

Haematological Response to Therapeutic Phlebotomy in Patients with Erythrocytosis: A Retrospective Cohort Study Of 134 Patients at a Tertiary Care Centre

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Abstract

Background: Therapeutic phlebotomy is used to manage selected conditions associated with erythrocytosis and iron overload. Although its clinical role is established in specific indications, the magnitude of haematological response and treatment patterns in routine tertiary-care practice require evaluation in appropriately characterised patient cohorts.

Objective: To evaluate changes in haemoglobin and haematocrit following therapeutic phlebotomy and to describe treatment characteristics and associated changes in blood volume and plasma volume among patients treated at a tertiary-care centre.

Methods: This retrospective cohort study included 134 patients who underwent therapeutic phlebotomy between January 2022 and December 2023. Clinical records were reviewed for patient characteristics, indications for treatment, number of procedures, volume of blood removed, and available pre- and post-treatment laboratory measurements. Paired outcome comparisons were performed using appropriate statistical methods. The study was reported in accordance with the STROBE recommendations for observational research.

Results: The mean haemoglobin decreased from 17.6 ± 1.6 to 17.2 ± 1.7 g/dL, while mean haematocrit decreased from $54.2 \pm 4.6\%$ to $52.6 \pm 4.7\%$. Mean blood volume decreased from 69.4 ± 4.0 to 66.6 ± 4.5 mL/kg, and mean plasma volume changed from 31.6 ± 3.5 to 31.5 ± 3.9 mL/kg. Paired statistical analyses, effect estimates and confidence intervals are required to establish the precision and statistical significance of these changes.

Conclusion: The observed pre- and post-treatment differences suggest a reduction in haemoglobin, haematocrit and estimated or measured blood volume following therapeutic phlebotomy. The clinical significance of these changes and their relationship to diagnosis-specific treatment targets require further evaluation.

Keywords: Therapeutic phlebotomy; Erythrocytosis; Polycythaemia; Haemoglobin; Haematocrit; Retrospective cohort study

1. Introduction

Erythrocytosis is characterised by an increase in haemoglobin concentration and/or haematocrit and may result from primary haematological disorders or secondary causes, including chronic hypoxia, medication use and other underlying conditions (Gangat et al., 2023). Polycythaemia vera (PV) is a clonal myeloproliferative neoplasm, usually associated with JAK2 mutations, that increases the risk of arterial and venous thrombosis, bleeding and disease progression (Harrison et al., 2025; Tefferi & Barbui, 2023). Consequently, appropriate diagnosis, risk stratification and management are essential to reduce complications and improve clinical outcomes.

Therapeutic phlebotomy (TP) involves the controlled removal of blood to reduce circulating red-cell mass or body iron stores, depending on the underlying indication. It is a cornerstone of PV management, with a recommended haematocrit target below 45%, generally alongside low-dose aspirin when not contraindicated (Tefferi & Barbui, 2023; Tremblay et al., 2025). TP is also used in selected cases of secondary erythrocytosis and in iron-overload disorders, including hereditary haemochromatosis and porphyria cutanea tarda (Leaf & Dickey, 2024; Palmer & Stancampiano, 2025). However, its indications and treatment targets are not interchangeable across conditions. In non-PV erythrocytosis, indiscriminate phlebotomy may be inappropriate, and treatment should be guided by the underlying cause and potential symptomatic benefit (Gangat et al., 2023). Individualised prescriptions, appropriate procedural monitoring and reliable clinical documentation are therefore important components of TP practice (Peedin & Karp, 2021).

