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Quality Improvement Project

Reducing Inappropriate Blood Transfusion in Stable CKD Anemia: Management Stewardship

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ABSTRACT

Background: Inappropriate transfusions in patients with stable anemia due to chronic kidney disease (CKD) pose serious safety and resource concerns. This study aimed to evaluate and implement a transfusion stewardship program to reduce unnecessary transfusions while maintaining patient safety.

Objective: To evaluate the effectiveness of a structured transfusion stewardship program in reducing inappropriate blood transfusions among patients with stable CKD anemia while maintaining clinical safety.

Methodology: A prospective interventional quality improvement study was conducted in the Department of Nephrology at Ayub Teaching Hospital, Abbottabad, Pakistan, over 12 months from January 2025 to December 2025. A total of 150 adult patients with CKD stages 3–5 and stable anemia (hemoglobin 8–10 g/dL) were enrolled using stratified random sampling. Baseline transfusion practices were assessed before implementing a stewardship intervention comprising clinician education, audit and feedback, and electronic decision support tools. Data were analyzed using SPSS version 26. 0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Pre- and post-intervention outcomes were compared using paired t- tests and chi- square tests, with p< 0. 05 considered statistically significant.

Results: Among 150 participants, 88 (58.7%) were male, and the mean age was 49.6 ± 12.8 years. At baseline, 120 (80.0%) patients received blood transfusions, of which 50 (33.3%) were considered inappropriate. Following implementation of the stewardship program, inappropriate transfusions decreased significantly to 15 (10.0%) ($p < 0.001$), while appropriate transfusions increased from 46. 7% to 60. 0%. The average number of transfused units per patient declined from 2.5 ± 0. 0.9 to 2. 1 ± 0. 0.7, without compromising hemoglobin stability (8. 8 ± 0. 0.4 vs. 8. 9 ± 0. 3 g/dL, p = 0. 18).

Conclusion: The transfusion stewardship program was an effective intervention that led to greater transfusion appropriateness, fewer unnecessary transfusions, improved resource utilization, and greater hemoglobin stability. Education, audits, and decision support are key interventions that can improve patient safety in the management of stable CKD anemia.

INTRODUCTION

Chronic kidney disease (CKD) is a significant public health issue worldwide, characterized by high morbidity and mortality, as well as progressive loss of kidney function. One of the most prevalent complications of CKD is anemia, caused mainly by low levels of erythropoietin, iron deficiency, chronic inflammation, and a shortened lifespan of red blood cells. If left untreated, anemia leads to fatigue, diminished quality of life, cardiovascular events, frequent hospitalizations, and poor clinical outcomes [1]. Iron replacement and erythropoiesis- stimulating agents (ESAs) are key components of anemia management in CKD. In the absence of severe anemia with symptoms, and when clinically necessary for rapid hemoglobin correction, blood transfusion is restricted to selected patients [2]. However, over- and/or inappropriate transfusion can cause patient transfusion reactions, iron overload, all immunization, transmission of infectious diseases, and added healthcare costs. Additionally, multiple transfusions can increase the risk of future kidney transplantation failure due to HLA sensitization [3,5]. International guidelines, including those from the Kidney Disease: Improving Global Outcomes (KDIGO) and the Association for the Advancement of Blood and Biotherapies (AABB), recommend restricted transfusion policies and caution against using hemoglobin concentration alone as the basis for transfusion decisions [6]. Despite these recommendations, many healthcare settings continue to use inappropriate transfusion practices due to poor compliance, limited clinician awareness, and a lack of standardized transfusion protocols [7,9]. Transfusion stewardship programs have become successful quality improvement initiatives that encourage evidence-

based practices by providing clinician education, periodic audits and feedback, and clinical decision support systems. These interventions have been shown to minimize unnecessary blood transfusions, enhance patient safety, optimize blood product use, and reduce health care expenditures. However, the practice and effectiveness of transfusion stewardship in the specific context of patients with stable CKD anemia are not well documented, especially in low- resource health care environments [10]. A structured transfusion stewardship program was therefore implemented, and this quality improvement project was undertaken to assess its effectiveness in reducing inappropriate blood transfusion rates among patients with stable CKD anemia while ensuring patient safety and adherence to evidence- based transfusion guidelines.

METHODOLOGY

Study Design

A prospective interventional Quality Improvement Project (QIP) was conducted to evaluate the effectiveness of a structured transfusion stewardship program in reducing the rate of inappropriate blood transfusion among stable, anemic patients with chronic kidney disease (CKD).

Study Setting and Duration

The study was conducted in the Department of Nephrology at Ayub Teaching Hospital, Abbottabad, Pakistan, over 1 year from January 2025 to December 2025.

