vs 229 hours; Welch P=0.056).

Conclusions

Among geriatric hip fracture patients requiring postoperative ICU admission, vasopressor support was an independent marker of markedly increased 30-day and one-year mortality, even after adjustment for measured comorbidity and procedure category. Postoperative vasopressor requirement should be interpreted as an early prognostic signal that may prompt multidisciplinary reassessment, escalation planning, and timely goals-of-care discussions.

Clinical trial number: not applicable.

Background

Hip fractures in older adults are among the most severe and costly orthopedic injuries in the geriatric population, frequently resulting in loss of independence, reduced quality of life, and increased mortality. With population aging, the incidence of geriatric hip fractures is expected to increase, creating a growing clinical and economic burden for health systems [1–5]. Despite advances in surgical timing, anesthesia, co-management pathways, and rehabilitation, mortality remains substantial after operative hip fracture care, particularly during the first postoperative year [6, 7]. Reported in-hospital mortality is approximately 4%, 30-day mortality is commonly near 9%-10%, and one-year mortality may approach 20%-30% [8, 9]. Because nonoperative management carries even higher mortality in many older adults, surgery remains the standard pathway for most medically optimized patients [10].

Considerable work has focused on improving operative technique, anesthesia protocols, and post-acute rehabilitation for hip fracture patients, yet the smaller subgroup requiring postoperative intensive care unit (ICU) admission remains less well characterized [5]. Geriatric hip fracture patients admitted to the ICU often have hemodynamic instability, limited physiologic reserve, multiple comorbidities, or perioperative complications [11–15]. ICU admission itself is associated with increased resource utilization and worse outcomes in other surgical populations, but the prognostic implications of specific ICU interventions after geriatric hip fracture surgery remain underexplored [16–18].

Vasopressor administration is frequently used in the ICU to support arterial pressure and organ perfusion during hypotension, shock, or perioperative hemodynamic instability. In the present study, postoperative vasopressor support was treated as a prognostic exposure and marker of acute illness severity rather than as proof of a causal treatment effect. This distinction is important because vasopressors may reflect hypotension, frailty, impaired cardiovascular reserve, occult complications, or shock physiology that are not fully captured by baseline comorbidity indices [19, 20]. Whether vasopressor requirement adds prognostic information beyond measured comorbidity and surgical procedure type in elderly patients after hip fracture surgery is not well defined.

A clearer understanding of this association has practical value for orthopedic surgeons, anesthesiologists, intensivists, geriatricians, and families. If postoperative vasopressor requirement identifies a high-risk phenotype even after adjustment for measured baseline factors, it may help guide early multidisciplinary reassessment, escalation planning, and goals-of-care discussions. It may also provide a benchmark for future studies of resuscitation, ICU triage, and perioperative optimization in frail orthopedic trauma patients.

The objective of this study was to evaluate the association between postoperative ICU vasopressor support and outcomes among geriatric patients undergoing surgery for hip fracture. The primary outcomes were 30-day and one-year mortality. Secondary outcomes included longer-term survival estimates, discharge disposition, 90-day readmission, reoperation, and length of stay. We hypothesized that vasopressor support would remain independently associated with mortality after adjustment for measured comorbidity, anesthesia type, and procedure category.

Methods

Following approval by the NYU Langone Health Institutional Review Board, with waiver of informed consent for retrospective de-identified data review, a retrospective cohort study was conducted across three hospitals within one integrated urban academic medical center between September 2015 and January 2025. The study was conducted in accordance with the Declaration of Helsinki and applicable institutional requirements. During the study period, 4,012 patients underwent operative treatment for a native hip fracture and were screened for eligibility. The analytic cohort consisted of patients aged 65 years or older with a low-energy native hip fracture who required postoperative ICU admission after operative treatment. Included procedures were open reduction internal fixation (ORIF), closed reduction percutaneous pinning (CRPP), hemiarthroplasty, and total hip arthroplasty (THA). Procedures were selected according to fracture pattern, patient factors, and surgeon judgment and were performed by attending orthopedic surgeons with resident staff. Patients were taken to the operating room once medically optimized.

Patients were excluded if they were younger than 65 years at the time of fracture, sustained a high-energy mechanism, had a non-native hip fracture, or did not require postoperative ICU admission. Vasopressor exposure was defined as administration of norepinephrine, phenylephrine, vasopressin, or any combination during the postoperative ICU stay. Intraoperative-only vasopressor administration did not qualify as the exposure unless vasopressor support continued or was restarted postoperatively in the ICU. Because vasopressors are commonly administered in response to hypotension, vasopressor exposure was interpreted as a marker of postoperative hemodynamic instability and critical illness, not as evidence that vasopressor therapy itself caused mortality.

Given the heterogeneity of hip fracture procedures, procedure type was explicitly handled as a potential confounder. Procedure distribution was compared between vasopressor and non-vasopressor groups, procedure-specific survival was examined using Kaplan-Meier analysis, and procedure category was included in multivariable models. Because the CRPP and THA strata were small, procedures were also modeled as arthroplasty (hemiarthroplasty or THA) versus fixation (ORIF or CRPP) for regression analyses to reduce model instability.

The primary outcomes were 30-day mortality and one-year mortality. Secondary outcomes included 7-day, 90-day, two-year, and five-year mortality, discharge disposition, 90-day all-cause and category-specific readmission, aseptic and septic hip reoperations, and total length of stay (LOS). Because not all patients had equal potential duration of follow-up across the nearly decade-long study period, long-term mortality beyond one year was treated as secondary and interpreted together with Kaplan-Meier censoring.