Previous studies have investigated the haematological effects and clinical applications of TP. In a prospective longitudinal study involving 26 patients, Bhatia et al. (2023) reported significant reductions in haemoglobin and

haematocrit following serial phlebotomy using a fixed-volume and fixed-interval protocol, accompanied by improvements in reported symptoms. Gupta et al. (2024), in a five-year retrospective study at a tertiary-care hospital in Navi Mumbai, examined TP indications and laboratory responses among 150 patients and reported reductions in haemoglobin and haematocrit with increasing treatment sessions. Das et al. (2018) specifically investigated plasma-volume changes in patients undergoing TP, highlighting the relevance of assessing volume-related parameters alongside conventional haematological measurements. More recently, Dhiman et al. (2026) analysed 272 procedures in 174 patients and examined differences between primary and secondary erythrocytosis, procedural characteristics, laboratory responses, adverse events and follow-up. Collectively, these studies demonstrate the clinical relevance of evaluating treatment response while also highlighting the importance of diagnostic classification and comprehensive outcome assessment.

Despite this evidence, comparisons between institutional cohorts require careful consideration of differences in patient characteristics, indications, treatment protocols, measurement methods and follow-up. Changes in group-average haemoglobin or haematocrit alone do not establish whether individual patients achieve diagnosis-specific treatment targets or experience improved symptoms, fewer adverse events or reduced long-term complications. Furthermore, blood-volume and plasma-volume findings require clear documentation of measurement methods and appropriate statistical analysis.

The present retrospective study evaluated patients who underwent TP at a tertiary-care centre between January 2022 and December 2023. The primary objective was to assess paired changes in haemoglobin and haematocrit before and after treatment. Secondary objectives were to describe treatment indications and characteristics and to evaluate changes in blood volume and plasma volume, where valid measurements were available. By characterising these outcomes in a routine-care setting, the study aims to contribute institution-specific evidence on TP practice and identify opportunities for improving clinical documentation, monitoring and future outcome assessment.

2. Materials and Methods

2.1. Study Design and Setting

A retrospective observational study was conducted at a tertiary care centre to evaluate the clinical applications of therapeutic phlebotomy and associated changes in selected laboratory and blood-volume parameters. The study covered the period from January 2022 to December 2023. Data were obtained retrospectively from hospital medical records of patients who underwent therapeutic phlebotomy during the study period.

2.2. Study Population and Sample Size

The study included 134 patients who underwent therapeutic phlebotomy at the tertiary care centre between January 2022 and December 2023. Patient records were retrospectively reviewed to obtain relevant clinical and laboratory information for evaluating the study parameters before and after therapeutic phlebotomy.

2.3. Data Collection

Clinical and laboratory information was retrospectively retrieved from hospital medical records for the 134 patients who underwent therapeutic phlebotomy during the study period. The data collected included the indications for therapeutic phlebotomy, number of treatment sessions, volume of blood removed per session, and laboratory and physiological parameters recorded before and after treatment. The collected information was used to evaluate changes in haemoglobin, haematocrit, blood volume, and plasma volume following therapeutic phlebotomy.

2.4. Therapeutic Phlebotomy and Outcome Measures

Therapeutic phlebotomy was the intervention evaluated in this study. The primary parameters assessed were haemoglobin concentration (Hb) and haematocrit (Hct), while blood volume (BV) and plasma volume (PV) were evaluated as additional parameters. Pre-treatment and post-treatment values were compared to assess changes in these parameters following therapeutic phlebotomy. The number of treatment sessions and the volume of blood removed per session were also recorded from the available hospital medical records.

2.5. Statistical Analysis

Descriptive statistics were used to summarise the study variables. Continuous variables were expressed as mean $\pm$ standard deviation (SD). Pre-treatment and post-treatment values of haemoglobin (Hb), haematocrit (Hct), blood volume (BV), and plasma volume (PV) were compared to describe the changes observed following therapeutic phlebotomy.

2.6. Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. The study procedures were carried out in accordance with the applicable institutional ethical requirements.

3. Results

3.1. Overview of the Study Population

The present retrospective study evaluated changes in selected laboratory and blood-volume parameters among 134 patients who underwent therapeutic phlebotomy at a tertiary care centre between January 2022 and December 2023. The analysis focused on four parameters: haemoglobin concentration (Hb), haematocrit (Hct), blood volume (BV), and plasma volume (PV). The mean values and standard deviations recorded before and after therapeutic phlebotomy were used to describe the observed changes associated with the procedure. The comparative results are presented in Table 1 and Figure 1.

