Review Article

Comparison of Post-Decompressive Haematuria in Rapid Versus Gradual Bladder Decompression in Patients with Chronic Urinary Retention

Peter Olalekan Odeyemi, Najeem Adedamola Idowu

Division of Urology, Department of Surgery, Ladoke Akintola University of Technology Teaching Hospital, Ogbomosho, Nigeria

Abstract

Background: Chronic urinary retention (CUR) is a common urological emergency. Initial management involves the drainage of the bladder by urethral catheterisation. Relief of CUR may be associated with post-decompressive haematuria. The two primary methods of emptying the obstructed bladder are rapid and gradual emptying. The method of relief of CUR to reduce this complication has been debated for decades. **Objective:** To compare the risk of post-decompressive haematuria following rapid versus gradual urinary bladder decompression in patients with CUR. **Materials and Methods:** This was a prospective, randomised study in which patients with CUR were randomised into two groups: group A and group B. Group A had rapid urinary decompression with an 18 Fr urethral catheter attached to a urine bag, whereas group B had gradual decompression using a urethral catheter attached to an intravenous fluid-giving set, which was then attached to the urine bag. Post-decompressive haematuria in each group was assessed at designated times and documented based on a research protocol. **Data Analysis and Result Presentation:** Data were analysed using the Statistical Package for Social Sciences (IBM) SPSS version 21. Data were summarised by descriptive statistics. The two arms were compared for similarities in demographic variables. Continuous and categorical variables were compared using the Student's *t* test and Pearson's chi-square test, respectively. The results of the analysis were presented with the aid of bar charts and tables for clarity. Significant *P* value was ≤0.05. **Result:** Sixty patients were recruited into the study and randomised into groups A (rapid urinary decompression) and B (gradual urinary decompression) with 30 patients in each arm of the study. The mean age was 70.92 ± 13.98 years (range 20–96 years). The mean age of the patients recruited into group A was 68.50 ± 14.77 years, whereas that of group B was 73.33 ± 13.19 years. The *P* value was 0.187. Fifteen patients (50%) developed gross haematuria in group A compared with 7 patients (23.3%) in group B with a statistically significant *p* value of 0.032. Four (26.7%) of the patients with gross haematuria had blood transfusions in group A, whereas only 1 (16.7%) of the patients with gross haematuria in group B had a blood transfusion. The *P* value was 0.920. **Conclusion:** The rate of haematuria is significantly higher in group A with a higher rate of blood transfusion than that of group B. Though gradual urinary decompression is cumbersome, it is recommended to reduce the rate of haematuria and blood transfusion with its associated complications.

Keywords: *Acute urinary retention, bladder outlet obstruction, benign prostatic hyperplasia, chronic urinary retention, gradual bladder decompression, rapid bladder decompression*

Received: 05-Jan-2024
Accepted: 22-Feb-2024
Published: 24-May-2024

Address for correspondence:
Dr. Peter Olalekan Odeyemi, Division of Urology, Department of Surgery, Ladoke Akintola University of Technology Teaching Hospital, PMB 4007, Ogbomosho, Nigeria.
E-mail: docpeto4all@yahoo.com

Access this article online

Website: www.jwacs-jcoac.com

DOI: 10.4103/jwas.jwas_5_24

Quick Response Code:

Introduction

Post-decompressive haematuria as a complication of urinary bladder decompression has been a concern for many years.[1] It has been reported to occur in 2%–16% of patients following relief of chronic urinary retention (CUR).[2] It is thought to be due to the rupture of mucosal capillary vessels as a result of rapid blood flow and subsequent engorgement of the vesical veins during urinary bladder decompression.[3] In some instances, this may be heavy requiring bladder irrigation with normal saline and blood transfusion.[4] Bleeding, which occurs within an hour or two of emptying the bladder will almost certainly be caused by the sudden hyperemia which develops in the bladder mucosa from the large veins that become grossly distended as a result of the sudden release of pressure or rupture of these veins,[5] though rarely, from acute tubular necrosis in the kidney. Post-decompressive haematuria is thought to be a common complication and sudden

How to cite this article: Odeyemi PO, Idowu NA. Comparison of post-decompressive haematuria in rapid versus gradual bladder decompression in patients with chronic urinary retention. J West Afr Coll Surg 2024;14:249-54.