Demographic characteristics, comorbidities, type of surgery, anesthesia type, transfusion data, procedure duration, time to surgery, and primary ICU indication were recorded. The Charlson Comorbidity Index (CCI), a validated measure of comorbidity burden, was calculated for all patients [21]. Categorical variables were compared using chi-square tests when expected cell counts were adequate and Fisher

exact tests for sparse binary comparisons, including readmission and reoperation outcomes. Continuous variables were compared using t-tests; for LOS, a Welch t-test sensitivity analysis was used because group variances differed. Absolute risk differences with approximate 95% confidence intervals and unadjusted relative risks with log-method 95% confidence intervals were calculated for key mortality endpoints to complement odds ratios (ORs). Binary logistic regression was used to evaluate the association between vasopressor support and mortality while adjusting for age, sex, smoking status, American Society of Anesthesiologists (ASA) class, CCI, body mass index (BMI), anesthesia type, and procedure category. Because the 30-day mortality model included a limited number of events relative to candidate covariates, multivariable estimates were interpreted as explanatory adjusted associations rather than as a validated prediction model. Time-to-event outcomes were assessed using Kaplan-Meier estimates and log-rank tests, with censoring at last known follow-up. A two-tailed P-value < 0.05 was considered statistically significant.

Results

ICU Admissions and Vasopressor Use

Of the 4,012 surgically treated hip fracture patients screened during the study period, 243 (6.1%) required postoperative ICU admission and comprised the analytic cohort (Figure 1). Among ICU patients, 91 (37.4%) received postoperative vasopressor support and 152 (62.6%) did not. Baseline demographic and clinical characteristics were similar between groups, including age, sex, race, CCI, ASA classification, and BMI (Table 1). General anesthesia was more frequent in patients who subsequently required postoperative vasopressors (81.3% vs 67.1%; P=0.016). Procedure distribution did not differ significantly between groups (P=0.10).

ICU Indications

Hypotension was the most common primary indication for ICU admission, accounting for 48 of 243 ICU admissions (19.8%) and 34 of 91 admissions (37.4%) among vasopressor recipients (Table 2). Hypotension was more frequent among vasopressor recipients than non-recipients (37.4% vs 9.2%; Fisher exact P<0.001). Because hypotension is also the usual indication for vasopressor initiation, vasopressor support should be interpreted as a postoperative prognostic marker of hemodynamic instability and critical illness severity rather than as an isolated causal exposure.

Hemoglobin and Blood Transfusions

There were no differences in preoperative hemoglobin levels between groups (112 vs 114 g/L, P=0.44). Blood transfusions were required in patients in both groups equally (7.7 vs 7.2%, P=0.89). Among patients receiving blood, the average number of units required was the same in both groups (2.0 vs 2.2, P=0.89).

Readmissions and Reoperations

There were no significant differences in 90-day all-cause readmission between vasopressor and non-vasopressor groups (26.4% vs 19.7%; Fisher exact P=0.27), nor were readmission subcategories separately hypothesis-tested because of sparse counts and descriptive intent (Table 3). Aseptic reoperations (0.0% vs 3.9%; Fisher exact P=0.086) and septic reoperations (1.1% vs 3.9%; Fisher exact P=0.26) did not differ significantly between groups. Multivariable logistic regression (Table 4) was calculated for the combined endpoint of revision surgery or one-year mortality, recognizing that high early mortality can preclude later revision events. In this exploratory model, vasopressor administration (OR 2.40, P=0.005) and arthroplasty (hemiarthroplasty or THA versus ORIF or CRPP) (OR 1.93, P=0.047) were associated with the composite endpoint.

Mortality, Survivorship Free of Death, and Discharge Outcomes

Vasopressor support was associated with significantly higher mortality at each assessed time point (Table 3). Seven-day, 30-day, 90-day, and one-year mortality among vasopressor recipients were 12.1%, 28.6%, 35.2%, and 38.5%, respectively, compared with 0.0%, 4.6%, 9.9%, and 13.2% among non-recipients (all Fisher exact P<0.001). For 30-day mortality, the crude absolute risk difference was 24.0 percentage points (95% CI, 14.1-33.8), corresponding to an unadjusted relative risk of 6.20 (95% CI, 2.81-13.71). For one-year mortality, the crude absolute risk difference was 25.3 percentage points (95% CI, 14.0-36.7), corresponding to an unadjusted relative risk of 2.92 (95% CI, 1.80-4.74). Survival free of death is depicted in Figure 2, which showed significantly increased mortality in the vasopressor group (log-rank P<0.001). There was no statistically significant difference in survival based on procedure type (ORIF, CRPP, hemiarthroplasty, or THA) in exploratory Kaplan-Meier analysis (log-rank P=0.537; Figure 3). Length of stay was numerically longer among ICU patients receiving vasopressors (269 vs 229 hours), but this difference was not statistically significant using Welch sensitivity analysis (P=0.056).

Discharge disposition was significantly different between groups (P<0.001). In-house mortality was significantly higher in patients receiving vasopressors (19.8 vs 0.7%). Patients receiving vasopressors were also more likely to be discharged to hospice (9.9 vs 3.9%), and less likely to be discharged to a skilled nursing facility (45 vs 65%) or acute rehab facility (14 vs 20%).

In multivariable logistic regression adjusting for age, sex, smoking status, ASA class, CCI, BMI, anesthesia type, and procedure category, postoperative vasopressor support remained independently associated with 30-day mortality (OR 10.07, 95% CI 4.09-28.22; P<0.001; Table 5) and one-year mortality (OR 3.98, 95% CI 2.06-7.90; P<0.001; Table 6). These adjusted estimates were interpreted as explanatory associations because the number of events, particularly for 30-day mortality, was limited relative to the number of modeled covariates.

Discussion

In this retrospective cohort of geriatric hip fracture patients requiring postoperative ICU admission, postoperative vasopressor support identified a subgroup with markedly worse survival. The mortality difference was clinically large in both absolute and relative terms: 30-day mortality was higher by 24.0 percentage points and one-year mortality was higher by 25.3 percentage points among vasopressor recipients. The unadjusted relative risk for death was 6.20 at 30 days and 2.92 at one year, and the association persisted after adjustment for measured demographic, comorbidity, anesthesia, and procedure variables.

