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Original Article

Transfusion Medicine Section

Time and Motion Study of Blood Delivery System in a Regional Blood Transfusion Centre in West Bengal: A Pilot Study

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ABSTRACT

Introduction: Delay in turnaround time (TAT) of blood delivery for transfusion is an important administrative problem in hospitals. Time and motion study for a definite root cause analysis (RCA) is valuable to identify the root causes of problems in the operating events.

Aim: The study was undertaken to observe TAT and the causes of increased TAT of blood delivery for transfusion to the admitted patients on an emergency basis at hospital and to formulate plans to rectify them.

Materials and Methods: This descriptive longitudinal study was performed on 50 randomly selected admitted patients requiring emergency blood transfusion during a period of six months and were not assisted by volunteers. Another 50 control patients were incorporated, who were accompanied by volunteers who assisted them in getting the blood. RCA of the delays in TAT was done. Time intervals of TAT in the two groups were compared by 2 tailed t-tests for equality of means. The data was analysed using Epi-info 7 and SPSS version 16. A 'p-value' of less than 0.05 was taken to be statistically significant.

Results: All the time intervals were high in the study group in comparison to the control group and in most cases they were statistically significant ($p < 0.05$) within a 95% confidence interval of the difference. The maximum time needed in both groups was in D7 (mean 89.70 and 83.50 minutes in cases and controls respectively) i.e. the interval between the relative reaching regional blood transfusion centre with blood sample and donor (T7) and patient's blood sample being processed for grouping and cross matching (T8).

Conclusion: The study revealed that certain easy to implement administrative steps would help to reduce the TAT significantly.

Keywords: Blood delivery system, Delay, Root cause analysis

INTRODUCTION

Health care processes are difficult to define, because of their complexity [1]. Assessing time definitions in clinical processes can help in analysing workflows and weak points in hospital information systems (HIS) [2]. Improvement in the efficiency of clinical workflows decreases the cost of health care [3].

Blood is a very important resource to be used in a wide range of hospital procedures like accidents, emergency obstetric services and other surgical procedures. Blood transfusion service is an integral part of modern health care. Aim of a good blood transfusion centre should be 'right blood to right patient at right time'. In other words, blood delayed is equivalent to blood denied [4].

One of the common measures of performance of patient care services like laboratory or radiological services is the turnaround time (TAT), which has been frequently used since 1980, to quantify the time taken for doing laboratory tests in an objective manner [5]. Probably the first reference of TAT was by Tell and Hoffman in 1971, who described TAT as the time interval between electrocardiogram printing and placement of the printout in the patient chart [6]. In a laboratory, the turnaround time has a fixed component, which depends on the time taken for an assay, and a variable component (pre and post analytic component) [3,7]. Prolonged turnaround time (TAT) of patient care services like laboratory investigations, Radiology services, Blood banking services affect patient care as well as patient satisfaction adversely.

Root cause analysis (RCA) is a method by which an investigator tries to identify the basic causes of faults or problems that cause operating events and tries to rectify or overcome them [3,8,9].

Lack of availability of blood at regional blood transfusion centre is a constant complaint on the part of the patients coming to get blood for transfusion in our hospital. At times, it becomes difficult for a patient's relative to arrange a blood donor if he/she is alone or hails from a distant place. It was identified as a problem in the functioning of the institution. There are a number of other factors which delay the procurement of blood from RBTC and thus jeopardise patient's condition which is already critical [5].

The present 'pilot study' attempts at pinpointing root causes of delay in procuring blood for an admitted patient from an in house blood transfusion centre of a rural tertiary care hospital and suggest practical corrective measures if any. This type of study related to TAT in blood banking service has not been documented in the literature as per best of our knowledge.

MATERIALS AND METHODS

The present study was a descriptive longitudinal study which was conducted on patients who were admitted to emergency department of a tertiary care hospital in North Bengal and needed urgent whole blood or packed cell transfusion. Ethical clearance was obtained by institutional ethical committee. During the study period of six months (1st March 2014 to 31st August, 2014), two set of patients (cases and control subjects from two different settings, one unassisted and the other assisted) from two different settings (one assisted and other unassisted) were studied for comparing the difference in outcome. These cases and controls were matched for all variables except the variable of interest. The beneficiaries were followed up at all points to assess time taken in each step. On each day we collected data from a case and a control.

