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Investigation of the Relationship Between Early Changes in Serum Potassium Levels After Transfusion and the Storage Duration of Red Blood Cells in the Emergency Department

Original Article

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ABSTRACT

Objective: This study aimed to investigate the relationship between early changes in serum potassium levels following red blood cell (RBC) transfusion and the storage duration of transfused RBCs.

Methods: This retrospective study included 23 patients who received one unit of non-irradiated RBCs for symptomatic anemia or active bleeding in the emergency department. Serum potassium, lactate, hemoglobin, and hematocrit levels were evaluated before and 15–30 minutes after transfusion. Patients were categorized according to RBC storage duration as <14 days (n=14) or ≥14 days (n=9).

Results: In the <14-day group, serum potassium increased from 3.9 to 4.05 mmol/L, without statistical significance (p=0.063), while lactate significantly decreased from 2.3 to 1.25 mmol/L (p<0.001). In the ≥14-day group, potassium increased significantly from 3.8 to 3.9 mmol/L (p=0.049), whereas the change in lactate was not significant (p=0.110). Significant changes in hemoglobin and hematocrit were observed after transfusion.

Conclusion: RBC storage duration may influence early post-transfusion serum potassium levels. RBCs stored for ≥14 days were associated with a small but statistically significant increase in potassium, suggesting that storage duration may warrant consideration in patients at increased risk from potassium load.

Keywords: Potassium; Red blood cell transfusion; Storage duration; Emergency department.

Introduction

Red blood cell (RBC) transfusion is a fundamental treatment widely used in many clinical conditions characterized by impaired tissue oxygenation, particularly symptomatic anemia and acute bleeding. In emergency departments, RBC transfusion plays an important role in increasing oxygen-carrying capacity and maintaining adequate tissue perfusion in conditions such as trauma, gastrointestinal bleeding, and severe anemia [1,2]. Before transfusion, RBC units are stored under defined temperature conditions in appropriate preservative solutions. However, cellular, biochemical, and metabolic changes occur in erythrocytes during storage. These alterations are collectively referred to as the "storage lesion" and include deterioration of erythrocyte membrane integrity, changes in energy metabolism, and movement of intracellular electrolytes into the extracellular environment [2,3]. Among

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these storage-related biochemical changes, alterations in the potassium concentration of the blood product are particularly important [4,5].

Potassium is the principal intracellular cation and is essential for maintaining normal cellular electrical activity. The Na^+/K^+-ATPase pump maintains a substantially higher intracellular potassium concentration than the extracellular concentration. This concentration gradient is required for the resting membrane potential and generation of action potentials, particularly in nerve and muscle cells [6-8]. Consequently, clinically important changes in serum potassium may lead to neuromuscular dysfunction and serious cardiac arrhythmias. As stored erythrocytes undergo progressive membrane alterations and hemolysis, intracellular potassium leaks into the extracellular storage solution, and the potassium concentration of the RBC unit may increase with storage duration [9,10]. Therefore, transfusion of RBC products stored for longer periods may affect the recipient's serum potassium level. This issue may become particularly important during rapid or massive transfusion, when severe hyperkalemia and life-threatening cardiac arrhythmias may ocur [11].

Nevertheless, data regarding the effect of storage duration on serum potassium levels in the very early period after transfusion of a single RBC unit remain limited. Although post-transfusion hemoglobin and hematocrit measurements are commonly assessed in clinical practice, routine early electrolyte monitoring is less consistently performed in patients who do not undergo massive transfusion [12,13]. Clarifying the relationship between storage duration and early potassium changes may therefore be clinically relevant, particularly in patients in whom hyperkalemia could pose an increased risk. In the present study, the early post-transfusion assessment was performed 15–30 minutes after transfusion [14].

The aim of this study was to evaluate early changes in serum potassium after transfusion of one unit of non-irradiated RBCs in patients presenting to the emergency department with symptomatic anemia or active bleeding and to investigate whether these changes were associated with the storage duration of the transfused RBC unit. For this purpose, early potassium changes were compared between patients receiving RBCs stored for <14 days and those receiving RBCs stored for ≥14 days.

Materials and Methods

Study Design and Population

This retrospective observational study included adult patients who presented to the Emergency Department of Istanbul Medeniyet University Göztepe Prof. Dr. Süleyman Yalçın City Hospital and received red blood cell (RBC) transfusion for symptomatic anemia or active bleeding. A total of 23 patients who met the eligibility criteria were included. The study was approved by the Clinical Research Ethics Committee of Istanbul Medeniyet University Göztepe Prof. Dr. Süleyman Yalçın City Hospital (approval date: January 12, 2022; approval no: 2021/0708).