The key clinical message is not that vasopressors should be withheld when indicated. Rather, vasopressor requirement after geriatric hip fracture surgery should be recognized as an early, objective prognostic signal within the postoperative ICU course. This distinction directly addresses the problem of confounding by indication: hypotension and shock drive vasopressor use, and these conditions themselves are associated with mortality. Nevertheless, the persistence of the association after adjustment for measured baseline and surgical factors indicates that vasopressor requirement adds clinically useful risk information beyond standard orthopedic variables.

Procedure heterogeneity is an important consideration in hip fracture research because ORIF, CRPP, hemiarthroplasty, and THA differ in indication, surgical burden, blood loss, and physiologic stress. In the present study, procedure distribution did not significantly differ between vasopressor and non-vasopressor groups, procedure type was incorporated into multivariable models, and exploratory survival analysis by procedure type did not demonstrate a significant difference. These findings do not eliminate residual confounding, particularly given small CRPP and THA strata, but they make it less likely that the observed vasopressor-mortality association is explained solely by procedure mix.

Notably, in a separate analysis of primary elective total joint arthroplasty patients, higher rates of revision and reoperation were observed among ICU patients who required vasopressors compared with those who did not [22]. In the present investigation on geriatric hip fracture outcomes, however, mortality predominated, which may have limited the opportunity for prosthesis-related complications to emerge.

The orthopedic relevance of this finding lies in the postoperative trajectory of a frail surgical fracture population. Although vasopressor use is broadly associated with poor outcomes in critically ill patients, geriatric hip fracture patients differ from general ICU cohorts because they undergo urgent surgery after a sentinel injury, often with competing priorities of mobilization, delirium prevention, fracture healing, rehabilitation disposition, and goals-of-care decision-making. Identifying a readily available postoperative marker associated with early and one-year mortality may help orthopedic teams participate more effectively in ICU-family communication and multidisciplinary decision-making.

Mechanistically, norepinephrine and phenylephrine increase systemic vascular resistance through adrenergic stimulation, whereas vasopressin acts through V1 receptor-mediated vasoconstriction [23–25]. Although these agents can restore macrocirculatory pressure, they may not fully correct

microvascular perfusion, particularly in older patients with limited cardiovascular reserve [26–29]. The present analysis cannot distinguish the effect of vasopressor medication from the severity of the shock state that prompted treatment. Therefore, vasopressor exposure should be viewed primarily as a marker of hemodynamic vulnerability and postoperative critical illness.

Transfusion and anemia were also examined because blood loss, anemia, and resuscitation strategy may influence postoperative hemodynamics. Preoperative hemoglobin, transfusion frequency, and units transfused were similar between groups, suggesting that anemia or transfusion alone does not explain the observed mortality difference. The present dataset was not designed to compare vasopressor-based versus transfusion-based resuscitation strategies. Future studies should capture timing, dose, lactate, mean arterial pressure targets, transfusion thresholds, and markers of end-organ perfusion to better understand modifiable components of postoperative shock management.

This study has several limitations. The retrospective design cannot establish causality, and confounding by indication remains likely because vasopressors are administered in response to hypotension or shock. Vasopressor exposure was analyzed as a binary variable without dose, duration, timing, maximum vasopressor intensity, lactate, mean arterial pressure, or organ dysfunction scores. ICU admission and vasopressor initiation were not standardized and may have varied by provider, hospital site, and calendar year. Procedure heterogeneity was addressed through adjustment and exploratory procedure-specific survival analysis, but the study was underpowered for definitive procedure-level effect modification. The number of events relative to model covariates was limited, especially for 30-day mortality and low-frequency reoperation outcomes; therefore, multivariable estimates should be interpreted as explanatory and hypothesis-generating. Long-term mortality estimates depend on complete ascertainment of death and appropriate censoring at last known follow-up. The single-system design and need for detailed clinical granularity limited sample size and generalizability.

Conclusions

Among geriatric hip fracture patients requiring postoperative ICU admission, vasopressor support was an independent marker of substantially increased 30-day and one-year mortality after adjustment for measured comorbidity, anesthesia type, and procedure category. Readmission and reoperation rates were not significantly different, suggesting that mortality rather than surgical complication burden dominated outcomes in this high-risk subgroup. Postoperative vasopressor requirement should prompt early multidisciplinary reassessment and clear communication with patients and families regarding prognosis, escalation planning, and goals of care. Prospective studies with granular hemodynamic data are needed to determine whether specific resuscitation pathways can mitigate this elevated risk.

Abbreviations

ASA: American Society of Anesthesiologists; BMI: body mass index; CCI: Charlson Comorbidity Index; CI: confidence interval; CRPP: closed reduction percutaneous pinning; DAIR: debridement, antibiotics, and

implant retention; GI: gastrointestinal; ICU: intensive care unit; IP: intellectual property; IRB: institutional review board; LOS: length of stay; NE: norepinephrine; OR: odds ratio; ORIF: open reduction internal fixation; PE: phenylephrine (Table 1) or pulmonary embolism (Table 2); RR: relative risk; SD: standard deviation; THA: total hip arthroplasty; Vaso: vasopressin.

Declarations

Ethics approval and consent to participate

This study was approved by the NYU Langone Health Institutional Review Board. The research was conducted in accordance with the principles of the Declaration of Helsinki and applicable local statutory requirements. As this was a retrospective analysis of existing clinical data, no direct patient contact occurred, and the requirement for informed consent was waived by the IRB. No identifiable patient information was included in the analyses or presented in the manuscript.

Consent for publication

Not applicable. No identifiable individual participant data are presented.

Availability of data and materials

The datasets analysed during the current study are not publicly available because they contain confidential patient-level information. Requests for access to de-identified data may be directed to the corresponding author and will be considered subject to institutional approval and applicable data-protection requirements.

Competing interests

Nele Wagener declares no competing interests.

Braden V Saba declares no competing interests.

Ran Schwarzkopf reports consulting relationships with Sylk, Zimmer Biomet, Smith & Nephew, Heraeus Medical, and Intellijoint; board or committee roles with the American Association of Hip and Knee Surgeons, the Hip Society, the Knee Society, and the International Hip Society; and editorial or governing board roles with The Journal of Arthroplasty and Arthroplasty Today. He also reports intellectual property royalties from Smith & Nephew and Zimmer Biomet and stock or stock options in Intellijoint, Gauss Surgical, and PSI.