We included patients requiring urgent whole blood/ packed cell transfusion and admitted in one of the six wards- i) casualty (emergency), ii) surgery, iii) medicine iv) obstetrics & gynaecology, v) orthopaedics and vi) paediatrics. Patients requiring blood transfusion in 'cold' operation cases, thalassemia and other patients requiring regular blood transfusion, unwilling patients and patients receiving blood against past donation (patients having a donor card) were excluded from the study.

Fifty (50) patients requiring blood transfusion for emergency, were selected by systemic random sampling formed the 'cases'. Fifty (50) patients & relatives who were assisted from the beginning with volunteers formed the 'control' group. All control cases (total 50) were accompanied by volunteers who helped the relatives (through verbal guidance) to get the blood for transfusion and tried to reduce the time intervals as far as possible without actively involving in any step. No randomisation was done. One case and one control were selected in a day and time taken by them at each step was noted by the observer.

The results obtained from the uninterfered patients (50 cases) and those helped by volunteers (50 controls) were compared. Time of each steps from physician's order for blood transfusion (T1) to matching of blood bag with label, group, expiry date and keeps it for transfusion (T11) were recorded . [Table/Fig-1] represents the flowchart of steps of blood requisition to transfusion. Time interval in each step was calculated in both cases and control groups [Table/Fig-2]. By this, the delay in each step of the 'cases' were matched against the 'controls' and TAT was calculated. Then the causes of the delay of obtaining blood was noted and RCA was done.

START -

Physician orders for blood transfusion in the ward (T1)
D1 ↓
Ward Nurse processes Physician's orders and enters in the Duty register (T2),
D2 ↓
Junior Doctor fills up the blood requisition form (T3)
D3 ↓
Bedside Nurse/Junior doctor collects blood sample for grouping and cross matching (T4)
D4 ↓
Sample labelled and handed over to the patient's relative with form (T5)
D5 ↓
Relative arranges for blood donor(s) /donor card (T6)
D6 ↓
Relative reaches RBTC with blood sample and donor (T7)
D7 ↓
Patient's blood sample is processed for grouping and cross matching (T8)
D8 ↓
Required units of blood handed over to relative (T9)
D9 ↓
Relative takes blood to the ward and gives it to the ward nurse (T10)
D10 ↓
END- Nurse matches the blood with label, group, expiry date and keeps it for transfusion (T11)

[Table/Fig-1]: Flow chart of key steps in blood delivery system in this study.

Time Interval	Time range of cases and (Mean) minutes	Time range of controls and (Mean) minutes	Mean difference (mins)	Std error of difference	p-value
D1	12.0-5.0 (7.60)	12.0-5.0 (6.58)	1.02	0.332	0.83
D2	12.0-3.0 (7.08)	5.0-2.0 (3.14)	3.94	0.30	<0.05
D3	15.0-5.0 (9.40)	7.0-3.0 (4.80)	4.60	0.37	<0.05
D4	10.0-3.0 (6.18)	5.0-1.0 (2.40)	3.78	0.29	<0.05
D5	180.0-10.0 (59.60)	180.0-15.0 (58.70)	0.90	6.86	0.59
D6	10.0-3.0 (5.72)	8.0-2.0 (4.60)	1.12	0.31	0.08
D7	120.0-65.0 (89.50)	120.0-50.0 (83.50)	6.00	2.59	0.52
D8	15.0-3.0 (7.02)	10.0-2.0	1.84	0.46	<0.05
D9	12.0-3.0 (7.44)	10.0-1.0	3.58	0.39	<0.05
D10	10.0-3.0 (4.92)	6.0-1.0	1.40	0.23	<0.03

[Table/Fig-2]: Comparison of time intervals of cases and controls.

