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# Early versus delayed post-transfusion hemoglobin and hematocrit measurement in adults: a narrative review

## Medición temprana versus tardía de hemoglobina y hematocrito postransfusión en adultos: una revisión narrativa

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### *Abstract*

Delaying the measurement of a complete blood count (CBC) for 6 to 24 hours after red blood cell transfusion remains a common practice in hospitals worldwide, despite the absence of strong physiological or empirical justification. This narrative review summarizes the available clinical evidence comparing early versus delayed post-transfusion evaluation of hemoglobin (Hb) and hematocrit (Hct) levels in adult patients. Studies conducted in the United States, Spain, Colombia, and Thailand, including more than 290 hemodynamically stable, non-bleeding adults, assessed Hb and Hct levels at different intervals ranging from 15 minutes to 24 hours after transfusion. Across all studies, early post-transfusion measurements showed no statistically significant differences when compared with delayed testing, demonstrating that Hb and Hct values stabilize rapidly within 15 to 60 minutes following transfusion. These findings refute the traditional assumption that several hours are required for equilibration. Implementing early CBC testing provides accurate results, enables prompt assessment of transfusion efficacy, reduces unnecessary delays in clinical decision-making, and improves hospital workflow efficiency. Therefore, early measurement of Hb and Hct is safe, reliable, and cost-effective in stable adult patients.

### *Resumen*

Retrasar la medición de la biometría hemática completa (BHC) durante un periodo de 6 a 24 horas después de una transfusión de concentrados eritrocitarios continúa siendo una práctica frecuente en los hospitales, a pesar de carecer de un sustento fisiológico o empírico sólido. La presente revisión narrativa resume la evidencia clínica disponible que compara la evaluación temprana frente a la diferida de los niveles de hemoglobina (Hb) y hematocrito (Hct) en pacientes adultos. Los estudios realizados en Estados Unidos, España, Colombia y Tailandia, con una muestra combinada superior a 290 adultos hemodinámicamente estables y sin sangrado activo, midieron los niveles de Hb y Hct en intervalos que oscilaron entre 15 minutos y 24 horas después de la transfusión. En todos los trabajos, las mediciones tempranas no mostraron diferencias estadísticamente significativas en comparación con las tardías, lo que demuestra que los valores de Hb y Hct se estabilizan rápidamente, dentro de los primeros 15 a 60 minutos posteriores a la transfusión. Estos resultados contradicen la creencia tradicional de que es necesario esperar varias horas para alcanzar el equilibrio. Por lo tanto, la medición temprana de Hb y Hct es segura, confiable y rentable en pacientes adultos estables.

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## Introduction

In daily hospital practice, it is common for clinicians to delay obtaining a complete blood count (CBC) for six to twenty-four hours following a red blood cell (RBC) transfusion. This delay is often justified by the assumption that newly transfused erythrocytes require several hours to equilibrate within the intravascular space before hemoglobin (Hb) and hematocrit (Hct) levels accurately reflect post-transfusion status. Many institutions have incorporated this delay into their transfusion protocols, largely as a matter of tradition and anecdotal reasoning rather than evidence-based practice.

Physiologically, this rationale is weak. In adults with normal cardiac output, blood circulates through the entire vascular system in less than a minute, allowing for rapid distribution of transfused erythrocytes.[1] Multiple studies over the past three decades have demonstrated that, in hemodynamically stable, non-bleeding adults, Hb and Hct levels reach equilibrium within minutes after transfusion. Despite this consistent evidence, the belief that several hours are required for stabilization remains entrenched in clinical routines, leading to unnecessary diagnostic delays and potential inefficiencies in patient care.

A 67-year-old man was admitted with symptomatic anemia secondary to chronic kidney disease illustrates this issue. On admission, his hemoglobin level was 6.2 g/dL, and he remains hemodynamically stable with no signs of bleeding. After transfusion of one unit of packed red blood cells, the medical team delays ordering a CBC for six hours to "*allow equilibration*" of Hb and Hct levels. During this interval, the patient continues to experience fatigue and lightheadedness, prompting extended observation and delaying further management decisions.

This case exemplifies a routine but low-value hospital practice, delaying post-transfusion CBC measurement based on the misconception that several hours are necessary for red cell equilibration. Physiological and clinical evidence demonstrate that intravascular mixing occurs rapidly, rendering early post-transfusion testing both accurate and clinically meaningful. Nevertheless, this outdated approach remains embedded in many hospital protocols, highlighting a persistent gap between evidence and everyday clinical practice.