decompression of the bladder and subsequent engorgement of the vesical veins and their rupture could be responsible.[2] Studies have shown that the incidence of haematuria is low and is often variable; when it does occur, it is usually mild, inconsequential, resolves within 24–48 h, and rarely requires blood transfusion.[1,3,5] Ahmed *et al*.[3] reported a 54.5% incidence of post-decompressive haematuria following rapid decompression of 22 patients who presented with CUR. Even when haematuria occurs following bladder decompression, it is typically benign and self-limited.[1,3] A systematic literature review of related studies published from 1920 to 1997 found no case of haematuria severe enough to necessitate further invasive therapy, such as bladder irrigation or blood transfusion.[2]

Materials and Methods

Study duration

The study was carried out between 2019 and 2021. The entry point was at the time of presentation at the emergency/urology clinic before urethral catheterisation to 24 h after catheterisation.

Ethical clearance

Ethical clearance was obtained from the Ethical Review Committee (ERC) of the University of Ilorin Teaching Hospital (UITH), Ilorin, Kwara State, Nigeria, as part of part-two fellowship dissertation study of National Post-Graduate Medical College of Nigeria titled 'Comparison of post decompressive complications in rapid versus gradual bladder decompression in patients with CUR' with approval number ERC PAN/2018/11/1845 dated 15/11/2018. The intent and importance of the study were explained to all patients and only those that consented to participate in the study were recruited. The study duration was between 2019 and 2021.

Study population

Male patients presenting with symptoms of CUR were enrolled after signing an informed written consent to participate.

Study design

The study was a prospective, hospital-based, randomised comparative clinical study. Simple randomisation was used. Patients were randomised to rapid (group A) or gradual (group B) decompression by balloting. Each patient picked from an envelope that contained equal numbers of ballot papers labelled A and B and then assigned to the group corresponding with the letter on their ballot paper.

Funding

The study was funded by the researchers. All additional costs that were not part of the routine care at UITH were provided by the researcher. There was no additional cost to the patient/caregiver.

Sample size determination

Ahmed *et al*.[3] reported 54.5% incidence of post-decompressive haematuria. In this study, a 65% reduction in post-decompressive haematuria from 54.5% to 19% with gradual bladder decompression will be regarded as being clinically significant. At a power of 80% and a significance level of 5%, the sample size will be calculated using the formula for the sample size for comparison of two proportions as follows[6]:

$$n = \frac{2(Z_\alpha + Z_\beta)^2 P(1-P)}{(P_1 - P_2)^2}$$

where n is the sample size required in each group (double this for total sample); $P1$ is the first proportion – here 0.55[6]; $P2$ is the second proportion—here 0.19[6]; $P1$-$P2$ is the size of difference of clinical importance—here 0.36[6]; P is the pooled occurrence = prevalence in case group (P_1) + Prevalence in control group (P_2)/2 = (0.55 + 0.19)/2 = 0.37; Z_α is the desired significance level—here 1.96 (from Z table at type 1 error of 5%); Z_β is the desired power—here 0.842 (from Z table at 80% power).

Thus,

$$n = \frac{2[1.96 + 0.842]^2\, 0.37\,(1-0.37)}{0.36^2} = 28.24$$

Giving a 5% attrition rate was considered for patients who voluntarily withdrew or were lost to follow-up

Estimated sample size in each group = 28.24 + 1.412= 29.65

A sample size of 60 participants (30 in each group) was recruited.

Sixty patients were recruited into the study and randomised into group A (rapid urinary decompression) and group B (gradual urinary decompression) with 30 patients in each arm of the study.

Inclusion criteria

All consenting adult male patients with CUR and easy urethral catheterisation

Exclusion criteria

The exclusion criteria are as follows:

1. patients with a history of haematuria;
2. patients with traumatic catheterization;
3. patients on anticoagulant medications;
4. patients with urethral stricture disease and failed urethral catheterization and
5. patients with a history of bleeding disorder.

Procedure

Evaluation

The patients were assessed according to the standard protocol. Blood samples were taken for a full blood count. electrolyte, urea, and creatinine before bladder decompression. Urinalysis and abdominopelvic ultrasound were also done.