3.2. Changes in Haemoglobin Concentration

The mean haemoglobin concentration before therapeutic phlebotomy was 17.6 ± 1.6 g/dL. Following treatment, the mean value decreased to 17.2 ± 1.7 g/dL. The absolute difference between the reported pre-treatment and post-treatment means was 0.4 g/dL, representing an approximately 2.3% reduction relative to the baseline mean. This decrease indicates that the post-treatment group mean haemoglobin concentration was lower than the corresponding pre-treatment value. The standard deviation increased slightly from 1.6 g/dL before treatment to 1.7 g/dL after treatment. This describes the variability around the respective group means but does not establish whether individual patients experienced similar reductions. The available summary data demonstrate a modest decrease in mean haemoglobin concentration following therapeutic phlebotomy. However, the statistical significance of this difference cannot be determined without the appropriate paired statistical analysis.

3.3. Changes in Haematocrit

The mean haematocrit value decreased from $54.2 \pm 4.6\%$ before therapeutic phlebotomy to $52.6 \pm 4.7\%$ after treatment. The absolute reduction was 1.6 percentage points, corresponding to an approximately 3.0% decrease relative to the pre-treatment mean. Among the four parameters evaluated, haematocrit showed a clearer numerical reduction than haemoglobin when expressed as a percentage of its baseline mean. The standard deviation increased slightly from 4.6 to 4.7 percentage points following treatment. These descriptive findings indicate a lower mean haematocrit after therapeutic phlebotomy, accompanied by a small increase in the variability of the recorded values. Nevertheless, the reported means alone do not establish whether the reduction was statistically significant or whether patients achieved specific diagnosis-dependent treatment targets. Such conclusions require individual-level results and appropriate statistical testing.

3.4. Changes in Blood Volume

The mean blood volume decreased from 69.4 ± 4.0 mL/kg before treatment to 66.6 ± 4.5 mL/kg after therapeutic phlebotomy. The absolute difference between the reported means was 2.8 mL/kg, representing an approximately 4.0% reduction from baseline. Numerically, this was the largest relative decrease among the four parameters assessed. The standard deviation increased from 4.0 to 4.5 mL/kg after treatment, indicating greater dispersion around the post-treatment mean. The observed reduction in mean blood volume occurred alongside the decreases in haemoglobin and haematocrit. However, the available summary statistics do not establish a direct relationship between changes in these parameters or demonstrate that the reduction in blood volume was caused exclusively by therapeutic phlebotomy. Interpretation also depends on the method used to measure or estimate blood volume and the timing of the post-treatment assessment.

3.5. Changes in Plasma Volume

In contrast to the reductions observed in haemoglobin, haematocrit, and blood volume, the mean plasma volume showed minimal numerical change. The pre-treatment mean was 31.6 ± 3.5 mL/kg, compared with 31.5 ± 3.9 mL/kg after treatment. The absolute difference was 0.1 mL/kg, corresponding to an approximately 0.3% decrease relative to baseline. The standard deviation increased from 3.5 to 3.9 mL/kg, suggesting greater variability around the post-treatment mean. Although the group-average plasma volume remained relatively similar before and after treatment, this finding does not demonstrate that plasma volume was unchanged in every patient. Individual responses may differ, and the available aggregate data do not permit assessment of those differences.