Based on the findings, the severity of the problems were categorized in to 'high', 'medium' and 'low' [Table/Fig-3]. The impact of the individual problem on procurement of the blood were categorized similarly. Salient recommendations were formulated on the basis of the findings [Table/Fig-4].

S.no.	Major Problems	Its impact on functioning	Severity of the problem
1.	Arranging of blood donor by the patients' relatives	High	High
2.	Cross matching of the blood samples being done by older time consuming techniques	High	High
3.	Lack of proper direction to reach RBTC, which is far away from many wards. Difficulty in identifying RBTC entrance. No sign-boards.	High	High
4.	Less number of blood donation camps per year	High	High
5.	a. Less no of ward nurses b. No separate staff for test order entry	Medium	Low
6.	Inadequate number of technicians at RBTC. No designated staff for blood collection from donors	Medium	Medium
7.	Inadequate medical officers to supervise the functioning	Low	Low
8.	Lack of staff motivation to perform pre-analytic steps. Tendency to accumulate cases during pre-analytic step (before blood sample collection)	Medium	Medium
9.	Much paper work is involved in multiple steps	Medium	Low
10.	No separate security guard at RBTC to thwart touts	Low	Medium

[Table/Fig-3]: Major managerial problems, their severity and impact on functioning of the system

STATISTICAL ANALYSIS

Overall TAT in cases and controls were estimated and compared them with a t-test for equality of means using Epi-info 7 and SPSS version 16. A 'p-value' of less than 0.05 was taken to be statistically significant.

RESULTS

Out of 50 cases, 28 (54%) were male and 22 (46%) were female respectively. The age range was from 6 year to 81year, with an average age of 42.02yrs.Out of 50 controls, 29 (58%) were male and 21 (42%) were female respectively. The age range was from 6yrs to 81yrs, with a mean of 40.56yrs.

[Table/Fig-2] represents the descriptive statistics of cases and control groups. The maximum time needed in both groups was in D7 (mean 89.70 mins in cases and 83.50 mins in controls) i.e. the interval between the relative reaching RBTC with blood sample and donor (T7) and patient's blood sample being processed for grouping and cross matching at RBTC (T8). In short it was the time taken for grouping and cross matching at RBTC. The second most time needed in both groups was in D5 (mean 59.60 minutes in cases and 58.70 minutes in controls) i.e. the sample blood labelled and handed over to the patient's relative with form (T5) and relative arranging for blood donor(s) /donor card (T6). In short it was the time taken to arrange for blood donors by the patient's relative. The standard deviation (SD) and range was exceptionally high in both these time intervals: I a) D7 (cases)-range= 55; mean=89.5± 12.21 minutes (SD); I b) D7 (controls)-range=70; mean=83.50 ±13.67 minutes (SD); II a) D5 (cases) -range =170, mean=59.60 ±36.61 minutes (SD); II b) D5 (controls) -range=165, mean= 58.70 ±31.84 minutes(SD).

The range in D7 was high because more units of blood needed more time for grouping and cross matching. Major managerial problems, their severity and impact on functioning of the system have been represented in [Table/Fig-3].

DISCUSSION

According to F W Taylor "time study is the technique of observing and recording the time required to do each element of an industrial operation. It helps in fixing the standard time required to do a particular job". Motion study is the study of movements of an operator or a machine. Its purpose is to eliminate useless motions and to find out the best method of doing a particular work [10].

Turnaround time (TAT) determination is a type of time and motion study used in diagnostic services e.g. pathology, radiology etc., and its principle can be applied to other time motion studies as well [11,12]. TAT in Pathology comprises a fixed component, which is assay dependent (the time required to analyse the specimen) and a variable component (the time taken to receive the specimen, order and post the result) [8]. In our study setting, fixed component was the time taken for grouping and cross matching in the blood bank (RBTC), while variable component included processing doctor's order by nurse, taking patient's blood sample for grouping and cross matching, arranging of a blood donor by the patient's relative and finally handing over the blood for transfusion to the ward nurse. The RBTC of our hospital follows a policy of supplying blood against a blood donor card (obtained though past voluntary donation) or fresh donation by patient's relatives. This is due to gap in demand and supply of blood collected through blood donation camps. Only under exceptional circumstances, blood is issued without card or donation. The process of self arrangement of blood is probably the main cause leading to the delay in the blood delivery to the patient.