Patients aged ≥18 years who received RBC transfusion based on the attending physician's clinical decision and had arterial or venous blood gas measurements available before and within 15–30 minutes after transfusion were eligible. Patients with acute or chronic renal failure, active malignancy and/or cytotoxic drug use, or major/multiple trauma were excluded. Patients were also excluded if blood gas samples were affected by coagulation; if they were receiving medications capable of altering potassium metabolism, excretion, or retention, including insulin, diuretics, angiotensin-converting enzyme inhibitors,

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or angiotensin receptor blockers; if transfusion could not be completed because of a transfusion reaction; or if cardiac arrest occurred during emergency department admission or follow-up.

Data Collection and Measurements

Demographic and clinical data, including age, sex, diagnosis, blood group, medications, and treatments administered in the emergency department, were obtained from hospital records. Information regarding transfused RBC units, including serial number, blood group, storage duration, cross-match results, irradiation and filtration status, packaging date, and transfusion date, was recorded. All patients were monitored for vital signs and cardiac rhythm during transfusion. In patients receiving multiple transfusions, only data related to the first transfusion were included in the analysis.

Blood samples obtained before and 15–30 minutes after transfusion were analyzed using a RAPIDPoint 500e blood gas analyzer (Siemens). Serum potassium, lactate, pH, hemoglobin, and hematocrit values were recorded. Patients were categorized into two groups according to RBC storage duration: <14 days and ≥14 days. Changes in laboratory parameters before and after transfusion were evaluated and compared between these groups.

Statistical Analysis

Statistical analyses were performed using SPSS version 21.0. Normality was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests, Q–Q plots, and histograms. Normally distributed continuous variables were expressed as mean ± standard deviation, whereas non-normally distributed variables were presented as median (minimum–maximum). Categorical variables were reported as frequencies and percentages. The Mann–Whitney U test was used for comparisons between two independent groups. Paired continuous variables were analyzed using the paired-samples t-test for normally distributed data and the Wilcoxon signed-rank test for non-normally distributed data. A two-sided $p<0.05$ was considered statistically significant.

Results

A total of 23 patients were included in the study, of whom 10 (43.5%) were male and 13 (56.5%) were female. The median age was 75 years (range, 23–87 years). The median storage duration of the transfused RBC units was 8 days (range, 1–26 days). Fourteen patients (60.9%) received RBCs stored for <14 days, whereas nine (39.1%) received RBCs stored for ≥14 days. The most common indication for transfusion was symptomatic anemia (65.2%), followed by upper gastrointestinal bleeding (21.7%), trauma-related active bleeding (8.7%), and lower gastrointestinal bleeding (4.3%).

In the overall study population, median serum potassium significantly increased from 3.9 (3.2–5.3) mmol/L before transfusion to 4.0 (3.4–5.5) mmol/L after transfusion ($p=0.007$). In contrast, median lactate decreased significantly from 2.2 (0.8–7.1) to 1.4 (0.6–6.1) mmol/L ($p=0.001$). As expected, following RBC transfusion, hemoglobin increased from 5.3 (2.4–11.9) to 6.9 (3.9–12.8) g/dL and hematocrit from 18% (8.2–36) to 21% (12.7–38), with both changes being statistically significant ($p<0.001$). No significant change was observed in pH ($p=0.693$).

Among patients receiving RBCs stored for <14 days, serum potassium increased from 3.9 (3.4–5.3) to 4.05 (3.4–5.5) mmol/L; however, this difference did not reach statistical significance ($p=0.063$). Lactate significantly decreased from 2.3 (1.0–7.1) to 1.25 (0.6–6.1) mmol/L ($p<0.001$). Significant increases were also observed in hemoglobin and hematocrit (both $p=0.001$),

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whereas pH remained unchanged (p=0.665).