3.6. Overall Comparison of Pre-treatment and Post-treatment Parameters

Taken together, the reported descriptive results showed decreases in mean haemoglobin, haematocrit, and blood volume following therapeutic phlebotomy, while mean plasma volume remained relatively stable. The corresponding absolute changes were -0.4 g/dL, -1.6 percentage points, -2.8 mL/kg, and -0.1 mL/kg, respectively. These differences are summarised in Table 1 and illustrated in Figure 1. The findings provide a descriptive account of changes in the selected parameters among the study population. However, in the absence of verified inferential statistical results, they should not be interpreted as evidence of statistically significant treatment effects. The available results also do not establish changes in symptoms, complications, adverse events, or long-term clinical outcomes. Further interpretation of the findings should therefore consider the retrospective study design, the methods used to obtain the measurements, and the availability of paired observations for each parameter.

Figure 1. Changes in haemoglobin, haematocrit, blood volume, and plasma volume before and after therapeutic phlebotomy (n = 134).

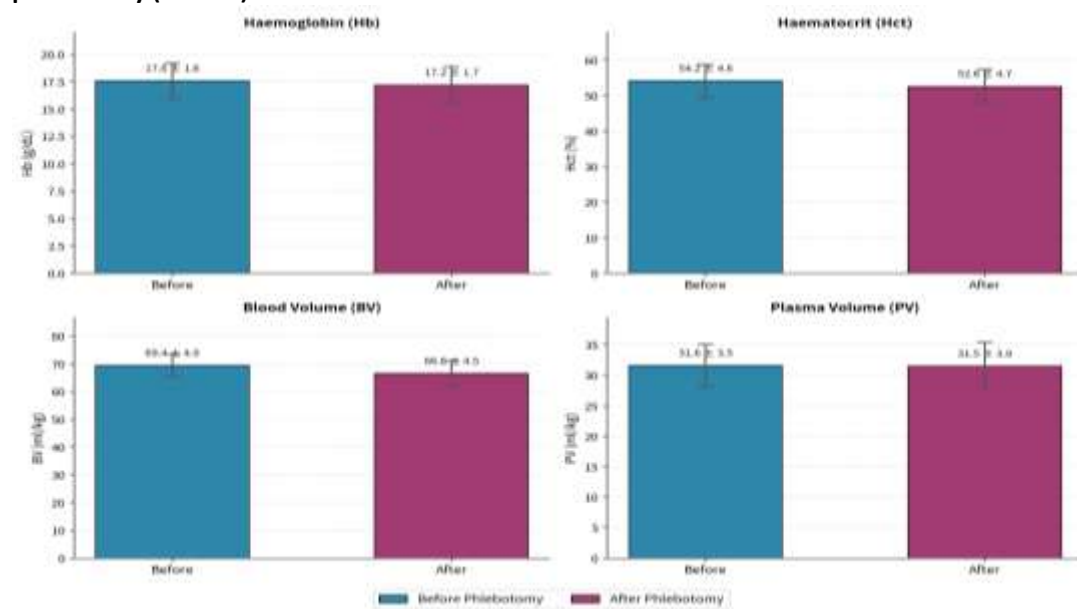


Table 1. Changes in laboratory and blood-volume parameters before and after therapeutic phlebotomy

Parameter	Before phlebotomy (mean ± SD)	After phlebotomy (mean ± SD)	Absolute change
Haemoglobin (g/dL)	17.6 ± 1.6	17.2 ± 1.7	-0.4
Haematocrit (%)	54.2 ± 4.6	52.6 ± 4.7	-1.6 percentage points
Blood volume (mL/kg)	69.4 ± 4.0	66.6 ± 4.5	-2.8
Plasma volume (mL/kg)	31.6 ± 3.5	31.5 ± 3.9	-0.1

Note: Absolute change is calculated as the post-treatment mean minus the pre-treatment mean. SD, standard deviation.

4. Discussion

The present retrospective study evaluated changes in haemoglobin (Hb), haematocrit (Hct), blood volume (BV), and plasma volume (PV) among 134 patients who underwent therapeutic phlebotomy at a tertiary care centre between January 2022 and December 2023. The principal findings were reductions in mean Hb, Hct, and BV after treatment, whereas mean PV remained relatively stable. These observations provide descriptive evidence of changes in selected parameters in routine clinical practice. However, the findings should not be interpreted as proof of statistically significant treatment effects or improved clinical outcomes because verified inferential statistics, individual patient-level changes, and long-term follow-up results were not available.

