SN Comprehensive Clinical Medicine (2025) 7:344
https://doi.org/10.1007/s42399-025-02126-5

RESEARCH

Assessment of Potential Errors in the Rational Administration of Albumin in a Teaching Hospital

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Received: 29 May 2025 / Revised: 26 September 2025 / Accepted: 2 October 2025

Abstract

Background/Objective Albumin, an essential yet expensive colloidal solution, is widely used in hospitals for managing various medical conditions. However, improper utilization can lead to unnecessary financial burdens and potential risks to patients. This study aims to identify and evaluate errors in albumin use in a teaching hospital, with the goal of improving healthcare quality and reducing misuse.

Methods This cross-sectional analytical study was carried out at Firouzabadi Hospital, Tehran, over a six-month period (June 30 to December 10, 2017). Data from 60 patients were reviewed, including their medical records, laboratory results, and compliance with albumin administration protocols. Errors in albumin prescription and usage were identified by comparing each case against national and institutional guidelines. These errors included clinical (e.g., unjustified indications), documentation (e.g., incomplete or duplicate forms), and laboratory issues (pre-analytical, analytical, and post-analytical phases (Each case was reviewed by clinical and laboratory experts to ensure unbiased classification.

Results Among the 60 patients reviewed, errors in albumin use were identified. The most frequent errors included deviations from serum albumin level requirements (27.8%), incomplete application forms (16.7%), and duplicate orders (19.4%), all indicating non-compliance with prescribing guidelines. Laboratory-related errors were minimal (2.8%) and primarily occurred in the pre-analytical phase. Error rates varied across hospital wards, with the highest observed in intensive care units (ICUs) and the lowest in the male surgical ward. Additional contributing factors included underlying medical conditions and inappropriate clinical indications for albumin administration.

Conclusion The study identified multiple errors in albumin use, including unjustified indications, incomplete documentation, and deviations from laboratory-based prescribing criteria. These findings highlight the need for improved compliance with clinical and administrative protocols to ensure safe and rational albumin administration. Targeted training and systematic review of prescribing practices are recommended to reduce misuse and enhance healthcare quality.

Keywords Human albumin · Rational use of medication · Medication errors

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Published online: 21 October 2025

Background

The use of albumin in hospitals plays a critical role in patient care but is associated with high costs and potential risks when misused. Inappropriate administration can lead to adverse clinical outcomes, prolonged hospital stays, patient dissatisfaction, and unnecessary financial burdens. In teaching hospitals, which often manage complex cases, evaluating medication errors and adherence to clinical guidelines is essential for improving care quality and optimizing resource utilization.

In pursuit of improved health promotion and compliance with standards set by international networks like the Health Promoting Hospitals (HPH) and the National Integrated Accreditation for Healthcare (NIAHO), hospitals are required to follow robust guidelines. These guidelines present measurable benchmarks for healthcare and health promotion services, breaking them down into actionable components and performance metrics for effective evaluation [1–4]. These standards emphasize the critical role of hospital medical staff, especially in specialized and educational centers. Studies have shown that medication inefficacy is a major factor contributing to both mortality and financial burdens in healthcare systems globally [5].

According to the World Health Organization, rational drug prescription involves selecting the most appropriate medication for a patient's condition, ensuring the correct dosage and timing, and minimizing both errors and costs [6].

Studies emphasize the significance of conducting drug use evaluations (DUE), particularly for costly medications or those with a narrow therapeutic index [7]. Albumin, a colloidal solution with diverse clinical applications, has not been extensively examined concerning its prescribing practices. Following the guidelines established by HPH and NIAHO, along with understanding the clinical and economic ramifications of albumin use, is essential. Inappropriate prescribing of albumin can burden the healthcare system with substantial costs, which is especially critical in strained economic conditions. Human albumin is a high-cost colloid solution; for instance, in the Iranian healthcare system during the study period, a 50 mL vial of 20% albumin cost approximately [Insert approximate cost, e.g., $53]. This high cost underscores the financial impact of its irrational use.

According to national guidelines, albumin should be prescribed by physicians based on clinical necessity, with pharmacists verifying the patient's condition and serum albumin levels. However, errors may occur when nurses, under pressure or workload stress, complete request forms. These mistakes are often linked to limited training and high professional demands [8]. This evaluation process generally includes analyzing existing practices, benchmarking them against established guidelines, and implementing strategies to mitigate inappropriate use. These efforts are crucial not only for improving healthcare quality but also for ensuring the efficient use of resources within medical institutions [8–10].