In patients receiving RBCs stored for ≥14 days, serum potassium increased significantly from 3.8 (3.2–4.5) to 3.9 (3.4–5.5) mmol/L (p=0.049). Hemoglobin and hematocrit also increased significantly (both p=0.008), whereas changes in lactate (p=0.110) and pH (p=0.107) were not statistically significant. When the magnitude of pre-to-post-transfusion changes was directly compared between the two storage-duration groups, no statistically significant between-group difference in potassium change was observed [median change: 0.1 (-0.3 to 0.6) mmol/L for <14 days vs. 0.2 (-0.1 to 0.6) mmol/L for ≥14 days; p=0.557]. Similarly, changes in pH (p=0.277), lactate (p=0.600), hemoglobin (p=0.926), and hematocrit (p=0.877) did not differ significantly between the groups.

Table 1. Characteristics of Patients Receiving Red Blood Cell Transfusion

	n=23
Sex, n (%)	
Male	10(%43.5)
Female	13(%56.5)
Age, median (range)	75(23-87)
Age group, n (%)	
80-89	7(%30.4)
70-79	7(%30.4)
60-69	2(%8.7)
50-59	1(%4.3)
40-49	2(%8.7)
30-39	1(%4.3)
20-29	3(%13)
Blood group, n (%)	
A Rh(+)	11(%47.8)
B Rh(+)	3 (%13)
O Rh(+)	8(%34.8)
A Rh(-)	1(%4.3)
RBC storage duration (days)[a]	8(1-26)
RBC storage duration, n (%)	
<14 days	14(%60.9)
≥14 days	9(%39.1)
Indication for transfusion, n (%)	
Symptomatic anemia	15(%65.2)
Upper GI bleeding[b]	5(%21.7)
Lower GI bleeding[b]	1(%4.3)
Trauma-related active bleeding	2(%8.7)
Presenting complaint/reason for ED admission, n (%)	
Weakness	11(%47.8)
Palpitations	1 (%4.3)
Dyspnea	2(%8.7)
Syncope	2(%8.7)
Altered mental status	3(%13)
Seizure	1 (%4.3)
Abdominal pain	1 (%4.3)
Nausea/vomiting (non-bloody)	3(%13)
Hematemesis	3(%13)
Hematochezia	2(%8.7)
Melena	3(%13)
Hemoptysis	1 (%4.3)
Forearm laceration	2(%8.7)

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Table 2. Comparison of Clinical Parameters Before and After Red Blood Cell Transfusion

Clinical parameter	Pre-transfusion value	Post-transfusion value	p value
Potassium (mmol/L)[1]	3.9 (3.2-5.3)	4 (3.4-5.5)	0.007a
pH[2]	7.39 ± 0.05	7.39 ± 0.03	0.693b
Lactate (mmol/L)[1]	2.2 (0.8-7.1)	1.4 (0.6-6.1)	0.001a
Hemoglobin (g/dL)[1]	5.3 (2.4-11.9)	6.9 (3.9-12.8)	<0.001a
Hematocrit (%)[1]	18 (8.2-36)	21 (12.7-38)	<0.001a
[1]Median (minimum–maximum); [2]Mean ± standard deviation aWilcoxon signed-rank test; bPaired-samples t-test			

Table 3. Comparison of Clinical Parameters Before and After Transfusion in Patients Receiving RBCs Stored for <14 Days

Clinical parameter	Pre-transfusion value[1]	Post-transfusion value[1]	p value[a]
Potassium (mmol/L)	3.9 (3.4-5.3)	4.05 (3.4-5.5)	0.063
pH	7.40 (7.27-7.50)	7.39 (7.32-7.47)	0.665
Lactate (mmol/L)	2.3 (1-7.1)	1.25 (0.6-6.1)	<0.001
Hemoglobin (g/dL)	4.2 (2.4-9.3)	5.85 (3.9-9)	0.001
Hematocrit (%)	13.5 (8.2-29)	19 (12.7-28.1)	0.001
[1]Median (minimum–maximum); aWilcoxon signed-rank test *Time from RBC collection to transfusion			

Table 4. Comparison of Clinical Parameters Before and After Transfusion in Patients Receiving RBCs Stored for ≥14 Days

Clinical parameter	Pre-transfusion value[1]	Post-transfusion value[1]	p value[a]
Potassium (mmol/L)	3.8 (3.2-4.5)	3.9 (3.4-5.5)	0.049
pH	7.38 (7.29-7.44)	7.4 (7.33-7.42)	0.107
Lactate (mmol/L)	1.5 (0.8-4)	1.7 (0.7-2.7)	0.110
Hemoglobin (g/dl)	7.1 (4.2-11.9)	8.3 (6-12.8)	0.008
Hematocrit (%)	22.1 (13.4-36)	25.8 (18.8-38)	0.008
[1]Median (minimum–maximum); aWilcoxon signed-rank test *Time from RBC collection to transfusion			