Mean Hb decreased from 17.6 ± 1.6 to 17.2 ± 1.7 g/dL, while mean Hct declined from $54.2 \pm 4.6\%$ to $52.6 \pm 4.7\%$. These changes are consistent with the expected direction of haematological response following blood removal. Bhatia et al. (2023) reported more substantial reductions in Hb and Hct after serial therapeutic phlebotomy using a fixed-volume and fixed-interval protocol, accompanied by improvements in reported symptoms. Dhiman et al. (2026) similarly documented reductions in these parameters among patients with primary and secondary erythrocytosis. Differences in the magnitude of change between these studies and the present findings may reflect variations in baseline values, treatment frequency, number of procedures, patient characteristics, and assessment timing.

The clinical importance of Hct reduction is particularly evident in polycythaemia vera (PV), a myeloproliferative neoplasm associated with increased thrombotic risk. In the CYTO-PV randomised trial, Marchioli et al. (2013) demonstrated that maintaining Hct below 45% was associated with a lower rate of cardiovascular death and major thrombosis than a less intensive target of 45–50%. This evidence supports the importance of appropriate Hct control in confirmed PV. Nevertheless, the post-treatment mean Hct of 52.6% in the present study does not establish whether individual patients achieved their intended targets. Moreover, the CYTO-PV findings should not be directly extrapolated to all forms of erythrocytosis, because treatment goals depend on the underlying diagnosis and clinical circumstances.

Diagnostic classification is therefore essential when interpreting the observed changes. Mithoowani et al. (2020) emphasised the need to distinguish relative erythrocytosis, caused by reduced plasma volume, from absolute erythrocytosis associated with increased red-cell mass. The diagnostic framework described by Arber et al. (2016) also highlights the importance of distinguishing PV from other myeloid disorders through appropriate clinical, haematological, and molecular assessment. McMullin et al. (2019) further outlined evidence-based recommendations for diagnosing and managing PV. Because the present results do not provide detailed diagnostic subgroup data, it is not possible to determine whether the observed changes differed between primary and secondary erythrocytosis or whether treatment targets were achieved in specific patient groups.

The interpretation of haematological parameters in a tertiary-care setting should consider laboratory quality and the clinical context of the patient population. Previous studies from Saveetha Medical College and Hospital have examined preanalytical errors in haematology and clinical haematological profiles, highlighting the importance of reliable laboratory assessment in patient care (Kani et al., 2024; Yogalakshmi et al., 2024). Related work from the institution has also described therapeutic red-cell exchange in a patient with sickle cell disease, illustrating the role of specialised blood-based interventions in selected clinical settings (Iyyapan et al., 2025). These studies provide institutional context, although their findings should not be interpreted as direct evidence of the effectiveness of therapeutic phlebotomy.

The management of secondary erythrocytosis requires particular caution. Gangat et al. (2023) and O'Neill and O'Connell (2024) highlighted the limited evidence supporting routine phlebotomy in some non-clonal and idiopathic forms of erythrocytosis. Treatment should address the underlying cause, and phlebotomy should be considered in the context of symptoms and the individual clinical situation rather than applied indiscriminately. McMullin et al. (2018) also discussed the management of specific clinical situations in PV and related disorders. These recommendations underline the need to document the indication for each procedure and to interpret laboratory changes in conjunction with the underlying diagnosis.

Mean BV decreased from 69.4 ± 4.0 to 66.6 ± 4.5 mL/kg, representing an absolute reduction of 2.8 mL/kg. In contrast, mean PV decreased only slightly, from 31.6 ± 3.5 to 31.5 ± 3.9 mL/kg. Das et al. (2018) specifically examined plasma-volume changes in patients with polycythaemia undergoing therapeutic phlebotomy, demonstrating the relevance

of considering volume-related measurements alongside conventional haematological parameters. However, the present group averages do not establish that PV was preserved in every patient or that the BV reduction resulted exclusively from the intervention. The methods used to measure or estimate these parameters and the timing of post-treatment assessment are important for reproducibility and interpretation.