Research has identified prevalent mistakes in the inappropriate use of albumin, including issues such as incomplete request forms, overlooking patient symptoms, irrational prescribing practices, excessive requests, neglecting to monitor therapeutic serum albumin levels, and insufficient scientific guidance for managing complications related to albumin misuse. Furthermore, laboratory errors—whether pre-analytical, analytical, or post-analytical—can exacerbate medication inaccuracies.

Improving drug use and minimizing errors requires identifying both random and systemic issues, monitoring lab processes, and addressing reporting mistakes. Comparing these errors with hospital standards and DUE outcomes helps reduce future risks and costs [11]. The aim of this research is to evaluate potential errors in the rational administration of albumin within a teaching hospital setting. This study seeks to identify instances of misuse, analyze systematic and laboratory-related errors, and assess compliance with established guidelines to enhance the quality of healthcare.

Patients and Method

This analytical cross-sectional study was carried out over six months (June 30, 2017, to December 10, 2017) at Firouzabadi Hospital, affiliated with Iran University of Medical Sciences, Tehran, Iran. Inclusion criteria were: (1) documented albumin administration during the study period, and (2) availability of complete medical records and laboratory data. Patients with prior albumin use were not excluded, as the analysis focused on the appropriateness of albumin prescribing during the current admission. The study included patients of various ages, genders, and medical conditions across different departments. The only exclusion criterion was patient death or discharge from the department before the first 72-h follow-up serum albumin level could be measured. This was necessary to ensure a complete dataset for evaluating the entire sequence of albumin administration, including monitoring and re-assessment practices, which were the primary focus of this process-oriented study.

The sample size for this study, consisting of 60 patients, was determined using a census approach based on the feasibility of data collection during the six-month study period, the hospital's patient flow, and the exploratory nature of the research. All adult patients who received albumin during hospitalization and had complete medical and laboratory records were included. No statistical sample size calculation

was applied, as the study aimed to evaluate all eligible cases within the defined timeframe. This sample size enabled a focused analysis of prescription and administration errors in albumin use, based on patient records, laboratory data, and adherence to clinical guidelines. To achieve the study objectives, patient records, laboratory test results, medical histories, and guidelines for the rational use of albumin (approved by the Food and Drug Organization, PHR-FO-20/A (supplementary Table 1), were reviewed and analyzed. Additionally, the percentage of laboratory errors was assessed across the pre-analytical, analytical, and post-analytical phases (Table 2).

According to the guidelines, albumin is indicated for patients with serum albumin levels below 2.5 g/dL. In this study, serum albumin levels were measured every 72 h following the initial dose of albumin injection. In certain cases, based on the physician's clinical judgment, albumin administration was continued in patients with serum albumin levels equal to or above 2.5 g/dL until levels reached 2.8, 3.0, or 3.7 g/dL. The patient cohort included individuals with conditions such as gastrointestinal bleeding, bedsores, extensive wounds, tissue edema in diabetic patients, multiple wounds, and those undergoing procedures such as laparotomy, anastomosis, or pleural catheter insertion (supplementary Table 1).

Prescriptions for albumin by physicians were required to include comprehensive details such as dosage, method of administration, intervals for initiation and discontinuation, monitoring requirements, necessary warnings, prescription date, as well as the physician's signature and seal. Nursing documentation was essential for ensuring alignment with the prescribed orders, confirming the correct drug name, formulation, and proper handling of laboratory samples, alongside delivering appropriate nursing care.

Laboratory-related assessments focused on several critical aspects, including the specifications of tools and equipment, the performance of biochemical units, experimental procedures, human resource management, sample collection and storage, environmental health, occupational safety, and the accurate reporting and recording of test results.

Laboratory Assays

Serum albumin levels were measured using the Mindray BS-800 automated biochemistry analyzer (Mindray, China), with reagents supplied by Delta Darman (Iran) (reference number available upon request). All serum samples were collected using standard serum separator tubes (SST) containing clot activator and gel, routinely used in our hospital's biochemistry laboratory to ensure consistency and optimal serum separation. The analyzer was regularly calibrated using certified reference standards provided by the manufacturer, although the specific product identifier was not recorded in the laboratory documentation.

To ensure accuracy and reliability, pre-analytical procedures—including proper sample collection, labeling, and centrifugation within two hours—were rigorously followed to minimize errors such as hemolysis and maintain sample integrity.