Jean Shanaa declares no competing interests.

Sanjit Konda reports a professional relationship with Stryker Corporation, classified in his AAOS disclosure as "Other Professional Activities". He also reports intellectual property royalties, research support, and consulting payments from Stryker Corporation.

Abhishek Ganta declares no competing interests.

Kenneth A Egol declares no competing interests.

Diren Arsoy declares no competing interests.

Funding

This study did not receive external funding.

Authors' contributions

NW contributed to study design, data analysis and interpretation, and drafted the manuscript. BVS and JS contributed to data acquisition, data curation, and analysis. RS, SK, AG, and KAE contributed to interpretation of the findings and critical revision of the manuscript. DA conceived and supervised the study, contributed to study design and interpretation, and critically revised the manuscript. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

Acknowledgements

Not applicable.

References

1. Ebeling PR. Hip Fractures and Aging: A Global Problem Requiring Coordinated Global Solutions. J Bone Min Res. 2023;38:1062–3.
2. Sing C-W, Lin T-C, Bartholomew S, et al. Global Epidemiology of Hip Fractures: Secular Trends in Incidence Rate, Post-Fracture Treatment, and All-Cause Mortality. J Bone Min Res. 2023;38:1064–75.
3. Autier P, Haentjens P, Bentin J, et al. Costs induced by hip fractures: a prospective controlled study in Belgium. Belgian Hip Fracture Study Group. Osteoporos Int. 2000;11:373–80.
4. Leal J, Gray AM, Prieto-Alhambra D, et al. Impact of hip fracture on hospital care costs: a population-based study. Osteoporos Int. 2016;27:549–58.

5. Folbert ECE, van der Smit RS, et al. Geriatric fracture center: a multidisciplinary treatment approach for older patients with a hip fracture improved quality of clinical care and short-term treatment outcomes. Geriatr Orthop Surg Rehabil. 2012;3:59–67.
6. Magaziner J, Lydick E, Hawkes W, et al. Excess mortality attributable to hip fracture in white women aged 70 years and older. Am J Public Health. 1997;87:1630–6.
7. Carpintero P, Caeiro JR, Carpintero R, et al. Complications of hip fractures: A review. World J Orthop. 2014;5:402–11.
8. Özel M, Altıntaş M, Tatlıparmak AC. Predictors of one-year mortality following hip fracture surgery in elderly. PeerJ. 2023;11:e16008.
9. Pettit C, Herbosa C, Ganta A, et al. Ready for discharge? Factors associated with prolonged length of stay following geriatric hip fracture. Eur J Orthop Surg Traumatol. 2025;35:266.
10. Loggers SAI, Van Lieshout EMM, Joosse P, et al. Prognosis of nonoperative treatment in elderly patients with a hip fracture: A systematic review and meta-analysis. Injury. 2020;51:2407–13.
11. Yang P, Fan Y, Tang W. Correlation of intraoperative blood pressure variability and postoperative delirium in elderly hip fracture surgery. Sci Rep. 2025;15:15007.
12. Menzies IB, Mendelson DA, Kates SL, et al. The impact of comorbidity on perioperative outcomes of hip fractures in a geriatric fracture model. Geriatr Orthop Surg Rehabil. 2012;3:129–34.
13. Li W, Min A, Zhao W, et al. Predictors and prognosis of elderly hip fracture patients with perioperative atrial fibrillation: a nested case-control study. BMC Geriatr. 2025;25:4.
14. Su H, Aharonoff GB, Zuckerman JD, et al. The relation between discharge hemoglobin and outcome after hip fracture. Am J Orthop (Belle Mead NJ). 2004;33:576–80.
15. Gruson KI, Aharonoff GB, Egol KA, et al. The relationship between admission hemoglobin level and outcome after hip fracture. J Orthop Trauma. 2002;16:39–44.
16. Hirshberg EL, Wilson EL, Stanfield V, et al. Impact of Critical Illness on Resource Utilization: A Comparison of Use in the Year Before and After ICU Admission. Crit Care Med. 2019;47:1497–504.
17. Morgan DJ, Ho KM, Kolybaba ML, et al. Adverse outcomes after planned surgery with anticipated intensive care admission in out-of-office-hours time periods: a multicentre cohort study. Br J Anaesth. 2018;120:1420–8.
18. Martini V, Lederer A-K, Laessle C, et al. Clinical Characteristics and Outcomes of Surgical Patients with Intensive Care Unit Lengths of Stay of 90 Days and Greater. Crit Care Res Pract. 2017;2017:9852017.
19. Saetang M, Kunapaisal T, Chatmongkolchart S, et al. Association of Frailty with Intraoperative Complications in Older Patients Undergoing Elective Non-Cardiac Surgery. J Clin Med. 2025;14:593.
20. Weis F, Kilger E, Beiras-Fernandez A, et al. Association between vasopressor dependence and early outcome in patients after cardiac surgery. Anaesthesia. 2006;61:938–42.
21. Charlson ME, Carrozzino D, Guidi J, Patierno C. Charlson Comorbidity Index: A Critical Review of Clinimetric Properties. Psychother Psychosom. 2022;91:8–35.