Table 5. Comparison of Changes in Clinical Parameters According to RBC Storage Duration

Clinical parameter	<14 days	≥14 days	p value
Potassium (mmol/L)[1]	0.1((-0.3)-0.6)	0.2((-0.1)-0.6)	0.557a
pH[1]	0.005((-0.18)-0.11)	0.02((-0.03)-0.09)	0.277a
Lactate (mmol/L)[1]	-0.75((-2)-(-0.1))	-0.7((-2.1)-1.1)	0.600a
Hemoglobin (g/dL)[1]	1.35((-0.3)-2.5)	1.3(0.7-2.1)	0.926a
Hematocrit (%)[1]	3.95((-0.9)-7)	3.9(2-6.2)	0.877a
[1]Median (minimum–maximum); aMann–Whitney U test			

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Table 6. Comparison of Changes in Clinical Parameters According to Active Bleeding Status in Patients Receiving RBCs Stored for <14 Days

Clinical parameter	No active bleeding	Active bleeding	p value
Potassium (mmol/L)[1]	0 ((-0.3)-0.6)	0.1 (0-0.3)	0.699a
pH[1]	0 ((-0.1)-0.04)	0.02 ((-0.18)-0.11)	0.518a
Lactate (mmol/L)[1]	-0.6 ((-2)-(-0.2))	-1 ((-1.3)-(-0.1))	0.699a
Hemoglobin (g/dL)[1]	1.4 (0.3-2.5)	1.3 ((-0.3)-1.6)	0.438a
Hematocrit (%)[1]	4.3 (1-7)	3.9 ((-0.9)-5)	0.364a

[1]Median (minimum–maximum); aMann–Whitney U test
***Time from RBC collection to transfusion**

Table 7. Comparison of Changes in Clinical Parameters According to Active Bleeding Status in Patients Receiving RBCs Stored for ≥14 Days

Clinical parameter	No active bleeding	Active bleeding	p value
Potassium (mmol/L)[1]	0.25 (0-0.5)	-0.1 ((-0.1)-0.6)	0.548a
pH[1]	0.025 ((-0.03)-0.09)	0.02 (0.01-0.04)	0.905a
Lactate (mmol/L)[1]	-0.75 ((-1.9)-0.5)	-0.3 ((-2.1)-1.1)	0.905a
Hemoglobin (g/dL)[1]	1.25 (0.7-2.1)	1.8 (0.9-1.8)	0.548a
Hematocrit (%)[1]	3.75 (2.1-6.2)	5.4 (2-6)	0.905a

[1]Median (minimum–maximum); aMann–Whitney U test
***Time from RBC collection to transfusion**