Study Population

Adult patients with CKD stages 3-5 who had stable anemia and were receiving routine nephrology outpatient care were included in the study.

Sample Size

150 patients took part in the study. A sample size was determined using the WHO sample size calculator with a 95% confidence level, 80% power, and an expected 20% reduction in inappropriate blood transfusion after implementation of the transfusion stewardship program.

Sampling Technique

Patients were recruited using stratified random sampling to ensure adequate representation across CKD stages and treatment groups.

Inclusion Criteria

1. Adult patients (18 years old and above).
2. Has been diagnosed with CKD stages 3 – 5.
3. Stable levels of anemia (Hb 8-10g/dl).
4. Conservative Management, Iron Therapy, or Erythropoiesis-Stimulating Agent (ESA) Therapy.
5. Willingness to take part and written informed consent.

Exclusion Criteria

1. Bleeding/hemorrhage.
2. Emergency blood transfusion needed due to hemodynamic instability.
3. Acute Infection or Sepsis.
4. A blood malignancy that needs to be treated with multiple blood transfusions.
5. Pregnant women.
6. Patients who did not accept participation.

Intervention

A structured transfusion stewardship program was instituted, and baseline transfusion practices were assessed before its implementation. The intervention comprised educating clinicians on evidence-based transfusion guidelines. Ongoing audit and feedback of transfusion practices—clinical decision-support reminders (CDSR). Recommendations for transfusion from KDIGO and AABB were reinforced. The stewardship program was implemented throughout the study period and re-evaluated at its conclusion to assess the intervention's effectiveness.

Data Collection

Standardized data collection proforma was used to gather data. Patients' medical records and the hospital electronic health record system were used to obtain baseline demographic data, CKD stage, hemoglobin level, usage of an erythropoiesis-stimulating agent (ESA), iron therapy, transfusion history, number of blood units received, and transfusion indications. The appropriateness of each transfusion episode was evaluated using the Kidney Disease: Improving Global Outcomes (KDIGO) and the Association for the Advancement of Blood and Biotherapies (AABB) transfusion guidelines. The same variables were reassessed after the stewardship intervention to assess changes in transfusion practices.

Statistical Analysis

All data were input and analyzed with IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Data were continuously presented as mean ± standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Continuous variables were compared before and after the stewardship intervention using a paired t-test, and categorical

variables were compared with a chi-square test. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

This project was conducted as a Quality Improvement Project (QIP) to evaluate and improve routine blood transfusion practices in the Department of Nephrology, Ayub Teaching Hospital, Abbottabad. In accordance with institutional policy, formal Institutional Review Board (IRB) approval was not required because the project involved evaluation of standard clinical practice without introducing experimental interventions or altering routine patient care. All data were anonymized before analysis, and no personal identifiers were collected or recorded, ensuring strict patient confidentiality. The project was conducted in accordance with institutional quality improvement standards and the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 150 patients with stable anemia due to chronic kidney disease (CKD) were included in the study. Baseline demographic and clinical characteristics are presented in Table 1. Among the participants, 88 (58.7%) were male, and 62 (41.3%) were female. The majority of patients were aged 46–60 years (41.3%), followed by 31–45 years (32.0%). Regarding CKD severity, 62 (41.3%) patients had Stage 4, 55 (36.7%) had Stage 3, and 33 (22.0%) had Stage 5. Baseline transfusion practices are summarized in Table 2. Before implementation of the transfusion stewardship program, 120 (80.0%) patients received blood transfusions. Of these, 70 (46.7%) were considered appropriate, whereas 50 (33.3%) were classified as inappropriate. The mean number of blood units transfused per patient was 2.5 ± 0.9. Factors associated with inappropriate blood transfusions are shown in Table 3. The most common contributing factor was lack of awareness of transfusion guidelines (35 cases), followed by hemoglobin level >9.0 g/dL (28 cases), clinician decision without laboratory review (22 cases), and absence of erythropoiesis-stimulating agent therapy (15 cases). Post-intervention transfusion practices are presented in Table 4. The proportion of patients receiving transfusions decreased to 105 (70.0%), while appropriate transfusions increased to 90 (60.0%) and inappropriate transfusions declined to 15 (10.0%). The mean number of blood units transfused per patient decreased to 2.1 ± 0.7. Comparison of pre- and post-intervention outcomes is shown in Table 5. Inappropriate transfusions were significantly reduced from 33.3% to 10.0% ($p<0.001$), while the mean pre-transfusion hemoglobin remained stable (8.8 ± 0.4 vs. 8.9 ± 0.3 g/dL; $p=0.18$). The reductions in inappropriate transfusions and in the mean number of blood units transfused per patient are illustrated in Figures 1 and 2, respectively.