Analytical precision was assessed using internal laboratory data collected over a one-month period, based on two levels of control material (normal and pathological) and 20 datapoints per level. The coefficient of variation (CV) was 0.83 and the standard deviation (SD) was 0.04. Although the mean values were not documented in the available records, these indicators reflect acceptable performance under routine testing conditions.

Statistical Analysis

The collected data were analyzed using SPSS software, version 21. Descriptive statistics, including frequencies, percentages, and means, were used to summarize patient demographics, clinical conditions, and the distribution of albumin administration errors across departments. Inferential statistical tests, such as the chi-square test, were employed to assess the association between error rates and specific departments or conditions. Additionally, the rates of laboratory errors in the pre-analytical, analytical, and post-analytical phases were calculated and compared. Statistical significance was set at a p-value of less than 0.05. These analyses provided insights into error patterns and helped identify areas requiring targeted interventions to improve the rational use of albumin.

Results

A total of 60 hospitalized patients who received albumin were included in the analysis. The main clinical diagnoses associated with albumin administration are summarized in Table 1. The most frequent indication was reduced

Table 1 Distribution of main diagnoses among hospitalized patients receiving albumin

Diagnosis	Frequency (%)	Male	Female
Reduced level of consciousness	**22%**	**8**	**5**
Severe sepsis	**14%**	**5**	**3**
Laparotomy	**10%**	**4**	**2**
Acute respiratory failure	**8%**	**3**	**2**
Pneumonia	**8%**	**2**	**3**
Other conditions	**38%**	**12**	**11**
Total	**100**	**34**	**26**

Table 2 Errors in prescribing rational albumin use in hospital

Error	Frequency (%)
Failure to complete the albumin application form	6 (16.66)
Repeated request for a completed albumin application form	7 (19.44)
Failure to observe rational serum albumin levels	5 (13.88)
Lack of explanation of the rational indication for continued albumin administration	3 (8.33)
Failure to observe the periodicity of determination of serum albumin level	10 (27.77)
Laboratory error	1 (2.77)
Other errors	4 (11.11)
Albumin prescription indication error	0 (0)

Table 3 Frequency percentage of hospitalized patients with albumin levels less than and more than 2 g/dL

Albumin ratio of patients	Frequency ratio
The ratio of patients with albumin less than 2.5 g/dL to the total (before injection)	69
The ratio of patients with albumin more than 2.5 g/dL to the total (before injection)	22
Percentage of patients not registered in the albumin application form (albumin level and number of injected vials)	9
Total	100

level of consciousness (22%), followed by severe sepsis (14%), laparotomy (10%), acute respiratory failure (8%), and pneumonia (8%). Other conditions accounted for the remaining 38% of cases.

Among the 60 patients included in the study, 57% were women ($n=34$) and 43% were men ($n=26$), with a mean age of 74.9 years (SD: 13.7). A total of 491 vials of albumin were administered to these patients. Common errors identified included non-compliance with serum albumin levels (27.77%), while laboratory procedures accounted for the fewest errors (2.77%).

Errors related to inappropriate albumin use included incomplete albumin application forms (16.66%), duplication of request forms (19.44%), non-compliance with serum albumin levels (13.88%), and incorrect indications for continuing albumin administration (8.33%) (Table 2).

The average rate of laboratory errors across pre-analytical, analytical, and post-analytical phases was 2.77%, based on an internal evaluation of potential risks from sample collection to post-experiment procedures.

By albumin administration guidelines, serum albumin levels were assessed in hospitalized patients before initiating albumin therapy. The proportion of patients with serum albumin levels below 2.5 g/dL who received albumin, along with their corresponding clinical indications, was calculated for the entire cohort. Additionally, patients with serum albumin levels of 2.5 g/dL or higher completed the albumin request form as prescribed by their physicians and received albumin based on their specific diagnoses (Table 3). However, in several cases, albumin administration was continued despite initial serum albumin levels ≥ 2.5 g/dL, with treatment extended until levels reached 2.8, 3.0, or even 3.7 g/dL, indicating deviation from standard prescribing guidelines.

