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Patient Blood Management in Orthopedic Surgery- Prospective Study

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Abstract: ***Introduction: Patient Blood Management (PBM) is a multimodal, multidisciplinary approach done to limit the use and the need for allogeneic blood transfusion along with improving their clinical outcomes. PBM usually refers to surgical patients; its clinical use has evolved. Randomized trials show that patients do well when given less blood, remaining an impression that orthopedic surgery patients require a higher hemoglobin transfusion threshold than other patient. Material and Methods: After patient blood management program, we prospectively evaluated all orthopedic patients, comparing transfusion practices and clinical outcomes in the pre- and post-blood management in surgical cases. Risk adjustment accounted for sex, age, surgical procedure, and case mix index. Results: After patient blood management was implemented, the mean hemoglobin threshold decreased from 7.6 ± 1.0 g/dl to 6.9 ± 1.0 g/dl (P < 0.0001). Clinical outcomes do improved, with decreased morbidity (from 1.4% to 0.55%; P = 0.01), composite morbidity or mortality, and 30-day readmissions decreased. Improved outcomes were primarily recognized in patients 60 yr of age and older. Conclusions: In a prospective study, patient blood management was associated with reduced blood use with improved clinical or almost similar outcomes in orthopedic surgery. A hemoglobin threshold of 7g/dl appears to be safe.***

Keywords: PBM, Prospective, haemoglobin threshold, orthopedics

1. Introduction

Orthopedic and traumatology surgical procedures, such as knee and hip arthroplasties ,instrumented spinal operations or repair of fractures can produce, on an average, up to 1-2L of blood loss causing acute post-operative anemia, requiring the allogenic blood transfusion.

There are several factors which suggest transfusing less such as:

1) Human blood is as known a limited resource in developing countries like India.
2) The cost of the preparation including distribution as well as administration of blood components is higher.
3) Transfusion has many adverse effects such as acute hemolytic reactions, the transmission of infectious diseases, circulatory overload, immunomodulation, acute lung damage, amongst others; and the different provisions of current legislation.[1]

According to the AABB (American Association of Blood Banks), blood transfusions in hospital settings have significantly decreased (by approximately 25%) during the past years .Patient blood management programs implementing techniques such as restrictive hemoglobin triggers, clinical decision support, educational efforts, and technologic advances in surgery and blood conservation across hospitals and health systems have been effective in decreasing blood use.[2]

AABB-endorsed transfusion guidelines recommend a hemoglobin trigger of 8g/dl for orthopedic surgery patients but a hemoglobin trigger of 7g/dl for critically ill hospitalized patients.

Orthopedic patients may require more liberal transfusion than other patients, so we are specifically interested in the patient blood management program on orthopedic surgery patients. During the recent trends in blood management, our health system aim to decrease unnecessary blood transfusion.

Therefore, we did a Prospective Analysis from January 2021 to January 2022 to test that after implementation of a patient blood management program, orthopedic patients would receive fewer allogeneic blood transfusions without an increase in adverse outcomes

2. Materials and Methods

Institutional review board approval was obtained to assess changes in blood use and clinical outcomes. The patient blood management database with clinical outcomes covers the period from January 2021 to January 2022, a retrospective study. At the primary orthopedic centre of our institution, the patient blood management program was done.

Patient blood management was considered to be initiated in January 2021. All patients aged 18 or above admitted to the orthopedic surgery during this period were included in this study. Categories of surgical procedure included various fracture repairs, hip and knee arthroplasty (primary as well revision) and spine surgery.