## Development

Anemia continues to represent a significant global public health concern, affecting approximately 25% of the population worldwide across both developed and developing regions. Iron deficiency anemia is the most common subtype, predominantly affecting women of reproductive age, who account for approximately 50% of cases.[2,3] In hospitalized patients, prevalence rates as high as 50% have been reported.[4]

The most common causes include iron deficiency due to blood loss or nutritional deficiency, anemia of chronic disease, hereditary disorders, and infectious conditions, among others.[5,6]

Packed red blood cell transfusion remains a fundamental component of inpatient management for acute anemia, traumatic injuries, and obstetric or surgical hemorrhage.[7,8]

The transfusion of erythrocyte concentrates restores oxygen-carrying capacity and is indicated for the treatment of acute hemorrhage and symptomatic anemia. Its primary goal is to prevent tissue hypoxia by improving oxygen transport and utilization, and transfusion decisions should always be guided by the patient's overall clinical condition rather than hemoglobin level alone.[9,10] Although the decision to transfuse blood components ultimately depends on the individualized characteristics of each patient,[11] a restrictive transfusion strategy is recommended, reducing by up to 41% the number of patients exposed to blood products.[12]

Current American Association of Blood Banks (AABB) guidelines recommend restrictive transfusion thresholds: Hb < 7 g/dL for stable hospitalized adults and Hb < 8 g/dL for patients with cardiovascular disease or those undergoing orthopedic or cardiac surgery.[13] In non-bleeding adults, transfusion of one unit of RBCs typically increases Hb by approximately 1 g/dL and hematocrit by approximately 3%.[14,15]

Despite standardized guidelines, many clinicians continue to delay post-transfusion CBC measurement for 6 to 24 hours, assuming that early results may underestimate the "*true*" hemoglobin increment. This belief persists despite the absence of physiological or empirical justification.

The rationale stems from the assumption that red blood cells require several hours to distribute evenly within the intravascular compartment and that hemoglobin stabilization occurs only after 24 hours. Clinicians may fear that immediate measurements will underestimate Hb increments, potentially leading to unnecessary repeat transfusions. Institutional norms and anecdotal experiences further reinforce this perception.[16]

## Methodology

A narrative literature review was conducted to evaluate the evidence regarding the optimal timing of Hb and

Hct measurement following packed red blood cell transfusion. The literature search included studies published from January 1990 to June 2025 in PubMed (MEDLINE), Google Scholar, and ScienceDirect. The search strategy incorporated the keywords: *"hemoglobin", "hematocrit", "transfusion", "red blood cells", "equilibration", "stability", "comparison"* and *"early changes"*, as well as their spanish equivalents.

Original studies were included if they provided empirical data on Hb and Hct equilibration kinetics in hemodynamically stable adult patients without active bleeding. Preference was given to studies comparing early (≤ 60 minutes) versus delayed (≥ 6 hours) post-transfusion measurements.

Studies were excluded if they focused on pediatric or obstetric populations, patients with active hemorrhage or severe hemodynamic instability, or reports lacking explicit outcome reporting.

## Results

A total of five original studies published between 1994 and 2020 met the inclusion criteria and were included in this review. These investigations, conducted in the United States, Spain, Colombia, and Thailand, collectively analyzed 293 adult patients who received packed red blood cell transfusions.

Evidence spanning more than three decades consistently demonstrates no statistically significant differences in Hb or Hct levels when measured within minutes versus several hours after transfusion in hemodynamically stable adults without active bleeding, hemolytic anemia, or other acute events. Table 1 summarizes the evidence from the included studies.

- Wiesen *et al.* (1994, USA): This prospective study included 39 patients without active bleeding who received a two-unit erythrocyte transfusion. Hb measurements obtained at 15 minutes, 1 hour, 2 hours, and 24 hours post-transfusion showed no significant differences ($p = 0.82$).[17]

- Elizalde *et al.* (1997, Spain): This study evaluated 32 normovolemic patients with resolved gastrointestinal bleeding. Hb and Hct measurements obtained at 15 and 30 minutes, 1, 2, and 24 hours after a two-unit transfusion revealed no significant changes ($p = 0.40$), with excellent concordance between the 15-minute and 24-hour values.[18]

- Pardo *et al.* (2010, Colombia): In a concordance study involving 41 non-bleeding patients, Hb and Hct measurements at 15 minutes and 6 hours post-transfusion demonstrated statistically significant concordance ($p < 0.0001$).[19]

- García Habeych *et al.* (2019, Colombia): This prospective cohort study included 121 non-bleeding patients. The difference in Hb concentration between the 1-hour and 6-hour measurements was minimal and not statistically significant ($p = 0.94$), confirming Hb stability over time.[20]