Therapeutic phlebotomy also requires an appropriately prescribed and monitored procedure. Peedin and Karp (2021) described its use as a planned therapeutic intervention for conditions including PV and iron-overload disorders, rather than as an interchangeable substitute for routine blood donation. Kim and Oh (2016) reviewed its clinical applications in disorders such as hereditary haemochromatosis and porphyria cutanea tarda, where the treatment objectives differ from those in erythrocytosis. Van Buren et al. (2020) examined therapeutic phlebotomy in testosterone-induced polycythaemia, illustrating the importance of considering medication-related causes and the specific clinical context. Consequently, a decrease in Hb or Hct alone is not sufficient to establish the overall effectiveness of treatment across different indications.

Several limitations should be acknowledged. The retrospective design depends on the completeness and accuracy of existing medical records. The available results do not establish detailed diagnostic subgroups, treatment-session distributions, individual target attainment, or the timing of follow-up measurements. The methods used to determine BV and PV also require clear documentation. In addition, without verified paired statistical analyses, the observed differences cannot be described as statistically significant. Adverse events, symptom improvement, and long-term clinical outcomes were not reported in the available results and therefore cannot be evaluated.

Despite these limitations, this study provides a descriptive account of changes in four parameters among patients receiving therapeutic phlebotomy in a tertiary-care setting. The findings emphasise the value of documenting pre-treatment and post-treatment measurements and interpreting them according to the underlying indication. Future studies incorporating diagnostic stratification, standardised measurement procedures, paired statistical analysis, treatment-target attainment, and systematic monitoring of symptoms and adverse events would provide stronger evidence regarding the clinical outcomes of therapeutic phlebotomy.

5. Conclusion

This retrospective study evaluated changes in haemoglobin, haematocrit, blood volume, and plasma volume among 134 patients who underwent therapeutic phlebotomy at a tertiary care centre between January 2022 and December 2023. The findings demonstrated reductions in mean haemoglobin, haematocrit, and blood volume following the procedure, whereas mean plasma volume remained relatively stable. These observations provide a descriptive overview of changes in selected haematological and volume-related parameters in routine clinical practice. However, the absence of verified inferential statistical analyses, detailed diagnostic subgroup information, and long-term follow-up limits the conclusions that can be drawn regarding treatment effectiveness and clinical outcomes. Therapeutic phlebotomy should be individualised according to the underlying diagnosis, clinical indication, and appropriate treatment targets. Future prospective studies incorporating standardised measurement methods, paired statistical analyses, systematic adverse-event monitoring, and longitudinal clinical assessment are warranted to establish the magnitude and clinical significance of these changes. Overall, this study highlights the importance of documenting pre- and post-procedure parameters to support the evaluation and monitoring of therapeutic phlebotomy in tertiary-care settings.

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Conflicts of interest

There are no conflicts of interest.