Catheterisation

An indwelling size 18 Fr urethral catheter was used to decompress the bladder in an aseptic technique after prophylactic antibiotics and lubrication with 10 mL of 2% xylocaine gel. The catheter was passed by the researcher or research assistant who was a competent resident in the surgery department and well trained in the protocol.

Bladder emptying

For rapid decompression (group A), the bladder was drained completely by placing the drainage bag at a level of about 50 cm lower than the bladder. The volume was assessed using a calibrated container.

For gradual decompression (group B), the bladder was drained gradually by using an intravenous (IV) giving set as described by Perry *et al*.[7] An IV infusion giving set was connected between the urethral catheter and the drainage bag. The urine was drained gradually by the roller of the giving set, which was used to control the rate of drainage at 100 mL/min for 2 min and then stopped for 5 min until the bladder was completely drained.[1]

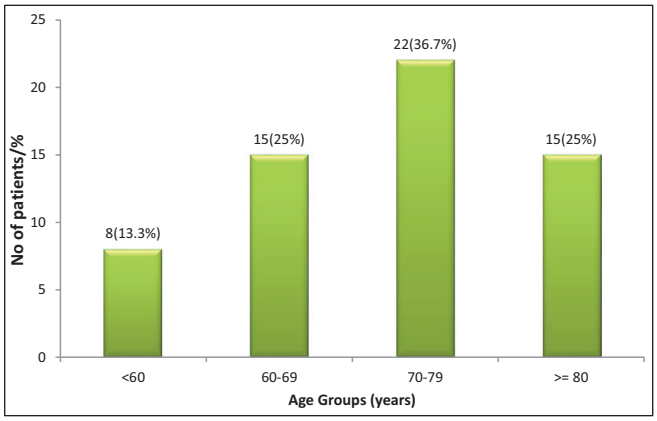

Figure 1: Bar chart showing the age distribution of the patients(*n* = 60)

Monitoring

The patients were admitted and monitored by the researcher or research assistant for 24 h after emptying the bladder with regular checks of vital signs (pulse rate, respiratory rate, and blood pressure) hourly.

In the case of post-decompressive haematuria developing, this was documented and standard treatment was given, as determined by its severity.

Result

Demographic characteristics of the patients

Sixty patients were recruited into the study and randomised into group A (rapid urinary decompression) and group B (gradual urinary decompression) with 30 patients in each arm of the study. The mean age was 70.92 ± 13.98 years (range 20–96 years).

The majority of the patients 44 (73.33%) were civil servants out of which 33 (55%) were retirees, 15 (25%) patients were self-employed, out of which 4 (6.67%) patients were artisans. Only 1 (1.67%) patient was a student [Figure 1 and Table 1].

Comparison of demographic characteristics amongst the groups

The mean age of the patients recruited into group A was 68.50 ± 14.77 years, whereas that of group B was 73.33 ± 13.19 years. The *P* value was 0.187 [Table 1].

Occurrence of microscopic haematuria amongst the groups

Sixteen patients in total had microscopic haematuria following urinary decompression, seven patients (23.3%) in group A and nine patients (30%) in group B. The *P* value was 0.559 [Table 2].

Table 1: Comparison of socio-demographic characteristics of the groups

Variables	Urinary decompression		χ^2/t	*P* value
	Rapid (%), *n* = 30	Gradual (%), *n* = 30		
Age groups (years)			3.494	0.322
<60	5 (16.7)	3 (10.0)		
60–69	10 (33.3)	5 (16.7)		
70–79	9 (30.0)	13 (43.3)		
≥80	6 (20.0)	9 (30.0)		
Mean ± SD	68.5 ± 14.8	73.3 ± 13.2	1.337	0.187
Occupation				
Retired	15 (50.0)	18 (60.0)		
Serving civil servant	7 (23.3)	4 (13.3)		
Self-employed	7 (23.3)	8 (26.6)		
Student	1 (3.3)	0 (0.0)		

Occurrence of gross haematuria amongst the groups

In group A, 15 patients (50%) developed gross haematuria compared with 7 patients (23.3%) in group B. The *P* value was 0.032 [Table 3].