22. Saba BV, Shanaa J, Cordero JK, Schwarzkopf R, Dweck E, Arsoy D. Does vasopressor administration in the ICU affect outcomes following primary total joint arthroplasty? Arch Orthop Trauma Surg. 2025;145(1):426. 10.1007/s00402-025-06026-0.
23. Thiele RH, Nemergut EC, Lynch C. The physiologic implications of isolated alpha(1) adrenergic stimulation. Anesth Analg. 2011;113:284–96.
24. Treschan TA, Peters J. The vasopressin system: physiology and clinical strategies. Anesthesiology. 2006;105:599–612.
25. Boerma EC, Ince C. The role of vasoactive agents in the resuscitation of microvascular perfusion and tissue oxygenation in critically ill patients. Intensive Care Med. 2010;36:2004–18.
26. Lamontagne F, Richards-Belle A, Thomas K, et al. Effect of Reduced Exposure to Vasopressors on 90-Day Mortality in Older Critically Ill Patients With Vasodilatory Hypotension: A Randomized Clinical Trial. JAMA. 2020;323:938.
27. Zhu B, Jiang J, Yu H, et al. Effect of norepinephrine, vasopressin, and dopamine for survivals of the elderly with sepsis and pre-existing heart failure. Sci Rep. 2024;14:1948.
28. Strait JB, Lakatta EG. Aging-associated cardiovascular changes and their relationship to heart failure. Heart Fail Clin. 2012;8:143–64.
29. Dai X, Hummel SL, Salazar JB, et al. Cardiovascular physiology in the older adults. J Geriatr Cardiol. 2015;12:196–201.

Tables

Table 1. Baseline Characteristics Stratified by Vasopressor Administration in the Intensive Care Unit

	Received Vasopressor (n = 91)	No Vasopressor (n = 152)	P value
Age, mean [SD] (range)	84.9 [7.8] (68-100)	84.8 [8.3] (65-100)	0.91
Sex, n (%)			0.055*
Female	50 (54.9)	102 (67.1)	
Male	41 (45.1)	49 (32.2)	
Unknown/Unavailable	0 (0.0)	1 (0.7)	
Race, n (%)			0.65
White	72 (79.1)	123 (80.9)	
Black	2 (2.2)	1 (0.7)	
Asian	6 (6.6)	7 (4.6)	
Other/Unavailable	11 (12.1)	21 (13.8)	
Smoking Status, n (%)			0.075
Current	3 (3.3)	6 (3.9)	
Former	42 (46.2)	48 (31.6)	
Never	46 (50.5)	98 (64.5)	
ASA Score, n (%)			0.053
1	0 (0.0)	0 (0.0)	
2	8 (8.8)	22 (14.5)	
3	40 (44.0)	81 (53.3)	
4	43 (47.3)	49 (32.2)	
Mean BMI in kg/m² [SD] (range)	25.2 [5.1] (16-43)	24.3 [5.1] (12-48)	0.18
Mean CCI, [SD] (range)	4.4 [3.3] (0-17)	4.1 [3.3] (0-13)	0.493
Anesthesia Type Received, n (%)			0.016
General	74 (81.3)	102 (67.1)	
Regional and/or Spinal	17 (18.7)	50 (32.9)	
Procedure Duration in Minutes, mean [SD] (range)	70 [33] (18-224)	74 [41] (17-258)	0.49
Surgical Operation Type			0.10

	Received Vasopressor (n = 91)	No Vasopressor (n = 152)	P value
Total Hip Arthroplasty	7 (7.7)	7 (4.6)	
Hemiarthroplasty	28 (30.8)	32 (21.1)	
Open Reduction Internal Fixation	53 (58.2)	112 (73.7)	
Closed Reduction Percutaneous Pinning	3 (3.3)	1 (0.7)	
Blood Transfusion Received, n (%)	7 (7.7)	11 (7.2)	0.89
Mean Units of Blood Received**, [SD] (range)	2.0 [0.9] (1-4)	2.2 [3.1] (1-13)	0.89
Preoperative Hemoglobin in g/L, mean [SD] (range)	112 [20] (66-150)	114 [19] (71-167)	0.44
Days from Admission to Surgery, mean (range)	2.16 (0-10)	1.84 (0-10)	0.17
Vasopressor Received, n (%)			-
Norepinephrine Only	45 (49.5)	-	
Phenylephrine Only	21 (23.1)	-	
Vasopressin Only	1 (1.1)	-	
Two or More	24 (26.4)	-	
NE + Vaso	5 (5.5)	-	
NE + PE	13 (14.3)	-	
NE + PE + Vaso	6 (6.6)	-	

ASA, American Society of Anesthesiologists; BMI, body mass index; CCI, Charlson Comorbidity Index; NE, norepinephrine; Vaso, vasopressin; PE, phenylephrine; SD, standard deviation. *Sex comparison calculated among patients with recorded male/female sex. **Among patients receiving blood transfusions.

Table 2. Primary Indications for Intensive Care Unit Admission

Primary Indication for ICU Admission	Received Vasopressor (n=91)	No Vasopressor (n=152)	Number of Patients (%)
Hypotension	34 (37.4)	14 (9.2)	48 (19.8)
Managing or Monitoring of Comorbidities	11 (12.1)	27 (17.8)	38 (15.6)
Cardiac Monitoring	5 (5.5)	24 (15.8)	29 (11.9)
Hypoxia, Respiratory Failure, or Respiratory Monitoring	14 (15.4)	13 (8.6)	27 (11.1)
Arrhythmia	5 (5.5)	15 (9.9)	20 (8.2)
Stroke, Altered Mental Status, or Other Neuromonitoring	1 (1.1)	17 (11.2)	18 (7.4)
Hemodynamic Instability	4 (4.4)	7 (4.6)	11 (4.5)
Sepsis or Septic Shock	4 (4.4)	4 (2.6)	8 (3.3)
Cardiac Arrest	6 (6.6)	0 (0.0)	6 (2.5)
Pulmonary Embolism or PE Rule-Out	0 (0.0)	6 (3.9)	6 (2.5)
Acute Blood Loss Anemia	1 (1.1)	5 (3.3)	6 (2.5)
Bowel Ischemia, Ileus, or GI Bleed	0 (0.0)	5 (3.3)	5 (2.1)
Aspiration	3 (3.3)	1 (0.7)	4 (1.6)
Diabetic Ketoacidosis	0 (0.0)	3 (2.0)	3 (1.2)
Hypertensive Urgency/Emergency	0 (0.0)	3 (2.0)	3 (1.2)
Pain Control	0 (0.0)	2 (1.3)	2 (0.8)
Cardiogenic Shock	1 (1.1)	1 (0.7)	2 (0.8)
Pneumonia	1 (1.1)	1 (0.7)	2 (0.8)
Myocardial Infarction	1 (1.1)	0 (0.0)	1 (0.4)
Agitation	0 (0.0)	1 (0.7)	1 (0.4)
Hyponatremia	0 (0.0)	1 (0.7)	1 (0.4)
Other/Unspecified	0 (0.0)	2 (1.3)	2 (0.8)

ICU, intensive care unit; GI, gastrointestinal; PE, pulmonary embolism. Values are n (%); group percentages use 91, 152, and 243 as their respective denominators. The Other/Unspecified row reconciles the denominator to the analytic cohort size of 243.