Patient Blood Management Program

The patient blood management program employed several strategies:

1) Obtaining support from hospital leadership.
2) Assembling multidisciplinary teams and holding monthly meetings.
3) Providing education based on rigorous peer-reviewed studies.
4) Implementing transfusion guidelines.
5) Implementing clinical support with best-practice advisory alerts.
6) Performing data acquisition and analytics.3

7) Creating blood use electronic dashboards.3
8) Providing transfusion guideline compliance audit reports.
9) Enacting specific methods to decrease blood use, including use of intraoperative antifibrinolytics (primarily tranexamic acid), anesthetic management such as controlled hypotension and maintaining normothermia, surgical methods such as newer cautery techniques, 4 topical hemostatics, and reduction of phlebotomy blood loss by using smaller tubes and reducing unnecessary laboratory test ordering. Diagnosis and treatment of preoperative anemia was not emphasized, and there was no preoperative anemia clinic in the pre or post-patient blood management time periods.

Patient Blood Management Interventions, which are:
1) Considering Pre-patient blood management.
2) Warly patient blood management was introduced.
3) Post-patient blood management, across the health system, data dashboards, audits for transfusion guideline compliance along with feedback, and an early version of clinician decision support.
4) Enhancing patient blood management, informing clinicians about guideline orders, as well as compliance audits with feedback sent to Othopaedics departments.

Assessment (Blood Use)
For erythrocyte-transfused patients, the lowest hemoglobin concentration during the period of hospital stay was used to define the hemoglobin trigger and the last measured hemoglobin concentration before discharge was used to define the hemoglobin target from our database.

Blood use was assessed in two ways:
1) Percentage of patients receiving any erythrocyte units.
2) The number of units transfused per 1,000 patients during their entire hospital stay.

The primary clinical outcome assessed and secondary outcomes included are:
1) Composite morbidity
2) Mortality (during the hospitalization)
3) Length of stay in hospital
4) Within 30-days readmissions

3. Data Analysis

The analysis was designed as a pre-and post-patient blood management comparison, analysing periods and after introducing CME (continuing medical education) to Orthopedics Clinicians from January 2021.

(1) January 2020 to December 2020 before CME, and (2) January 2021 to January 2022 after Introducing CME. The methods of analysis were planned before accessing the data and was estimated on the basis of experience with morbid event rates from our previous studies.5 Analysis of blood use and clinical outcomes was first performed for the entire patient population and then by preplanned subgroup analyses with two age-defined subgroups (younger than 60 yr and older than 60 yr of age).

The logistic regression model included the following independent variables:
1) The design variable in the study (pre- and post-patient blood management)
2) Variables that have been linked to outcomes in previous studies
3) Variables with $P < 0.1$ on univariate analysis.

Table 1:Patient Characteristics before and after Patient Blood Management (All Patients in Orthopedics Department)

Parameter	Pre-patient Blood Management (n = 1000)	Post-patient Blood Management (n = 1000)	P Value
Age (years) mean ± SD	60±10	60±10	0.011
Age ≥ 60 years (%)	620(41.1)	1,042 (43.4)	0.17
Sex (% male)	685 (45.5)	1,114 (46.4)	0.57
Hip fracture (%)	124 (8.2)	194 (8.1)	0.87
Total hip arthroplasty(%)	321 (21.3)	647 (26.9)	< 0.0001
Total knee arthroplasty(%)	490 (32.5)	818 (34.1)	0.32
Total hip revision arthroplasty(%)	49 (3.3)	81 (3.4)	0.84
Total knee revision arthroplasty(%)	39 (2.6)	48 (2.0)	0.23

Table 2:Number of patients according to the postoperative hemoglobin assay value.

Postoperative hemoglobin (g/dL)	Number of patients
>12	111
11–12	200
10–11	240
9–10	244
8–9	171
7–8	34

4. Results

There were 1000 patients in the pre-patient blood management cohort and 1000 patients in the post-patient blood management cohort. The characteristics between the two groups are shown in table 1. The percentage of patients requiring surgery for fracture repair was similar in the two periods. The percentage of patients undergoing arthroplasty did increase in the post-patient blood management period.

The percentage of revision total joint arthroplasty patients was similar in the pre and post blood management study period.

The changes shown in the early patient blood management phase are likely due to education at SMS Hospital particularly Orthopaedics department and perioperative tranexamic acid use. Of significance is the average hemoglobin trigger, which was more than 7g/dl during the pre-patient period and less than 7g/dl during the post-patient period.