- Karndumri *et al.* (2020, Thailand): This prospective study evaluated 60 patients without active bleeding or hemolysis. Hb and Hct measurements at 1, 4, and 24 hours after transfusion of one erythrocyte unit showed no significant differences ($p = 0.109$). The authors concluded that Hb and Hct levels can be reliably assessed as early as one hour after transfusion.[21]

The hospital settings in which blood component transfusions are most frequently required include inpatient wards, emergency departments, and operating rooms, reflecting the substantial healthcare burden associated with their use.[22] Inappropriate use of blood components increases the risk of complications and mortality and represents an additional financial burden for healthcare institutions, making rational utilization a clinical priority.[23,24]

In this context, the widespread practice of delaying post-transfusion CBC testing for 6 to 24 hours lacks both physiological and empirical justification. On the contrary, such delays prolong hospitalization and hinder timely clinical decision-making. Physiological evidence demonstrates that, with a normal cardiac output of 4–8 L/min, transfused erythrocytes rapidly mix within the intravascular compartment, achieving stable concentrations within minutes in the absence of ongoing bleeding or hemolysis.[25,26] Consequently, early post-transfusion CBC measurement is both safe and clinically useful.

Multiple studies conducted across different countries consistently demonstrate that hemoglobin and hematocrit levels stabilize within 15 to 60 minutes after transfusion. The remarkable concordance of findings across diverse populations and clinical contexts supports the generalizability of early post-transfusion testing.

From a resource-efficiency perspective, early measurement prevents unnecessary repeat testing and avoids prolonged hospitalizations. These recommendations apply exclusively to stable adult patients without active bleeding. In cases of ongoing hemorrhage, hypovolemic shock, hemolysis, or hemodynamic instability, equilibration dynamics may differ, requiring individualized monitoring. Furthermore, extrapolation of these findings to pediatric populations[27,28] or pregnant women[29] is inappropriate due to distinct physiological characteristics.

Among the limitations of the available evidence are the

**Table 1** Summary of Included Studies

| Year | Author | *n* | Country | Post-transfusion timing | *p*-value | Statistical test | Correlation coefficient |
|---|---|---|---|---|---|---|---|
| 1994 | Wiesen *et al.*[17] | 39 | USA | 15 min / 1 h / 2 h / 24 h | 0.82 | ANOVA | 0.93 |
| 1997 | Elizalde *et al.*[18] | 32 | Spain | 15 min / 30 min / 1 h / 2 h / 24 h | 0.40 | ANOVA | 0.91 |
| 2010 | Pardo *et al.*[19] | 41 | Colombia | 15 min / 6 h | < 0.0001 | Concordance | 0.97 |
| 2019 | García *et al.*[20] | 121 | Colombia | 1 h / 6 h | 0.94 | Student t-test | 0.95 |
| 2020 | Karndumri *et al.*[21] | 60 | Thailand | 1 h / 4 h / 24 h | 0.109 | ANOVA | 0.92 |

relatively small sample sizes and the absence of large multicenter randomized trials. Future research should evaluate not only clinical outcomes but also cost reduction and hospital length of stay associated with early post-transfusion testing.

Overall, the available data support the conclusion that delaying post-transfusion CBC measurement lacks clinical justification and should be considered obsolete. Systematic adoption of early testing would enable faster, safer, and more cost-effective clinical decision-making, thereby optimizing hospital care.

Hospitals should revise transfusion protocols to adopt early post-transfusion CBC measurement as the standard of care for stable adult patients without active bleeding. CBC testing should be performed 15–60 minutes after transfusion to reduce delays, minimize repeat testing, shorten hospital stays, and optimize resource utilization. Future multicenter studies are warranted to assess the impact of this practice on clinical outcomes, cost-effectiveness, and workflow efficiency across diverse healthcare settings.

## Limitations

Although available evidence consistently supports the rapid stability of hemoglobin and hematocrit levels after transfusion, several methodological limitations must be acknowledged. Most studies were single-center investigations with relatively small sample sizes, potentially limiting statistical power. Additionally, study populations varied in baseline diagnoses, transfusion volumes, and laboratory measurement techniques, introducing potential confounding factors. Despite these limitations, the consistency of findings across diverse settings strengthens the conclusion that early post-transfusion testing provides clinically reliable results in stable, non-bleeding adults.

## Conclusion

Current evidence suggests that delaying CBC measurement after red blood cell transfusion in stable adults offers limited clinical value. Available studies indicate that hemoglobin and hematocrit levels stabilize within minutes, supporting the utility of early post-transfusion testing for timely and efficient patient management. While further research is warranted to confirm these findings in larger and more diverse populations, revising entrenched transfusion protocols may improve clinical efficiency and optimize patient care.


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