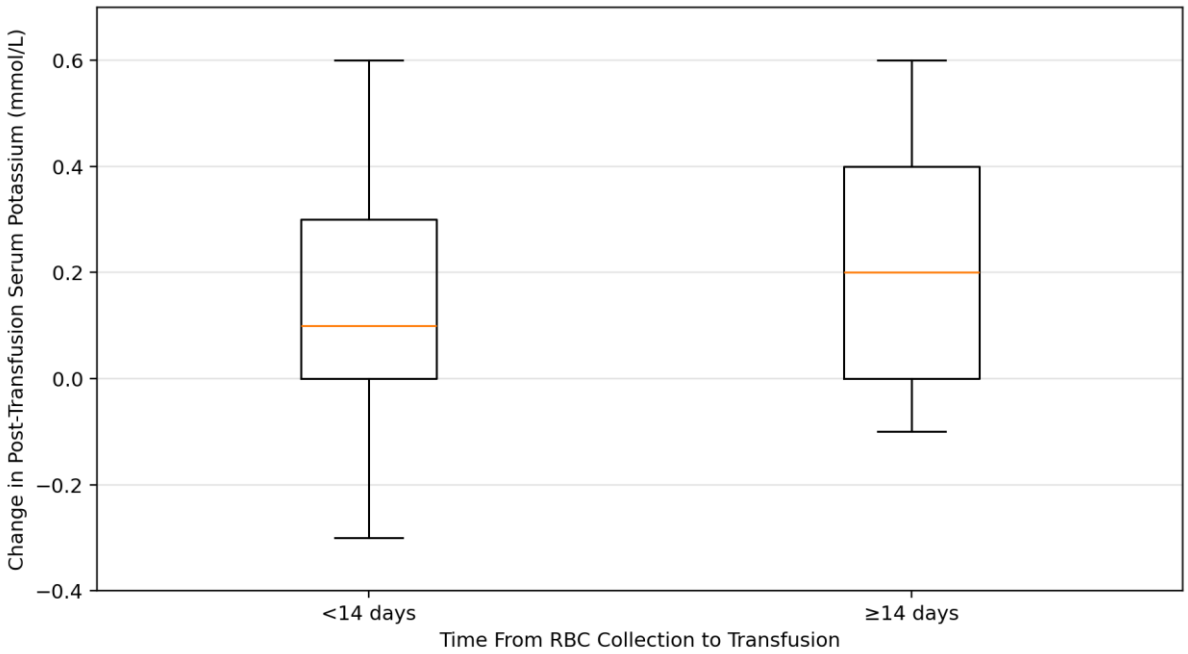

Figure 1. Change in Serum Potassium Levels in Patients Receiving RBCs Stored for <14 Days and ≥14 Days

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Discussions

The present study evaluated early changes in serum potassium and other laboratory parameters following the transfusion of one unit of non-irradiated red blood cells (RBCs), with particular emphasis on RBC storage duration. The principal finding was a small but statistically significant increase in serum potassium in the overall study population following transfusion. When patients were stratified according to storage duration, potassium increased significantly in patients receiving RBCs stored for ≥14 days, whereas the increase did not reach statistical significance in those receiving RBCs stored for <14 days. Importantly, however, the magnitude of potassium change did not differ significantly between the two storage-duration groups. Therefore, our findings suggest an early post-transfusion change in potassium but do not establish that longer RBC storage independently results in a greater potassium increase.

Potassium accumulation is a well-recognized component of the RBC storage lesion. During refrigerated storage, reduced activity of the energy-dependent Na^+/K^+-ATPase and progressive alterations in erythrocyte membrane integrity promote potassium leakage from the intracellular compartment into the extracellular storage medium [15,16]. Previous studies have demonstrated a progressive increase in extracellular potassium concentration with increasing RBC storage duration [17,18]. The thesis data also describe marked increases in potassium concentrations during storage of RBC units preserved with CPDA-1 or SAG-M solutions. These mechanisms provide a biological basis for evaluating storage duration as a potential determinant of post-transfusion potassium changes [18]. In our study, the median serum potassium concentration increased from 3.8 to 3.9 mmol/L in patients receiving RBCs stored for ≥14 days (p=0.049), whereas the change from 3.9 to 4.05 mmol/L among patients receiving RBCs stored for <14 days was not statistically significant (p=0.063). Nevertheless, interpretation of these within-group findings requires caution. Direct comparison of potassium changes between groups showed median increases of 0.1 mmol/L in the <14-day group and 0.2 mmol/L in the ≥14-day group, with no statistically significant difference (p=0.557). Thus, the statistical significance observed within the ≥14-day group should not be interpreted as evidence of a significant difference in the effect of storage duration between groups.

Furthermore, the observed potassium increases were small and did not appear to translate into clinically important electrolyte disturbances in this study. No post-transfusion hyperkalemia or hypokalemia was reported in either storage-duration group. Several mechanisms may explain this observation [19-22]. Following transfusion, restoration of erythrocyte metabolic activity and Na^+/K^+-ATPase function may facilitate intracellular potassium uptake. In addition, renal potassium elimination and redistribution into recipient tissues may limit the increase in circulating potassium [23,24]. These compensatory mechanisms may be sufficient to handle the potassium load associated with a single RBC unit in patients without substantial impairment of potassium homeostasis [25,26].

The clinical situation may differ considerably in patients receiving rapid or massive transfusion. The present study evaluated laboratory changes after one unit of RBCs and therefore cannot be extrapolated directly to massive transfusion protocols [27]. Previous observations cited in the thesis indicate that hyperkalemia may occur when substantially larger amounts of RBCs are administered, although clinically

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relevant consequences are not invariably observed. Accordingly, the effect of storage-related potassium accumulation may be more relevant when multiple units are administered rapidly or when the recipient has limited capacity to tolerate an acute potassium load [28]. An additional finding was the significant reduction in lactate among patients receiving RBCs stored for <14 days, from 2.3 to 1.25 mmol/L ($p<0.001$), whereas no significant change was observed in the ≥14-day group ($p=0.110$). The thesis cites previous evidence suggesting that prolonged RBC storage may influence lactate clearance, particularly in critically ill patients with impaired microcirculation. However, our findings should again be interpreted conservatively because the direct comparison of lactate changes between the two storage groups was not statistically significant ($p=0.600$). Consequently, these results do not demonstrate a storage-duration-dependent effect on lactate clearance. Changes in lactate shortly after transfusion may also reflect several factors unrelated to RBC storage, including the underlying disease, active bleeding, hemodynamic status, tissue perfusion, and concurrent treatment [29,30].