Comparison of rate of blood transfusion amongst the groups

The mean packed cell volume (PCV) drop amongst the patients with gross haematuria between admission and resolution of haematuria in group A was 3.17 ± 2.80 (range of 0%–11%) and 3.50 ± 3.18 (range of 0%–13%) in group B. Four (26.7%) of the patients with gross haematuria had a blood transfusion in group A, whereas only 1 (16.7%) of the patients with gross haematuria in group B had a blood transfusion. The highest PCV drop amongst patients in group A was 11% (28%–17%) and the patients had 4 points of blood transfusion. The only patients that had blood transfusion in group B had 8 points of blood transfusion following a 13% drop in PCV (25%–12%) [Tables 4–6].

Table 2: Occurrence of microscopic haematuria amongst the groups

Variable	Urinary decompression		χ^2	*P* value
	Rapid (%), *n* = 30	Gradual (%) *n* =30		
Microscopic haematuria				
Present	7 (23.3)	9 (30.0)	0.341	0.559
Absent	23 (76.7)	21 (70.0)		

Table 3: Occurrence of gross haematuria amongst the groups

Variable	Urinary decompression		χ^2	*P* value
	Rapid (%), *n* = 30	Gradual (%), *n* = 30		
Gross haematuria				
Present	15 (50.0)	7 (23.3)	4.593	0.032
Absent	15 (50.0)	23 (76.6)		

Table 4: Comparison of rate of blood transfusion amongst the groups

Variable	Urinary decompression		χ^2	*P* value
	Rapid (%), *n* = 15	Gradual (%), *n* = 7		
Number of patients transfused	4 (26.7)	1 (16.7)	0.010	0.920[y]

[y]Yates corrected *P* value

Discussion

Methods of decompressing the urinary bladder of patients with CUR have been debated for decades.[2,8,9] The two primary methods following successful urethral catheterisation are rapid and gradual decompressions. This study compared the rate of haematuria following rapid versus gradual urinary decompression.

The mean age of the patients was 70.92 ± 13.98 years (range of 20–96 years). The mean age of the patients recruited into group A was 68.50 ± 14.77 years, whereas that of group B was 73.33 ± 13.19 years. The *P* value was 0.187. This is comparable with the study by Boettcher *et al*.[1] who reported a mean age of 72.45 ± 10.7 with a range of 22–100 years. Gross haematuria is one of the major complications following the relief of CUR. Previous recommendations have suggested gradual decompression to reduce post-decompressive haematuria.[4,8] While some other studies do not find a significant association between the method of decompression and the occurrence of post-decompressive haematuria.[1,2] In this study, 15 patients (50%) developed gross haematuria following rapid urinary decompression compared with 7 patients (23.3%) following gradual urinary decompression with a statistically significant *P* value of 0.032. This is similar to the finding by Ahmed *et al*.[3] who reported a 54.5% incidence of post-decompressive haematuria following rapid decompression amongst the 22 patients with CUR. However, Boettcher *et al*.[1] reported 10.5% and 11.3% incidence of gross haematuria following rapid and gradual urinary decompression, respectively. The reduction in the rate of haematuria in the study by Boettcher *et al*.[1] maybe because the authors studied patients with both acute and CUR together. Glahn *et al*.[5] found a 16% incidence of gross haematuria following rapid decompression of the urinary bladder in 300 patients with CUR. Four (26.7%) of the patients with gross haematuria had blood transfusion following rapid urinary decompression, whereas only 1 (16.7%) of the patients with gross haematuria following gradual urinary decompression had a blood transfusion with a *P* value of 0.920[y]. This was similar to other studies, which showed that most post-decompressive haematuria does not need blood transfusion.[1,2] Ahmed *et al*.[3] reported that no patient had a

Table 5: Relevant haematologic parameters of the patients that had a blood transfusion

S. No.	Method of decompression	Initial PCV (%)	Final PCV (%)	PCV drop (%)	Pints of blood transfused
1	Rapid	30	25	5	2
2	Rapid	27	23.5	3.5	2
3	Rapid	36	29	7	2
4	Rapid	28	17	11	4
5	Gradual	25	12	13	8

PCV: packed cell volume

Table 6: Mean differences in PCV drop and blood transfusion amongst the groups

Variables	Urinary decompression		*T*	*P* value
	Rapid (%)	Gradual (%)		
Drop in packed cell volume	3.2 ± 2.8	3.5 ± 3.2	0.214	0.833
Number of pints transfused	2.5 ± 1.0	8.0	4.919	0.016

PCV: packed cell volume

blood transfusion despite a 54.5% incidence of haematuria amongst 22 patients studied. This was contrary to the findings in this study where four patients in group A and one patient in group B had blood transfusions.