The patients who are locals and have better knowledge about the location of blood bank could arrange blood in a short span of time while those from outside without known

Time Interval	Difference of means of cases and controls (minutes)	Major Causes of delay	Suggested Solutions
D1	1.02	No separate/designated staff for test order entry. Paper-work involved.	Additional staff may be posted in the wards.
D2	3.94	Ambiguity between junior doctor and nursing staff regarding filling up requisition forms. Paper-work involved. (dedicated staff absent)	Written instruction of duty charts and demarcation of duties between nurses and doctors
D3	4.60	No separate / designated staff for phlebotomy or sample collection. Usually treated as low priority job in comparison to therapeutic management of patients in the wards.	Training of staff regarding importance of pre-analytical phase of tests, blood transfusion. Written instruction of duty charts and demarcation of duties between nurses and doctors
D4	3.78	Lack of clear instruction to patient about where requisition would be made	Clear instruction regarding requisition making at the point of advising blood transfusion
D5	0.90	There is shortage of blood at RBTC. Patients are required to arrange for blood donors on their own to get blood for their patient	Situation explained to patient's relatives during blood requisition .Clear instruction regarding arranging blood donor etc Increasing frequency of voluntary blood donation camps for collection of blood by RBTC or through Non Government Organization (NGOs). Once adequate stored blood is present, it can be given to more patients on sale at low fixed government price
D6	1.12	Lack of proper direction to reach the Central Laboratory which is away from the Casualty block. Those who are conversant reach early; Difficulty in identifying the Central Laboratory entrance. No sign-boards in vernacular languages. Individual wards have separate staffs to transport the samples to the Laboratory. Hence availability of staff is less.	Direction to the Central Laboratory may be printed on the OPD tickets. Lab entrance should be made visible and more identifiable. Sign-boards especially in vernacular languages should be installed. Existing social workers, volunteers and 'May I help you' desks should be utilized more efficiently.
D7	6.00	Cross matching of the blood samples being done by older time consuming techniques. Inadequate number of technicians at RBTC. No designated staff for blood collection from donors RBTC staff accumulate samples and register and test them together.	Introduction of newer methods for cross matching at RBTC like gel-card system to reduce analytic time and give more accuracy. Increase in strength of all categories of staffs at RBTC by contractual or permanent recruitment
D8	1.84	Laboratory staff accumulate samples and register them at a time. Paper-work involved.	Accumulation of samples should be discouraged. Electronic test order entry software with bar coding of blood samples for cross matching may be started. It will fasten the process if an alert system is activated at RBTC once a blood requisition is done from a particular ward
D9	3.58	Some relatives may delay the process due to personal attitudes like gossiping etc	Tell the importance of early transfusion to the relatives
D10	1.40	Delay in registering received blood bags (for donation) Paper work involved	Motivation of staff Designate duties to individual staff

[Table/Fig-4]: Major causes and suggested solutions for every steps of delay.

contacts had to face great difficulty in arranging blood donors. Hence the range was higher in D5.

By doing root cause analysis (RCA) one tries to identify the basic causes or faults or problems of a particular operation. RCA is a useful management tool. It can be conducted at various levels in a system operation [7]. Thus TAT forms the basis of root cause analysis in a system.

Ten time intervals of TAT in study and control groups were compared by 2 tailed t-tests for equality of means. It was observed that most of the time intervals in the Study group

were high in comparison to the Control group and were statistically significant. Major causes and suggested solutions for every steps of delay [Table/Fig-3].