As expected, hemoglobin and hematocrit increased significantly following RBC transfusion. However, the magnitude of these increases did not differ according to storage duration, suggesting that within the storage range examined [31,32], RBC age was not associated with a measurable difference in the immediate hematological response to a single-unit transfusion. Similarly, no relevant association was observed between storage duration and early changes in pH [33].

The findings should be considered in light of several limitations. First, this was a retrospective, single-center study with a small sample size, particularly in the ≥14-day group, which included only nine patients. The limited sample size reduces statistical power and increases the possibility that borderline within-group findings may reflect sampling variability. Second, the study assessed only a single RBC unit and therefore cannot determine the effects of repeated or massive transfusions. Third, potassium concentration in the transfused RBC units was not measured directly; consequently, the actual potassium load administered to each patient remains unknown. Finally, the heterogeneous indications for transfusion and the retrospective design limit control over potential confounding variables affecting potassium and lactate concentrations.

Conclusion

In conclusion, transfusion of one unit of RBCs was associated with a small early increase in serum potassium. Although this increase reached statistical significance within the ≥14-day storage group, the change in potassium was not significantly different between patients receiving RBCs stored for <14 days and those receiving RBCs stored for ≥14 days. Therefore, the present data do not support a definitive storage-duration effect on early post-transfusion serum potassium. Larger prospective studies incorporating direct measurement of RBC-unit potassium concentrations and including patients receiving multiple transfusions are needed to clarify the clinical relevance of storage-related potassium exposure.

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Doi: 10.66288/actamedi.2026.147

References

1. Boddy, K., King, P. C., Hume, R., & Weyers, E. (1972). The relation of total body potassium to height, weight, and age in normal adults. Journal of Clinical Pathology, 25, 512.

2. Bennett-Guerrero, E., Veldman, T. H., Doctor, A., Telen, M. J., Ortel, T. L., Reid, T. S., et al. (2007). Evolution of adverse changes in stored RBCs. Proceedings of the National Academy of Sciences of the United States of America, 104, 17063–17068. https://doi.org/10.1073/pnas.0708160104

3. Klein, H. G., & Anstee, D. J. (2005). Mollison's blood transfusion in clinical medicine (11th ed.). Blackwell Publishing.

4. Sezdi, M., Bayik, M., & Ulgen, Y. (2006). Storage effects on the Cole-Cole parameters of erythrocyte suspensions. Physiological Measurement, 27, 623–635.

5. Gibson, J. G., II, & Peacock, W. C. (1947). The rate of post-transfusion loss of non-viable stored human erythrocytes and the reutilization of hemoglobin-derived radioactive iron. Journal of Clinical Investigation, 26, 739–746.

6. Weiskopf, R. B., Schnapp, S., Rouine-Rapp, K., Bostrom, A., Toy, P., & Feiner, J. (2005). Extracellular potassium concentrations in red blood cell suspensions after irradiation and washing. Transfusion, 45, 1295–1301.

7. Davey, R. J., McCoy, N. C., Yu, M., Sullivan, J. A., Spiegel, D. M., & Leitman, S. F. (1992). The effect of prestorage irradiation on posttransfusion red cell survival. Transfusion, 32, 525–528.

8. Vraets, A., Lin, Y., & Callum, J. L. (2011). Transfusion-associated hyperkalemia. Transfusion Medicine Reviews, 25, 184–196.

9. Hall, J. E., & Hall, M. E. (2021). Guyton and Hall textbook of medical physiology (14th ed.). Elsevier.

10. Rose, B. D., & Post, T. W. (2001). Clinical physiology of acid-base and electrolyte disorders (5th ed.). McGraw-Hill.

11. Gennari, F. J. (1998). Hypokalemia. The New England Journal of Medicine, 339, 451–458.

12. Stanton, B. A. (1989). Renal potassium transport: Morphological and functional adaptation. American Journal of Physiology, 257, F989–F997.