The mean PCV drop in patients with gross haematuria following rapid urinary decompression was 3.17 ± 2.80 (range 0%–11%) and 3.50 ± 3.18 (range 0%–13%) following gradual urinary decompression. The *P* value was 0.833. The highest PCV drop following rapid urinary decompression was 11% (28%–17%) and the participant had 4 points of blood transfusion. The only participants that had blood transfusion following gradual urinary decompression had 8 points of blood transfusion following a 13% PCV drop (25%–12%). The background anemia with a PCV of 25% might have contributed to increased blood transfusion. This is similar to a study by Boettcher *et al*.,[1] in which 16 patients in each group of rapid and gradual decompression had haematuria. Four patients in the rapid decompression group and 6 patients in the gradual decompression group were transfused. In this study, the ratio of blood transfusion was 4:1 compared with other studies with less or no blood transfusion.[2,3] Naranji and Bolgeri [7] reported a case of severe haematuria necessitating multiple blood transfusions and bladder irrigation.

Complications of blood transfusion could be early, which ranges from mild febrile non-haemolytic reaction to severe graft versus host disease and ultimately death or late complications, which includes bloodborne diseases, such as viral, fungal, or bacteria microorganisms:[10-39] even in a screened blood, especially when the donor is in the window period. Since every patient transfused is at risk of these complications, every surgeon aims to employ every medical option not to transfuse or reduce the rate of blood transfusion in surgical patients to avoid or minimise transfusion-related complications.[40-45] This is very important in Jehovah's Witness patients who will not consent to blood transfusion.[46-48] As shown in this study, gradual urinary bladder decompression may be one of the options to achieve this aim. This may reduce the rate of blood transfusion from the ratio of 4:1.

Conclusion and Recommendation

The rate of haematuria is significantly higher in group A with a higher rate of blood transfusion than that of group B. The ratio of blood transfusion was reduced from 4:1 with gradual urinary decompression. Though gradual urinary decompression is cumbersome, it is recommended to reduce the rate of haematuria and blood transfusion with its associated complications.

Author contributions

Both authors made significant contributions to this study ranging from conception, study design, execution, acquisition of data, analysis, interpretation, drafting, revising, and approval for its publication.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Boettcher S, Brandt AS, Roth S, Mathers MJ, Lazica DA. Urinary retention: Benefit of gradual bladder decompression-myth or truth? A randomized controlled trial. Urol Int 2013;91:140-4.
2. Nyman MA, Schwenk NM, Silverstein MD. Management of urinary retention: Rapid versus gradual decompression and risk of complications. Mayo Clin Proc 1997;72:951-6.
3. Ahmed M, Abubakar A, Lawal AT, Bello A, Maitama HY, Mbibu HN. Rapid and complete decompression of chronic urinary retention: A safe and effective practice. Trop Doct 2013;43:13-6.
4. Mohamed HE, Fatma HS, Cervando OV, Etafy MH, Saleh FH, Alaa M, *et al*. Rapid versus gradual bladder decompression in acute urinary retention. Urol Ann 2017;9:339-42.
5. Glahn BE, Plucnar BJ. Quick complete emptying of the bladder in 300 cases of urinary retention. The occurrence of haematuria. Dan Med Bull 1984;31:68-70.
6. Bartlett JE, Kotrlik JW, Higgins C. Organizational research: Determining appropriate sample size for survey research. Inform Technol Learn Perform J 2001;19:43-50.
7. Perry A, Maharaj D, Ramdass MJ, Naraynsingh V. Slow decompression of the bladder using an intravenous giving set. Int J Clin Pract 2002;56:619-21.
8. Naranji I, Bolgeri M. Significant upper urinary tract haematuria as a rare complication of high-pressure chronic retention of urine following decompression: A case report. J Med Case Reports 2012;6:254.
9. O'Reilly PH, Brooman PJ, Farah NB, Mason GC. High pressure chronic retention. Incidence, aetiology and sinister implications. Br J Urol 1986;58:644-6.
10. Holcomb JB, Tilley BC, Baraniuk S, Fox EE, Wade CE, Podbielski JM, *et al*; PROPPR Study Group. Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: The PROPPR randomized clinical trial. JAMA 2015;313:471-82.
11. Krishnamurthy AV, Mathialagan J, Raghavan AV, Srinivasan S. Analysis of patterns of adverse transfusion reactions and management: A novel initiative toward hemovigilance in a teaching hospital of South India. J Lab Physicians 2020;12:133-40.
12. Muche Y, Gelaw Y, Atnaf A, Getaneh Z. Blood transfusion complications and associated factors among blood-transfused