Table 1. Baseline Characteristics of Study Participants

Variable	Frequency (n)	Percentage (%)
Male	88	58.7
Female	62	41.3
18–30 Years	15	10.0
31–45 Years	48	32.0
46–60 Years	62	41.3
>60 Years	25	16.7
CKD Stage 3	55	36.7
CKD Stage 4	62	41.3
CKD Stage 5	33	22.0

150 patients with stable anemia due to chronic kidney disease (CKD) were enrolled in the study, including sex distribution, age groups, and CKD stages.

Table 2. Baseline Transfusion Practices

Variable	Frequency (n)	Percentage (%)	Average Units per Patient
Total Patients Transfused	120	80.0	2.5 ± 0.9
Appropriate Transfusions	70	46.7	-
Inappropriate Transfusions	50	33.3	-

Baseline blood transfusion practices before implementation of the transfusion stewardship program, including the number of patients receiving transfusions, transfusion appropriateness, and the mean number of blood units transfused per patient.

Table 3. Factors Associated with Inappropriate Blood Transfusion

Factor	Inappropriate Transfusions n (%)
Hemoglobin > 9.0 g/dL	28
Absence of ESA therapy	15
Clinician decision without lab review	22
Lack of guideline awareness	35

Clinical and practice-related factors associated with inappropriate blood transfusions among patients with stable CKD anemia before the implementation of the stewardship intervention.

Table 4. Post-Intervention Transfusion Practices

Variable	Frequency (n)	Percentage (%)	Average Units per Patient
Total Patients Transfused	105	70.0	2.1 ± 0.7
Appropriate Transfusions	90	60.0	-
Inappropriate Transfusions	15	10.0	-

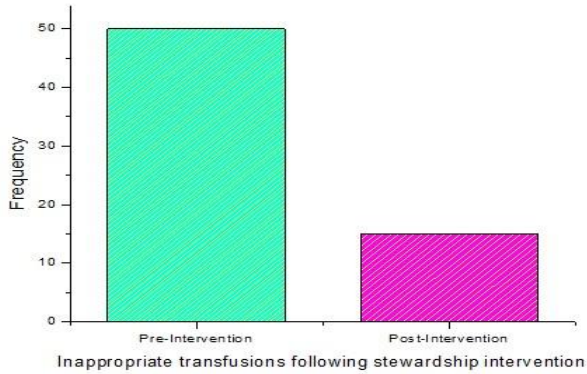
Blood transfusion practices following implementation of the transfusion stewardship program, including the frequency and appropriateness of transfusions, and the mean number of blood units transfused per patient.

Table **5. Comparison of Pre- and Post-Intervention**

Outcome	Pre	Post	p-value
Patients receiving transfusion	120 (80%)	105 (70%)	0.041
Inappropriate transfusion	50 (33.3%)	15 (10%)	<0.001
Hb	8.8±0.4	8.9±0.3	0.18
Units/patient	2.5±0.9	2.1±0.7	0.02

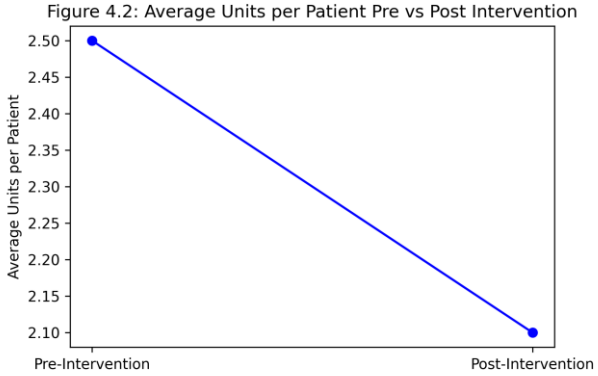
Comparison of transfusion-related outcomes before and after implementation of the transfusion stewardship program, including transfusion rates, inappropriate transfusions, pre-transfusion hemoglobin levels, and mean number of blood units transfused per patient.

Figure 1: Comparison of the number of inappropriate blood transfusions before and after implementation of the transfusion stewardship program among patients with stable CKD anemia.



Comparison of the number of inappropriate blood transfusions before and after implementation of the transfusion stewardship program among patients with stable CKD anemia.

Figure 2. Comparison of the mean number of blood units transfused per patient before and after implementation of the transfusion stewardship program.



Comparison of the mean number of blood units transfused per patient before and after implementation of the transfusion stewardship program.