13. Morgan, D. B., & Young, R. M. (1982). Acute transient hypokalemia: New interpretation of a common event. The Lancet, 2, 751–752.

14. Brown, M. J., Brown, D. C., & Murphy, M. B. (1983). Hypokalemia from beta2-receptor stimulation by circulating epinephrine. The New England Journal of Medicine, 309, 1414–1419.

15. Lipworth, B. J., McDevitt, D. G., & Struthers, A. D. (1989). Prior treatment with diuretic augments the hypokalemic and electrocardiographic effects of inhaled albuterol. American Journal of Medicine, 86, 653–657.

16. Braden, G. L., Von Oeyen, P. T., Germain, M. J., et al. (1997). Ritodrine- and terbutaline-induced hypokalemia in preterm labor: Mechanism and consequences. Kidney International, 51, 1867–1875.

17. Reid, J. L., Whyte, K. F., & Struthers, A. D. (1986). Epinephrine-induced hypokalemia: The role of beta adrenoceptors. American Journal of Cardiology, 57, 23–27.

18. Smellie, W. S. A. (2007). Spurious hyperkalaemia. BMJ, 334, 693.

19. Bashour, T., Hsu, I., Gorfinkel, H. J., et al. (1975). Atrioventricular and

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Doi: 10.66288/actamedi.2026.147

intraventricular conduction in hyperkalemia. American Journal of Cardiology, 35, 199.

20. Mattu, A., Brady, W. J., & Robinson, D. A. (2000). Electrocardiographic manifestations of hyperkalemia. American Journal of Emergency Medicine, 18, 721–729.

21. Winkler, A. W., Hoff, H. E., & Smith, P. K. (1939). Factors affecting the toxicity of potassium. American Journal of Physiology, 127, 430.

22. Braun, H. A., Van Horne, R., Bettinger, J. C., & Bellet, S. (1955). The influence of hypocalcemia induced by sodium ethylenediamine tetraacetate on the toxicity of potassium: An experimental study. Journal of Laboratory and Clinical Medicine, 46, 544.

23. Cid, J. (2016). Transfusion of irradiated red blood cell units with a potassium adsorption filter: A randomized controlled trial. Transfusion, 56, 1046.

24. Raza, S., Baig, M. A., Chang, C., Dabas, R., Akhtar, M., Khan, A., et al. (2015). A prospective study on red blood cell transfusion related hyperkalemia in critically ill patients. Journal of Clinical Medicine Research, 7, 417–421.

25. Livingston, M. H., Singh, S., & Merritt, N. H. (2014). Massive transfusion in paediatric and adolescent trauma patients: Incidence, patient profile, and outcomes prior to a massive transfusion protocol. Injury, 45, 1301–1306.

26. Lee, A. C., Reduque, L. L., Luban, N. L. C., Ness, P. M., Anton, B., & Heitmiller, E. S. (2014). Transfusion-associated hyperkalemic cardiac arrest in pediatric patients receiving massive transfusion. Transfusion, 54, 244–254.

27. Demirtunç, R., et al. (2015). Effect of transfusion of washed red blood cells on serum potassium level in hemodialysis patients. Turkish Journal of Medical Sciences, 45, 407–411.

28. Antwi-Baffour, S., et al. (2019). A study of the change in sodium and potassium ion concentrations in stored donor blood and their effect on electrolyte balance of recipients.

29. Aboudara, M. C., et al. (2008). Hyperkalemia after packed red blood cell transfusion in trauma patients.

30. Koch, C. G., Li, L., Sessler, D. I., Figueroa, P., Hoeltge, G. A., Mihaljevic, T., & Blackstone, E. H. (2008). Duration of red-cell storage and complications after cardiac surgery. The New England Journal of Medicine, 358, 1229–1239.

31. Adams, F., Bellairs, G., Bird, A. R., & Oguntibeju, O. O. (2015). Biochemical storage lesions occurring in nonirradiated and irradiated red blood cells: A brief review. BioMed Research International, 2015, 968302. https://doi.org/10.1155/2015/968302

32. Yoshida, T., Prudent, M., & D'Alessandro, A. (2019). Red blood cell storage lesion: Causes and potential clinical consequences. Blood Transfusion, 17, 27–52.

33. Hess, J. R. (2010). Red cell changes during storage. Transfusion and Apheresis Science, 43(1), 51–59.

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