adult patients at Debre Markos Comprehensive Specialized Hospital, Ethiopia: A cross sectional study. J Blood Med 2023;14:389-98.
13. Adewoyin AS, Oyewale OA. Complications of allogeneic blood transfusion: Current approach to diagnosis and management. Int Blood Res Rev 2015;3:135-51.
14. Sharma S, Sharma P, Lisa N. Transfusion of blood and blood products: Indications and complications. Am Acad Fam Physicians 2011;83:719-24.
15. Gelaw Y, Woldu B, Melku M. Proportion of acute transfusion reaction and associated factors among adult transfused patients at felege hiwot compressive referral hospital, Bahir Dar, Northwest Ethiopia: A cross-sectional study. J Blood Med 2020;11:227-36.
16. Muleta MB, Yisak EH, Gebreselassie HA, Tefera T, Berhanu E, Mekonnen AL, *et al*. A cross-sectional study to analyze blood and blood component transfusion practice at tertiary care hospital of Ethiopia. Clin Audit 2021;13:29-35.
17. Tamene M, Tsegaye A, Birhanu A, Taye B, Birhaneselassie M. Assessment of transfusion utilization and patient outcomes at the largest referral and university hospital in Addis Ababa, Ethiopia. ISBT Sci Ser 2016;11:7-13.
18. Tewabe H, Mitiku A, Worku H. Assessment of blood transfusion utilization and patient outcomes at Yekatit-12 Hospital, Addis Ababa, Ethiopia. J Blood Med 2022;13:171-80.
19. Unal D, Senayli Y, Polat R, Spahn DR, Toraman F, Alkis N, *et al*; Turkish Society of Anaesthesiology and Reanimation Patient Blood Management Group. Peri-operative blood transfusion in elective major surgery: Incidence, indications and outcome - an observational multicentre study. Blood Transfus 2020;18:261-79.
20. Yaddanapudi S, Yaddanapudi L. Indications for blood and blood product transfusion. Indian J Anaesth 2014;58:538-42.
21. Shweta P. Surveillance of transfusion related adverse reactions in a tertiary care centre in Bangalore: A 4-year hemovigilance initiative. Indian J Hematol Blood Transfus 2020;36:733-9.
22. Mehrdad P, Mohammad Erfan Z, Atefeh Nasir K, *et al*. Descriptions of acute transfusion reactions in the teaching hospitals of Kermanshah University of Medical Sciences, Iran. Int J Hematol Oncol Stem Cell Res 2013;7:11.
23. Harvey AR, Basavaraju SV, Chung KW, Kuehnert MJ. Transfusion-related adverse reactions reported to the National Healthcare Safety Network Hemovigilance Module, United States, 2010 to 2012. Transfusion 2015;55:709-18.
24. Meza BP, Lohrke B, Rea W. Estimation of the prevalence and rate of acute transfusion reactions occurring in Windhoek, Namibia. Blood Transfus 2014;12:352.
25. Musumari PM, Mbikayi SM, Srithanaviboonchai K, Techasrivichien T, Tangmunkongvorakul A, Tshilolo L. Symptoms of acute transfusion reactions at a general referral hospital in Kinshasa, Democratic Republic of Congo: A cross-sectional study. BMJ Open 2021;11:e045081-081.
26. Alter HJ, Klein HG. The hazards of blood transfusion in historical perspective. Blood 2008;112:2617-26.
27. Yao C-Y, Chien J-H, Chuang H-Y, Ho T-F. Associated factors with acute transfusion reaction from hospital online reporting events: A retrospective cohort study. J Patient Saf 2020;16: e303-9.
28. Gwaram BA, Borodo MM, Dutse AI, A K-G. Pattern of acute blood transfusion reactions in Kano, North-Western Nigeria. Niger J Basic Clin Sci 2012;9:27-32.