Table 3. Clinical Outcomes Stratified by Vasopressor Administration in the Intensive Care Unit

	Received Vasopressor (n = 91)	No Vasopressor (n = 152)	P value
7-Day Mortality, n (%)	11 (12.1)	0 (0.0)	<0.001
30-Day Mortality, n (%)	26 (28.6)	7 (4.6)	<0.001
90-Day Mortality, n (%)	32 (35.2)	15 (9.9)	<0.001
One-Year Mortality, n (%)	35 (38.5)	20 (13.2)	<0.001
Two-Year Mortality, n (%)	38 (41.8)	25 (16.4)	<0.001
Five-Year Mortality, n (%)	51 (56.0)	37 (24.3)	<0.001
Discharge Disposition, n (%)			<0.001
Home	7 (7.7)	15 (9.9)	
Skilled Nursing Facility	41 (45.1)	98 (64.5)	
Acute Rehab Facility	13 (14.3)	31 (20.4)	
Long Term Care Hospital	3 (3.3)	1 (0.7)	
Hospice	9 (9.9)	6 (3.9)	
Expired	18 (19.8)	1 (0.7)	
Total 90-Day Readmissions, n (%)	24 (26.4)	30 (19.7)	0.27
Cardiac/Hematologic*	5 (20.8)	5 (16.7)	-
Gastrointestinal*	4 (16.7)	6 (20.0)	-
Metabolic*	1 (4.2)	3 (10.0)	-
Neurologic*	1 (4.2)	3 (10.0)	-
Other*	2 (8.3)	0 (0.0)	-
Respiratory*	5 (20.8)	8 (26.7)	-
Infectious / Wound*	6 (25.0)	5 (16.7)	-
Mean LOS in Hours, [SD] (range)**	269 [170] (32-841)	229 [131] (73-959)	0.056
Aseptic Reoperations, n (%)	0 (0.0)	6 (3.9)	0.086
Dislocation	0 (0.0)	1 (0.7)	-
Pain Requiring Reoperation	0 (0.0)	2 (1.3)	-
Periprosthetic Fracture	0 (0.0)	3 (2.0)	-
Septic Reoperations, n (%)	1 (1.1)	6 (3.9)	0.26

	Received Vasopressor (n = 91)	No Vasopressor (n = 152)	P value
Infection Requiring DAIR	0 (0.0)	4 (2.6)	-
Infection Requiring Septic Revision	1 (1.1)	2 (1.3)	-

DAIR, debridement, antibiotics, and implant retention; LOS, length of stay; SD, standard deviation. P values for sparse binary outcomes were calculated using Fisher exact tests. *Readmission subcategory percentages are calculated among readmitted patients and are descriptive. **LOS P value reflects Welch t-test sensitivity analysis from available aggregate mean and SD values. Long-term mortality beyond one year should be interpreted together with Kaplan-Meier censoring.

Table 4. Multivariable Logistic Regression for Composite Endpoint of Revision Surgery or 1-Year Mortality

	Adjusted odds ratio [95% CI]	P value
Sex (Men)	0.12 [0.002-7.61]	0.324
Charlson Comorbidity Index	0.93 [0.84-1.02]	0.143
Current Smoker	0.89 [0.12-4.23]	0.894
Arthroplasty (vs fixation)	1.93 [1.00-3.71]	0.047
ASA ≥3	1.17 [0.43-3.53]	0.770
BMI	1.01 [0.96-1.04]	0.850
Age at Surgery	1.00 [0.96-1.04]	0.968
General Anesthesia	1.86 [0.89-4.11]	0.110
Vasopressor Received	2.40 [1.31-4.42]	0.005

ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval. All listed variables were entered in the multivariable model. Arthroplasty comprises hemiarthroplasty or total hip arthroplasty; fixation comprises open reduction internal fixation or closed reduction percutaneous pinning.

Table 5. Multivariable Logistic Regression for 30-Day Mortality

	Adjusted odds ratio [95% CI]	P value
Sex (Men)	1.28 [0.54-2.98]	0.567
Charlson Comorbidity Index	0.88 [0.75-1.01]	0.082
Current Smoker	1.12 [0.05-9.41]	0.928
Procedure (arthroplasty vs fixation)	1.04 [0.41-2.53]	0.929
ASA ≥3	1.26 [0.32-6.44]	0.754
BMI	0.96 [0.87-1.04]	0.291
Age at Surgery	1.05 [0.99-1.12]	0.110
General Anesthesia	1.21 [0.45-3.54]	0.713
Vasopressor Received	10.07 [4.09-28.22]	<0.001

ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval. All listed variables were entered in the multivariable model. Arthroplasty comprises hemiarthroplasty or total hip arthroplasty; fixation comprises open reduction internal fixation or closed reduction percutaneous pinning.

Table 6. Multivariable Logistic Regression for One-Year Mortality

	Adjusted odds ratio [95% CI]	P value
Sex (Men)	1.21 [0.61-2.39]	0.578
Charlson Comorbidity Index	0.93 [0.83-1.03]	0.158
Current Smoker	1.34 [0.17-7.04]	0.786
Procedure (arthroplasty vs fixation)	2.01 [0.98-4.12]	0.055
ASA ≥3	1.66 [0.53-6.32]	0.414
BMI	0.96 [0.89-1.02]	0.192
Age at Surgery	1.02 [0.98-1.07]	0.341
General Anesthesia	1.68 [0.75-4.04]	0.223
Vasopressor Received	3.98 [2.06-7.90]	<0.001

ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval. All listed variables were entered in the multivariable model. Arthroplasty comprises hemiarthroplasty or total hip arthroplasty; fixation comprises open reduction internal fixation or closed reduction percutaneous pinning.