The mean hemoglobin transfusion trigger was decreased by about 1 g/dl, and the mean hemoglobin target decreased by about 0.7g/dl (both $P < 0.0001$). The percentage of patients transfused with erythrocytes decreased from 16.1% to 9.4% ($P < 0.0001$), and there was a 32.5% decrease in the number of erythrocyte units per 1,000 patients ($P = 0.0007$). The percentages of patients transfused plasma (pre-patient blood management 1.6% vs. post-patient blood management 1.4%; $P = 0.66$) and platelets (pre-patient blood management 0.53% vs. post-patient blood management 0.37%; $P = 0.48$) were low.

Table 3:Bood Use and Clinical Outcomes before and after Patient Blood Management (All Patients)

Parameter	Pre-patient Blood Management (n = 1000)	Post-patient Blood Management (n = 1000)	P Value
Trigger Hb (g/dl) [mean ± SD]	7.8±1.0	6.8±1.0	< 0.0001
Target Hb (g/dl) [mean ± SD]	9.0±1.1	8.3±1.0	< 0.0001
Transfused RBC (%)	242 (16.1)	226 (9.4)	< 0.0001
RBC units per 1000 patients	338	228	0.0007
Length of Stay, days, median (IQR)	3 (1–4)	2 (1–3)	< 0.0001
Morbidity (%)	20 (1.3)	13 (0.54)	0.01
Mortality (%)	2 (0.13)	6 (0.25)	0.72
Morbidity or mortality (%)	22 (1.5)	18 (0.75)	0.035
30-day readmission (%)	133 (9.0)	135 (5.8)	0.0002

Clinical outcomes of the pre- and post-patient blood management periods are shown in table 3. The outcome of any morbidity or mortality (primary outcome) decreased by half ($P = 0.035$). The median (interquartile range) length of stay decreased by 1 day ($P < 0.0001$). The morbid event rate decreased by more than half ($P = 0.01$), and mortality was unchanged ($P = 0.72$). The 30-day readmission rate significantly decreased from 9.0% to 5.8% ($P = 0.0002$). In the pre- and post-patient blood management periods, 26 patients and 79 patients had missing readmission data, respectively.

In summary, when all adult orthopedic patients are included (both young and old cohorts), the implementation of patient blood management did show improvement in all outcomes, except for mortality, which almost remained unchanged. Our results suggest that patient blood management is important for orthopedic patients and that a hemoglobin trigger of 7 g/dl rather than 8g/dl is well tolerated, even by elderly patients. Our study adds efficacy of patient blood management programs on reducing transfusion overuse along with maintaining good outcomes. By reducing risks along with improving outcomes, we can promote high-value practice with effective patient blood management programs.

5. Discussion

The results of this study demonstrate that for orthopedic surgery patients, patient blood management program is a successful method for reducing blood use, along with maintaining or improving clinical outcomes. After age and risk adjustment in the post-patient blood management

cohort, patients did just as well with a lower hemoglobin trigger and target, resulting in decrease in the percentage of patients transfused and decrease in erythrocyte units transfused per patient.

Morbidity, length of stay, and readmission rates all were improved, while mortality was unchanged.

Regarding age, the older patients showed more benefit than younger patients with the changes in transfusion practice, because both morbidity and readmissions occurred with about half the frequency at baseline in the younger subgroup. The finding that older patients do as well or better with a restrictive transfusion strategy is supported by clinical trials in orthopedic .[6]

Our interest is the average hemoglobin trigger above 7 g/dl, decreasing to less than 7g/dl, in what we defined as the pre- and post-patient blood management periods in our study. It should be recognized that before blood management, approximately one third of all erythrocyte transfusions at our institution were ordered with a preceding hemoglobin concentration between 7.1 and 8g/dl. A patient blood management program specifically for hip and knee arthroplasty patients showed a 30 to 50% decrease in percentage of patients transfused, along with a decreased length of hospital stay.

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