29. Vasudev R, Sawhney V, Dogra M, Raina TR. Transfusion-related adverse reactions: From institutional hemovigilance effort to National Hemovigilance Program. Asian J Transfus Sci 2016;10:31-6.
30. Pomper GJ. Febrile, allergic, and nonimmune transfusion reactions. Rossi's Princ Transfus Med 2009;2009:826-46.
31. Heddle NM. Pathophysiology of febrile nonhemolytic transfusion reactions. Curr Opin Hematol 1999;6:420-6.
32. Webb C, Norris A, Hands K. An acute transfusion reaction. Clin Med 2018;18:95-7.
33. Fung YL, Silliman CC. The role of neutrophils in the pathogenesis of transfusion-related acute lung injury. Transfus Med Rev 2009;23:266-83.
34. Bhuva DK, Vachhani JH. Red cell alloimmunization in repeatedly transfused patients. Asian J Transfus Sci 2017;11:115-20.
35. Blajchman MA. Immunomodulation and blood transfusion. Am J Ther 2002;9:389-95.
36. Obrador R, Musulin S, Hansen B. Red blood cell storage lesion. J Vet Emerg Crit Care 2015;25:187-99.
37. Wanchaitanawong W, Tantiworawit A, Piriyakhuntorn P, Rattanathammethee T, Hantrakool S, Chai-Adisaksopha C, *et al*. The association between pre-transfusion hemoglobin levels and thalassemia complications. Hematology 2021;26:1-8.
38. Holowaychuk MK, Leader JL, Monteith G. Risk factors for transfusion-associated complications and nonsurvival in dogs receiving packed red blood cell transfusions: 211 cases (2008–2011). J Am Vet Med Assoc 2014;244:431-7.
39. Tormey CA, Hendrickson JE. Transfusion-related red blood cell alloantibodies: Induction and consequences. Blood 2019;133:1821-30.
40. Padmanabhan A, Connelly-Smith L, Aqui N, Balogun RA, Klingel R, Meyer E, *et al*. Guidelines on the use of therapeutic apheresis in clinical practice: Evidence-based approach from the writing committee of the American Society for Apheresis: The eighth special issue. J Clin Apheresis 2019;34:171-354.
41. Tufa F, Kiya T, Maleko G, *et al*. Assessment of recipients' characteristics, transfusion appropriateness, and utilization pattern of blood and blood products in Jimma Medical Center, Jimma, Ethiopia. PLoS One 2021;16:e0250623.
42. Miah SS, Doha MA, Islam A, *et al*. The first data of hemovigilance: Appraised from a single center in Bangladesh. Glob J Transfus Med 2021;2:18-23.
43. Dhiman Y, Raturi M, Kala M, Kusum A. Significance of mandating a dedicated hemovigilance nurse and objectification of "imputability" levels. Experience from a hospital-based blood centre in India. Transfus Clin Biol 2023;30:96-102.
44. Chonat S, Quarmyne M-O, Bennett CM, Dean CL, Joiner CH, Fasano RM, *et al*. Contribution of alternative complement pathway to delayed hemolytic transfusion reaction in sickle cell disease. Haematologica 2018;103:e483-5.
45. Bowman Z, Fei N, Ahn J, Wen S, Cumpston A, Shah N, *et al*. Single versus double-unit transfusion: Safety and efficacy for patients with hematologic malignancies. Eur J Haematol 2019;102:383-8.
46. Jakubowska K, Chrusciel P, Jurek K, Machul M, Kosciołek A, Dobrowolska B. Religiosity and attitudes towards health, disease, death and the use of stimulants among Jehovah's Witnesses. Int J Environ Res Public Health 2021;18:5049.
47. Thompson HA. Blood transfusions and Jehovah's Witnesses. Tex Med 1989;85:57-9.
48. Pavlikova B, van Dijk JP. Jehovah's Witnesses and their compliance with regulations on smoking and blood treatment. Int J Environ Res Public Health 2022;19:387.