References

1. Arber, D. A., Orazi, A., Hasserjian, R., Thiele, J., Borowitz, M. J., Le Beau, M. M., Bloomfield, C. D., Cazzola, M., Vardiman, J. W., & International Agency for Research on Cancer. (2016). The 2016 revision to the World Health Organization classification of myeloid neoplasms and acute leukemia. *Blood*, 127(20), 2391–2405. <https://doi.org/10.1182/blood-2016-03-643544>
2. Bhatia, S., Kaur, P., Kaur, G., Tahlan, A., Saini, V., Bedi, R., Mittal, K., & Sood, T. (2023). Revisiting the impact of serial therapeutic phlebotomy in polycythaemia on laboratory and clinical parameters using a fixed interval and fixed volume protocol. *Transfusion Clinique et Biologique*, 30(1), 63–68. <https://doi.org/10.1016/j.tracli.2022.07.003>
3. Bose, N., & Kanzariya, H. (2014). Role of therapeutic apheresis and phlebotomy techniques in anaesthesia and critical care. *Indian Journal of Anaesthesia*, 58(5), 672–678. <https://doi.org/10.4103/0019-5049.144685>
4. Das, S., Murugesan, M., & Shastry, S. (2018). Effect of therapeutic phlebotomy on plasma volume in polycythemia patients. *Global Journal of Transfusion Medicine*, 3(2), 117–120. https://doi.org/10.4103/GJTM.GJTM_27_18
5. Dhiman, Y., Khatriwada, B., Raturi, M., & Gaur, D. S. (2026). Therapeutic phlebotomy (TP): A continuously evolving primeval remedy—Five-year experience and review from a tertiary healthcare center in India. *Indian Journal of Hematology and Blood Transfusion*, 42(3), 986–996. <https://doi.org/10.1007/s12288-025-02034-7>
6. Gangat, N., Szuber, N., & Tefferi, A. (2023). JAK2 unmutated erythrocytosis: 2023 update on diagnosis and management. *American Journal of Hematology*, 98(6), 965–981. <https://doi.org/10.1002/ajh.26920>
7. Gupta, S. S., Dhote, S. W., Lad, S., & Dey, D. R. (2024). A study of indications, clinical applications, and effects of therapeutic phlebotomy at a tertiary care hospital Navi Mumbai. *Global Journal of Transfusion Medicine*, 9(2), 126–129. https://doi.org/10.4103/GJTM.GJTM_18_24
8. Harrison, C. N., Barbui, T., Bose, P., Kiladjian, J.-J., Mascarenhas, J., McMullin, M. F., Mesa, R., & Vannucchi, A. M. (2025). Polycythaemia vera. *Nature Reviews Disease Primers*, 11(1), Article 26. <https://doi.org/10.1038/s41572-025-00608-3>
9. Iyyapan, S. K., Annadurai, H. H., Thangavel, G. P., & Natesan, H. (2025). Therapeutic red blood cell exchange in a sickle cell disease patient with acute bone pain crisis: Our experience in a tertiary care center. *Asian Journal of Transfusion Science*, 19(2), 386–388. https://doi.org/10.4103/ajts.ajts_31_23
10. Kani, V., Kannan, K., Arumugam, S., & Sonti, S. (2024). Preanalytical errors in hematology: Insights from a tertiary care hospital. *Cureus*, 16(9), e69641. <https://doi.org/10.7759/cureus.69641>
11. Kim, K. H., & Oh, K. Y. (2016). Clinical applications of therapeutic phlebotomy. *Journal of Blood Medicine*, 7, 139–144. <https://doi.org/10.2147/JBM.S108479>
12. Landolfi, R., Marchioli, R., Kutti, J., Gisslinger, H., Tognoni, G., Patrono, C., Barbui, T., & European Collaboration on Low-Dose Aspirin in Polycythemia Vera Investigators. (2004). Efficacy and safety of low-dose aspirin in polycythemia vera. *The New England Journal of Medicine*, 350(2), 114–124. <https://doi.org/10.1056/NEJMoa035572>
13. Leaf, R. K., & Dickey, A. K. (2024). Porphyria cutanea tarda: A unique iron-related disorder. *Hematology*, 2024(1), 450–456. <https://doi.org/10.1182/hematology.2024000664>
14. Marchioli, R., Finazzi, G., Specchia, G., Cacciola, R., Cavazzina, R., Cillon, D., De Stefano, V., Elli, E., Iurlo, A., Latagliata, R., Lunghi, F., Lunghi, M., Marfisi, R. M., Musto, P., Masciulli, A., Musolino, C., Randi, M. L., Ruggeri, M., Rapezzi, D., ... Barbui, T. (2013). Cardiovascular events and intensity of treatment in polycythemia vera. *The New England Journal of Medicine*, 368(1), 22–33. <https://doi.org/10.1056/NEJMoa1208500>
15. McMullin, M. F., Harrison, C. N., Ali, S., Cargo, C., Chen, F., Ewing, J., Garg, M., Godfrey, A., Knapper, S., McLornan, D. P., Nangalia, J., Sekhar, M., Wadelin, F., & Mead, A. J. (2019). A guideline for the diagnosis and management of polycythaemia vera: A British Society for Haematology guideline. *British Journal of Haematology*, 184(2), 176–191. <https://doi.org/10.1111/bjh.15648>
16. McMullin, M. F., Harrison, C. N., Ali, S., Cargo, C., Chen, F., Ewing, J., Garg, M., Godfrey, A., Knapper, S., McLornan, D. P., Nangalia, J., Sekhar, M., Wadelin, F., & Mead, A. J. (2018). A guideline for the management of specific situations in polycythaemia vera and secondary erythrocytosis: A British Society for Haematology guideline. *British Journal of Haematology*, 184(2), 161–175. <https://doi.org/10.1111/bjh.15647>
17. Mithoowani, S., Laureano, M., Crowther, M. A., & Hillis, C. M. (2020). Investigation and management of erythrocytosis. *CMAJ*, 192(32), E913–E918. <https://doi.org/10.1503/cmaj.191587>