Table 4 Other errors in rational prescribing of albumin use in hospital

Variable	No. (%)
Error	4 (11.11)
Impact of underlying diseases such as hyperlipidemia and icterus	
Hemolysis of blood samples during sampling of the patient	
Deficiencies and weaknesses in monitoring the approved instructions for the implementation of rational use of albumin	
Error in performing a rewrite	
Error in executing prescriptions	

It is noteworthy that "other errors" were attributed to factors such as underlying diseases (e.g., blood lipids, icterus, and hemolysis of blood samples during patient sampling), poor adherence to approved guidelines for the rational use of albumin, errors in rewriting prescriptions, and mistakes in implementing drug orders. These "other errors" were collectively reported at a rate of 11.11% (Table 4).

This study also examined the frequency of prescription errors for patients receiving albumin across different hospital departments. The highest error rate was observed in the intensive care unit (ICU), while the lowest was recorded in the male surgery department (Table 5).

Table 5 Percentage of errors in the rational prescription of albumin in different hospital wards

Variable	Values (%)	Number of cases
Ward		
ICU 1 (general adult ICU)	41.66	15
ICU 2 (internal medicine ICU)	2.77	16
Male surgical ward	5.55	1
Female surgical ward	5.55	2
Emergency room	44.44	2

Discussion

An analysis of albumin use in 60 patients revealed significant challenges in its rational administration. Among the 36 medication errors identified, the most frequent were non-compliance with serum albumin levels (27.77%), duplicate request forms (19.44%), and incomplete forms (16.66%). While laboratory errors were minimal (2.77%), other issues like poor guideline adherence (11.11%) were noted. Error rates were highest in the ICU and lowest in the male surgery ward (2.77%). These findings underscore the need for improved monitoring, training, and strict adherence to protocols to enhance patient safety and clinical outcomes.

Accurate measurement of serum albumin at admission is vital for rational use [12]. Despite limited prior research, this study systematically identified prescription and laboratory errors and applied quality improvement strategies. A strict error threshold of 0.92% across all analytical phases reflected high performance standards. These findings highlight the need for ongoing attention to accuracy and quality assurance in albumin administration.

Most laboratory errors occur during the pre-analytical phase, which includes procedures prior to testing [13]. In this study, the error rate during this phase was reduced to 0.92%, attributed to structured laboratory management, effective albumin administration, and strong clinical infrastructure. Contributing factors included accurate sampling, proper transport and storage, and thorough staff training.

The analytical phase involves conducting diagnostic tests, while the post-analytical phase focuses on interpreting results to guide treatment decisions [14]. Laboratory specialists play a key role in supporting physicians through accurate result interpretation.

Implementing a quality management system across all laboratory phases offers a strong framework for performance monitoring. By integrating quality assurance protocols throughout the entire testing process, laboratories can build trust and ensure reliable results, from the initial test request to the preparation of results. A laboratory quality management system (LQMS) is an essential element for the effective operation of research, clinical or testing laboratories [15].

In this study, errors attributed to the work environment accounted for 11.11% of the total observed issues. These errors primarily involved issues such as incomplete documentation on albumin request forms, typographical or grammatical mistakes, and missing critical details like vial information, specific injection intervals, or serum albumin levels. Encouragingly, no errors related to the logical indication for albumin administration were identified.

Research on albumin usage in Iran remains limited; however, a cross-sectional study conducted at Shariati Hospital, affiliated with Tehran University of Medical Sciences (Tehran, Iran), revealed that only 32.1% vials of albumin were administered appropriately according to reliable guidelines. This study has shown that most prevalent inappropriate use of albumin is seen in patients after variety of cardiac surgeries [16] Similarly, the present study identified higher rates of errors in ICU1 and ICU2 compared to other hospital departments (Table 5), likely reflecting the complexity of care and the demanding environment in these units. While a prospective study in Spain of 197 patients receiving albumin showed that the internal and gastrointestinal departments were the most frequently prescribed; only 16 prescriptions (8.1%) were deemed appropriate [17].

A study conducted in Thailand found that only 64.4% of serum albumin orders were prescribed with an appropriate indication, rational dose, and duration. The remaining 35.6% were considered improper, with common inappropriate indications. Notably, 14% of all orders were administered to patients for whom albumin was contraindicated [18].

Given the high cost of albumin, its dosage should be carefully adjusted according to the severity of the patient's condition and the extent of fluid and protein loss. In this study, serum albumin levels were checked every 72 h for patients with conditions such as gastrointestinal bleeding, candidates for surgery, bedsores, extensive wounds, and edema. Despite guidelines recommending strict compliance with serum albumin thresholds, elevated levels of 2.8, 3.0, and even 3.7 g/dL were occasionally observed, suggesting possible overuse.