DISCUSSION

This quality improvement project demonstrated that implementation of a structured transfusion stewardship program significantly improved blood transfusion practices among patients with stable chronic kidney disease (CKD) anemia. Inappropriate transfusion rates dropped significantly after the intervention, and both the transfusion rate and the average number of blood units per transfusion fell. Importantly, these improvements were achieved without reducing pre-transfusion hemoglobin levels, allowing restrictive transfusion to be safely used in appropriately selected CKD patients. The results of this study support previous research showing the benefits of transfusion stewardship programs to support evidence-based clinical practice. Structured stewardship programs (SWP) involving clinician education and the use of decision-support tools resulted in improved transfusion appropriateness and optimized blood utilization, as reported by Napolitano et al. [11]. Likewise, Singh et al. found that patients with CKD anemia had inappropriate transfusion practices and recommended changes in transfusion strategies in line with guidelines to improve outcomes [12]. The observations reflect the value of multi-disciplinary stewardship interventions in optimizing transfusion practices in various health care settings. This decrease in inappropriate transfusion observed in this study also aligns with the Kidney Disease: Improving Global Outcomes (KDIGO) clinical practice guideline, which recommends avoiding transfusion and optimizing iron therapy and ESA before initiating transfusion in patients with CKD [13,14]. Improved compliance with these recommendations following the implementation of the stewardship program may have contributed to the reported decrease in unindicated transfusion. One of the main findings of this study was that no adverse effect on hemoglobin stability was observed with reduced transfusion frequency. This discovery indicates that a substantial percentage of baseline transfusions could have been avoided and that evidence-based stewardship can reduce unnecessary exposure to transfusion-related complications without affecting anemia management. The recommendations of the UK Kidney Association and the AABB International Guidelines have reached the same conclusion, urging more restrictive transfusion criteria and a clinical evaluation of the individual patient to ensure safer transfusion practice and minimize unnecessary blood use [15,16]. The results of this project have significant implications for clinical practice, especially in resource-constrained health care environments where blood products are limited. Implementation of clinician education, regular audit and feedback, and electronic decision-support systems can help increase adherence to transfusion guidelines, reduce unnecessary health care costs, and improve patient safety. These results also align with patient blood management recommendations, which include stewardship-focused strategies to improve transfusion utilization and the use of healthcare resources [17]. There are several limitations of this study. It was performed at a single tertiary care center, and the sample size was relatively small, so the results may not be generalizable. Long-term clinical outcomes (e.g., mortality, hospital readmission, patient satisfaction, and cost-effectiveness) were not assessed during the follow-up period, as this period was limited to the duration of the QIP. In addition, it would not have been possible to assess the individual contribution of each stewardship component without the other. The results of this study warrant further multicenter, large-cohort studies to confirm these findings and establish the long-term sustainability of transfusion stewardship programs in the management of CKD. In summary, this quality improvement initiative demonstrates that a well-designed transfusion stewardship program can significantly reduce inappropriate transfusions while still ensuring patient safety. The results demonstrated that stewardship strategies should be integrated into standard care in the nephrology setting to maximize blood utilization and enhance the quality of care for patients with CKD anemia.

LIMITATIONS

The study has several limitations that should be acknowledged. First, this study was conducted at a single tertiary care hospital, which may limit the generalizability of the results to other hospitals with different patient populations, clinical practices, and resource utilization. Second, some of the data were from a routine EMR, which may have introduced documentation bias and led to missing data. Furthermore, the Hawthorne effect could have influenced clinicians' behavior during the intervention period, potentially increasing adherence to the transfusion guidelines for a short time. Third, the relatively short follow-up period did not allow evaluation of long-term clinical outcomes, including reductions in transfusion rates, mortality, and hospital readmissions, as well as patient satisfaction, cost-effectiveness, and other measures. Lastly, the stewardship program included several interventions, such as clinician education, audit and feedback, and electronic decision-support tools, making it impossible to assess the individual impact of each. Larger multicenter studies with longer follow-up are recommended to confirm these results, and to examine the durability and impact of transfusion stewardship programs in patients with CKD anemia.

CONCLUSION

Implementation of a structured transfusion stewardship program improved adherence to evidence-based transfusion guidelines, reduced inappropriate blood transfusions, and optimized blood utilization without compromising patient safety. These findings support incorporation of transfusion stewardship into routine nephrology practice.

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AUTHORS' CONTRIBUTION

Kainat Bibi: Conceptualization, data collection, data analysis, manuscript drafting, and interpretation of results.

Salman Sher: Study conception and design, supervision, critical revision of the manuscript for important intellectual content, and data interpretation.

Sayyeda Aisha Bahar: Data interpretation, critical review of the manuscript, and methodological input.

All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work in accordance with the **ICMJE authorship criteria**.

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