18. O'Neill, C., & O'Connell, C. (2024). Idiopathic erythrocytosis: A diagnostic and management challenge with emerging areas for exploration. *British Journal of Haematology*, 204(3), 774–783. <https://doi.org/10.1111/bjh.19287>
19. Palmer, W. C., & Stancampiano, F. F. (2025). Hemochromatosis. *Annals of Internal Medicine*, 178(2), ITC17–ITC32. <https://doi.org/10.7326/ANNALS-24-03710>
20. Pearson, T. C. (1991). Apparent polycythaemia. *Blood Reviews*, 5(4), 205–213.
21. Peedin, A. R., & Karp, J. K. (2021). How do I...perform therapeutic phlebotomy? *Transfusion*, 61(3), 673–677. <https://doi.org/10.1111/trf.16308>
22. Rombout-Sestrienkova, E., Nieman, F. H. M., Essers, B. A. B., van Noord, P. A. H., Janssen, M. C. H., & van Deursen, C. T. B. M. (2013). Erythrocytapheresis versus phlebotomy in the initial treatment of HFE hemochromatosis: Results from a randomized trial. *Transfusion*, 53(3), 470–477. <https://doi.org/10.1111/j.1537-2995.2012.03778.x>
23. Spivak, J. L. (2019). How I treat polycythemia vera. *Blood*, 134(4), 341–352. <https://doi.org/10.1182/blood.2018834044>
24. Tefferi, A., & Barbui, T. (2023). Polycythemia vera: 2024 update on diagnosis, risk-stratification, and management. *American Journal of Hematology*, 98(9), 1465–1487. <https://doi.org/10.1002/ajh.27002>
25. Tremblay, D., Kremyanskaya, M., Mascarenhas, J., & Hoffman, R. (2025). Diagnosis and treatment of polycythemia vera: A review. *JAMA*, 333(2), 153–160. <https://doi.org/10.1001/jama.2024.20377>
26. Van Buren, N. L., Hove, A. J., French, T. A., & Gorlin, J. B. (2020). Therapeutic phlebotomy for testosterone-induced polycythemia. *American Journal of Clinical Pathology*, 154(1), 33–37. <https://doi.org/10.1093/ajcp/aqaa019>
27. Yogalakshmi, E., Vasudevan, S., Sonti, S., Kannan, K., & Srinivasan, C. (2024). Exploring the clinical and hematological characteristics of beta-thalassemia trait: A comprehensive analysis in a tertiary care hospital setting. *Cureus*, 16(5), e61093. <https://doi.org/10.7759/cureus.61093>