It is well established that laboratory results must be interpreted within the context of clinical history, physical examination, and presenting symptoms to enhance diagnostic accuracy. Providing comprehensive clinical information when requesting tests is also essential to reducing laboratory errors. This study further indicated that conditions like jaundice and hyperlipidemia could affect albumin administration, as these underlying issues may distort test results due to factors like poor blood sugar control.

Efficient medication management is crucial for promoting faster recovery, minimizing errors, and preventing the

waste of valuable resources. Enhancing prescription practices requires the adoption of standardized protocols, the integration of advanced monitoring systems, and ongoing training for healthcare staff. Albumin administration should be guided by serum albumin levels, with measurements performed within a 24-h timeframe. For levels below 2.5 g/dL, reassessment after 72 h is advised. If low levels persist, further administration must be justified with appropriate documentation. Conversely, for higher serum albumin levels, usage should be restricted to specific conditions and thoroughly documented.

This study had several strengths, including its comprehensive analysis of prescription and laboratory errors in albumin administration, its multifaceted approach involving various hospital departments, and its evaluation of quality assurance systems with strict performance thresholds. Additionally, the study explored potential mechanisms of inappropriate albumin use, providing valuable clinical insights. However, there were limitations such as the small sample size, single-center design, and the retrospective nature of the study, which may limit the generalizability of the findings. The lack of long-term evaluation of interventions and the variability in diagnoses also highlight areas for further research and improvement. These factors collectively emphasize the importance of tailored protocols and continuous efforts to optimize albumin use.

A key implication of our study is the necessity for an albumin stewardship program. Such initiatives, modeled on successful antimicrobial stewardship programs, could involve mandatory pharmacist approval for each albumin request against set criteria, thereby embedding a safety check directly into the prescribing workflow. Based on the findings of this study, we recommend conducting a prospective cohort study including all patients receiving albumin, regardless of outcome, to directly assess the relationship between prescribing errors and clinical endpoints such as mortality, length of stay, and complication rates.

Conclusion

This study revealed major challenges in the rational use of albumin, including non-compliance with serum albumin thresholds, incomplete forms, and incorrect continuation of administration, particularly in intensive care units. Minimal laboratory-related errors, along with issues like hemolysis and poor adherence to guidelines, highlight the multifaceted nature of these errors. The findings stress the importance of evidence-based guidelines, staff training, monitoring systems, and tailored protocols to reduce errors and optimize outcomes. Additionally, addressing inappropriate administration mechanisms, such as fluid overload and immune disruption, can improve patient safety. Enhanced quality assurance systems and better healthcare communication are vital for the effective and safe use of albumin in clinical settings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s42399-025-02126-5.

Acknowledgements The authors thank the Clinical Research Development Unit and Laboratory of Firozabadi Hospital, Iran University of Medical Sciences. Also, dear colleagues at the central laboratory of Firouzabadi Hospital in Tehran, Mohammad Taghi Rahnama, Shojauddin Lasan, Munira Karimi Yazdi, Reza Ghasemi and respected colleagues at the pharmacy, Mr. Dr. Seyed Ahmad Sajjadi, Aziz Delavar, Mahsa Gosheh and Rana Moradi.

Author Contributions Z.O. was involved in the study design, performed data analysis, and participated in manuscript preparation. S.N. reviewed the final manuscript, provided critical revisions, and contributed to the development of the research methodology. H.A. played a pivotal role in data collection, interpretation, and drafting the initial manuscript. L.Z. offered clinical expertise, validated the data, and reviewed the manuscript. S.Sh. assisted with data gathering and conducted initial data processing. M.I. managed data organization and ensured compliance with research protocols. F.Sh.L. supported data entry and verification processes. M.S. supervised the project, provided strategic oversight, and coordinated the research framework.

Data Availability All data generated and analyzed during this study are available from the corresponding author upon reasonable request.

Code Availability Not applicable.

Declarations

Ethics Approval This research has been registered with the registration number 1113020 on January 31, 2019 in the Vice-Chancellor of Management and Resources Development of the Ministry of Health, Treatment and Health, Treatment and Medical Education.

Consent to Participate Written informed consent was obtained from all participants.

Consent for Publication Consent for publication from all authors were obtained.

Informed Consent Informed consent was obtained from all the participants included in the study. This article does not contain any studies with animals performed by any of the authors.

Competing interests The authors declare no competing interests.

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