Recommendations

i. Entrance to RBTC should be made visible and more identifiable. Sign boards especially in vernacular languages must be installed.

ii. Direction to RBTC may be printed on the blood requisition form.

iii. Clear instruction to patients' relatives at the point of advising blood requisition regarding arranging blood donor etc.

iv. Effective utilisation of 'May I Help You desk' / volunteers/social workers, especially near the Casualty block.

v. Electronic test order entry software with bar coding of blood samples for cross matching may be started .This will reduce paper work. It will also fasten the process if an alert system is activated at RBTC once a blood requisition is done from a particular ward.

vi. Introduction of newer methods for cross matching at RBTC like gel-card system to reduce testing time. Cross matching for donor blood using Coomb's antisera takes 90-120 minutes whereas through gel card technique takes 30-45 minutes.

vii. Increased frequency of voluntary blood donation camps for collection of blood by RBTC or through Non-Government Organization (NGOs) or local clubs. Once adequate stored blood is present, it can be given to more patients on sale at fixed government price (presently the rate at NBMCH is Rs 50/unit of blood).

viii. Keep a list of persons with rare blood groups (Rh negative) in the nearby area with address and phone numbers.

ix. There should be increase in strength of all categories of staffs at RBTC either permanent or contractual posts for the time being. Arrange for training of existing and new staff (if posted) in newer modalities of blood banking system. Training of staffs regarding ill effects of sample accumulation and importance of pre analytic phase of blood transfusion.

x. Security guard posted at RBTC should be more active and vigilant.

LIMITATIONS

Due to time constraint, selection bias could not be eliminated completely. There was also logistic (human resource) constraint to work as volunteers and tracking the cases and their controls minutely.

CONCLUSION

The turnaround time of emergency blood delivery to patients from RBTC is prolonged due to increased time taken to locate the blood bank (RBTC), long time to arrange blood donor, and grouping - cross matching time at RBTC and for paper work in the ward.

The TAT can be substantially reduced if minor assistance without active interference is provided to the patients through better utilization of volunteers/social workers/ 'May I Help You desk' etc, (especially near Casualty block).

Also arranging for more blood donation camps to keep stored blood is necessary. This could be utilized by patients not able to arrange donor (s) and can be made purchasable at fixed government rates. This would substantially bring down the TAT and subsequently increase patient satisfaction.

Certain administrative initiatives like purchase of newer instruments (for example gel card system as per permissibility of funds) for cross matching will reduce the time taken for grouping and cross matching.

REFERENCES

[1] Ammenwerth E, Ehlers F, Eichstädter R, Haux R, Pohl U, Resch F. Systems analysis in health care: framework and example. Methods Inf Med. 2002;41(2):134-40.
[2] Lenz R, Buessecker F, Herlofsen H, Hinrichs F, Zeiler T, Kuhn KA. Demand driven Evolution of IT Systems in Healthcare. Methods Inf Med. 2005; 44:4-10.
[3] Khan K. Root cause analysis (RCA) of prolonged laboratory turnaround time in a tertiary care set up. J Clin Diagn Res. 2014 Apr;8(4):FC05-08.
[4] Peña JRA, Dzik WS. Utilization management in the blood transfusion service. Clin Chim Acta. 2014 Jan 1;427:178-82.
[5] Bloch DM. Computer-generated management tools for the clinical pathology laboratory. II. Computer-generated graphic work flow. J Med Syst. 1982; 6:305-10.
[6] Tell R, Hoffman I. The elimination of turnaround time in routine ECG processing. J Electrocardiol. 1971;4:279-81.
[7] Ash JS, Gorman PN, Lavelle M, Stavri PZ, Lyman J, Fournier L,et al. Perceptions of physician order entry: results of a cross site qualitative study. Methods Inf Med. 2003;42(4):313-23.
[8] Williams PM. Techniques for root cause analysis. Proc (Bayl Univ Med Cent). 2001;14(2):154-57.
[9] Battles JB, Kaplan HS, Van der Schaaf TW, Shea CE.The attributes of medical event-reporting systems: experience with a prototype medical event-reporting system for transfusion medicine. Arch Pathol Lab Med. 1998 Mar;122(3):231-38.
[10] Chhabra TN. Principles and practice of management.9th ed, New Delhi. Pp:75. 2005.
[11] Hawkins RC. Laboratory turnaround time. Clin Biochem Rev. 2007;28(4):179-94.
[12] Hoe J. Quality service in radiology. Biomed Imaging Interv J. 2007 Jul-Sep; 3(3):e24.

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