Figures

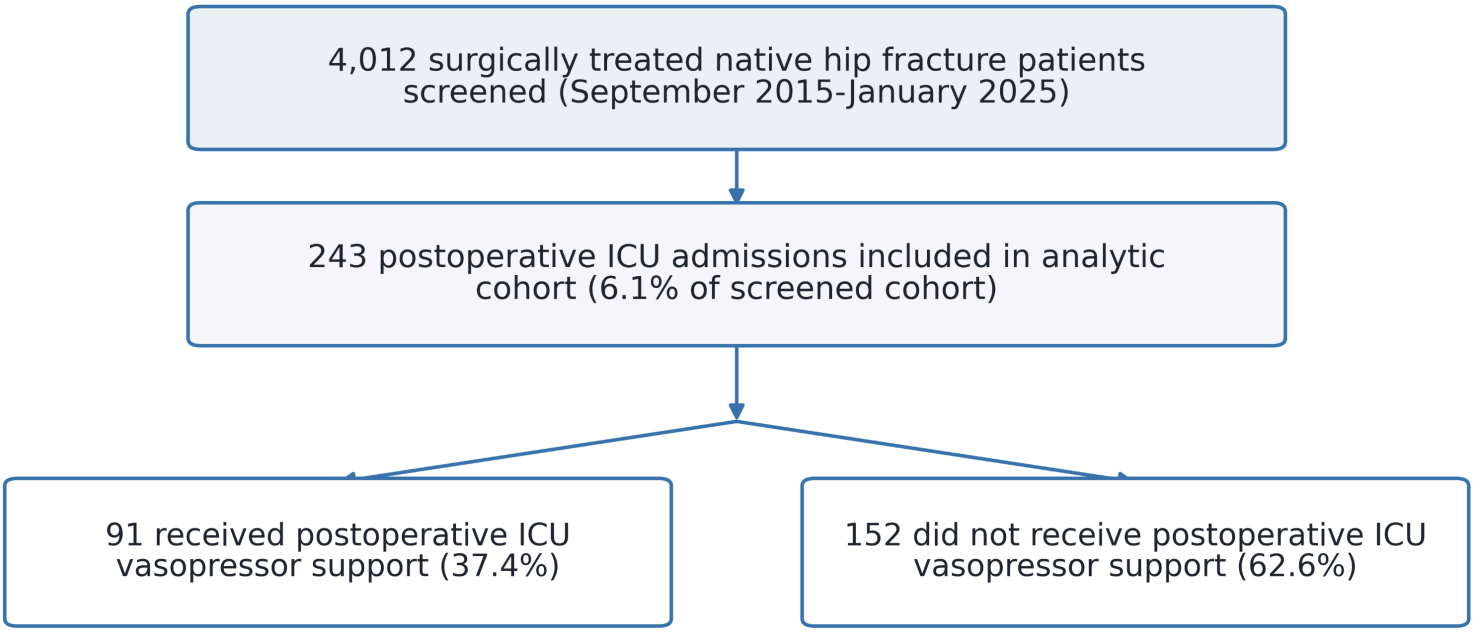


Figure 1

Study cohort flow diagram. Of 4,012 patients who underwent surgical treatment for a native hip fracture between September 2015 and January 2025, 243 (6.1%) required postoperative intensive care unit (ICU) admission and were included in the analytic cohort. Among these patients, 91 (37.4%) received postoperative vasopressor support and 152 (62.6%) did not.

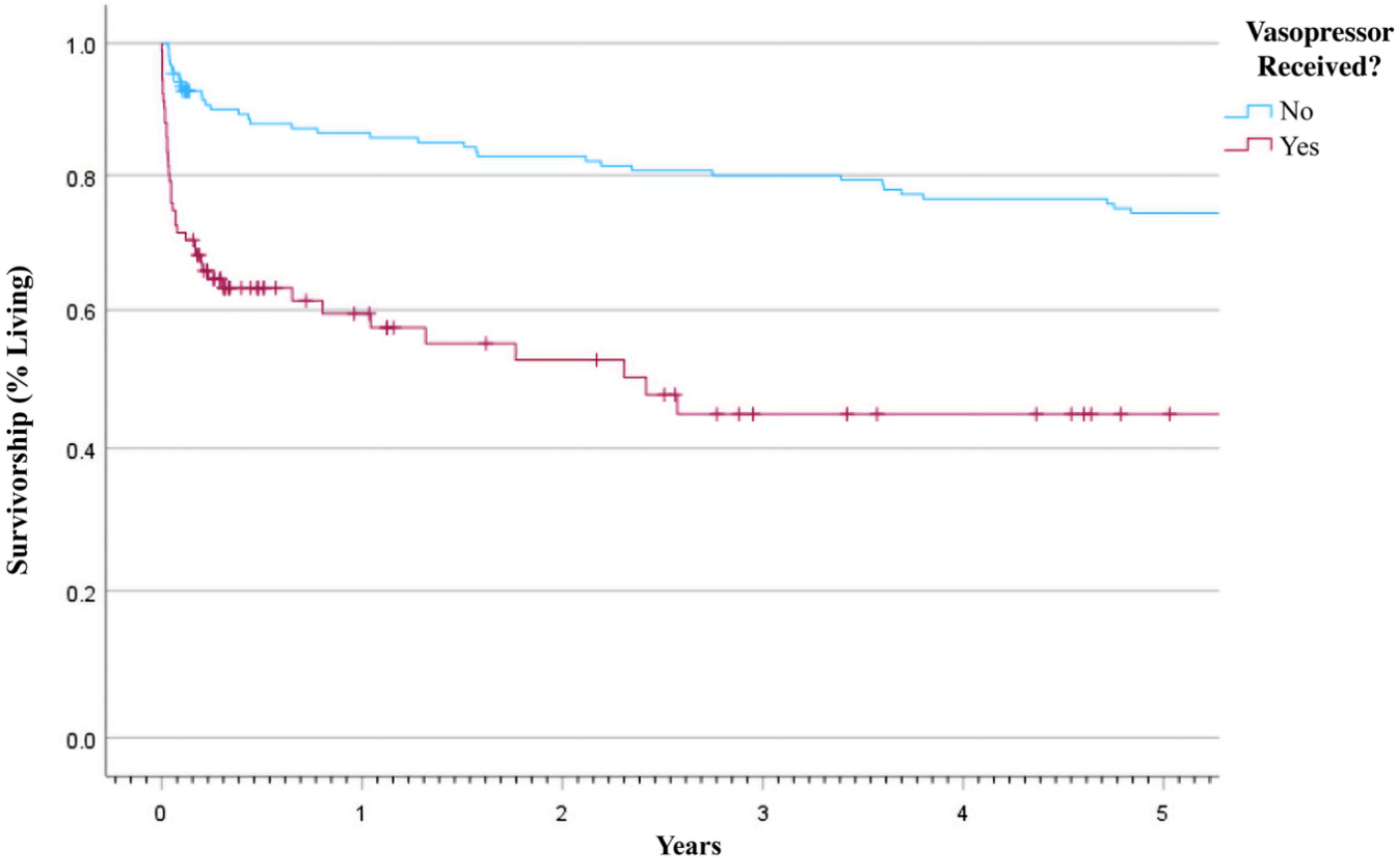


Figure 2

Kaplan-Meier survival curve stratified by postoperative ICU vasopressor support. Curves are color-coded by group: no vasopressor (blue) and vasopressor (red). Censoring marks indicate last known follow-up. Log-rank: P<0.001.

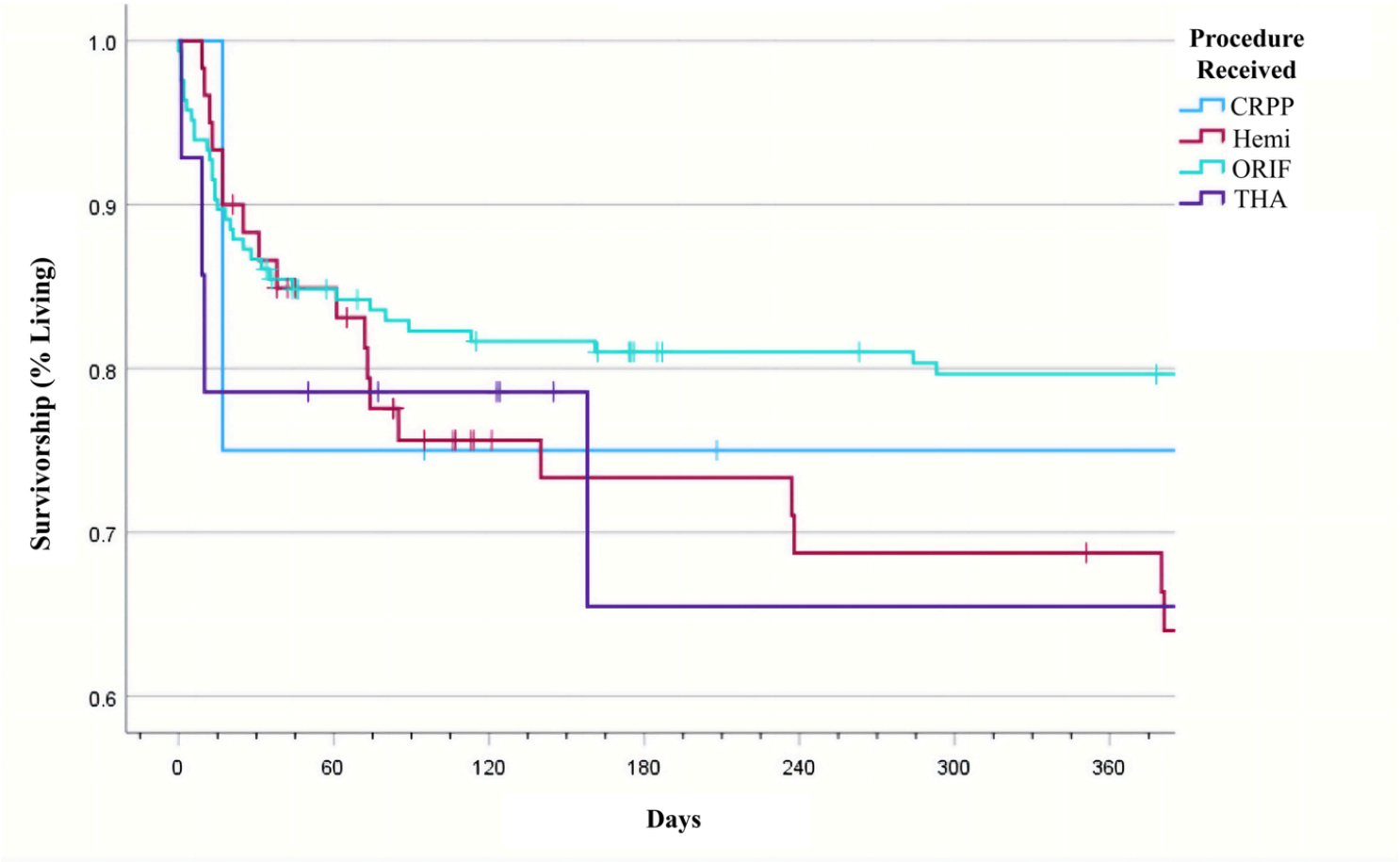


Figure 3

Exploratory Kaplan-Meier survival curve stratified by hip fracture procedure type. Curves are color-coded by procedure: closed reduction percutaneous pinning (CRPP), hemiarthroplasty, open reduction internal fixation (ORIF), and total hip arthroplasty (THA). Because strata were small, this exploratory procedure-specific analysis should be interpreted cautiously. Log-rank: P=0.537.