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Formatively evaluating the importance of different aspects of an electronic blood transfusion system from the end users' point of view: a questionnaire study

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Abstract

Blood transfusion is a process in which potential errors may result in serious adverse events to patients. To help improve the safety and efficiency of the blood transfusion process an electronic clinical transfusion management system is being piloted by NHS Connecting for Health. Evaluation of the implementation is being carried out in parallel. One component of the evaluation project aims to assess the importance placed in the various potential benefits of this new system by patients and healthcare workers. A questionnaire was generated and completed by healthcare workers and patients. Results indicate respondents viewing all factors as at least "important". "System" factors were deemed most important. Overall, clinical workers expressed the lowest importance to new process factors. Ultimately these results will be measured against final satisfaction with the system to assess 'fit' between perceived importance and satisfaction to guide areas for attention and resource allocation.

Keywords:

Blood transfusion, Value theory, Evaluation.

Introduction

Blood transfusion is the transference of blood or any blood products from one person to another. In many instances such as major trauma of post surgical operations this process can be life saving. It is also essential in treating certain chronic diseases which cause anemia.

A fundamental factor in safe blood transfusions is the compatibility between the transfused blood and that of the recipient. This compatibility is based on blood groupings. There are 30 major blood groups, among which the ABO and Rh systems are most significant. If incompatible blood is transfused to a patient the reactions may vary from a simple allergic reaction to severe hemolysis.

Cross match testing is used to ensure the compatibility of blood products to the recipient. In this test red blood cells of the donated blood are tested against the plasma of the recipient; if no agglutination occurs, it means that the product and the patient are compatible. Although rigorous regulations exist and cross match testing is performed prior to each transfusion, any mistakes during the transfer of the blood unit from the blood bank to bedside and then transfusion may result in fatal errors. Although this process appears deceptively simple it is composed of 11 stages and 66 steps. To tackle this potential problem a detailed procedure utilizing electronic technology – the Electronic Clinical Transfusion Management System (ECTMS) - has been defined by the National Patient Safety Agency (NPSA) in conjunction with the National Blood Transfusion Committee (NBTC) and the Serious Hazards of Transfusion (SHOT) to ensure the transfusion of right blood to right patient at bedside.

Traditionally this process was performed manually by two nurses. As blood transfusion is mostly required for more critical patients in high traffic wards, a new system would prove highly beneficial by reducing the number of staff required for this process, increasing the accuracy of this procedure and reducing the overall time spent carrying out the steps.

The ECTMS has been designed to improve this process by tracking the blood product through from arrival to blood lab to transfusion of the right blood to the right patient. After the pioneering implementation of this system at the Oxford Radcliffe Hospital, the Mayday Healthcare NHS Trust, South London, is the second site of implementation of this system and is the first site to integrate Radio Frequency Identification (RFID) technology into this process. One of the biggest problems in health care is the failure of uptake of new technologies which have been successfully implemented in other industries. To help document and prevent such problems in the Mayday project, the Centre for Health Informatics at City University, London, has been commissioned to perform a formative and summative evaluation of the implementation.

As the evaluation commenced before the "go live" of this system, the evaluation team had the opportunity to measure the perceived importance of factors in the new process before undertaking evaluation of opinions influenced by the bias of experience with the live system.

Based on definitions from Rokeach, Feather and Brown [1-3], values can be described as enduring principles with which people use to guide object evaluation and attitude formation.

Values are the main independent variables in the study of human attitude and behavior. User attitude and behavior are key factors in the acceptability of a new system which will lead to increased uptake and effectiveness. Rokeach classifies values into two groups, terminal and instrumental. Terminal values are those which are the end-state that one can strive for and in most cases are inaccessible to achieve. Instrumental values are single preferable modes of conduct, or means of achieving terminal values. The Johonson definition [4] includes a usability factor. According to this definition we attempted to include only instrumental values in this survey as both achievability and usability were the key factors for this evaluation.

As this evaluation was carried out within a formative framework, the goal of researchers in this phase of study was to ensure that the future users of system had the most realistic view of it. Pre-existing low expectations will result in unacceptability of the system. On the other hand extreme high expectations for the system will result in risk of future dissatisfaction.

Methods

Initially a literature review was performed to identify various values of electronic blood transfusion system or similar electronic management systems in health care [5].

In a brain storming session the obtained list of variables was discussed and related terminologies were merged. Finally, agreed variables were classified into four main categories: System, implementation, technical support and outcome. Detailed list of questions are presented in Table 1. Questions were adapted from the expected benefits outlined by the Mayday Project Initiation Document (PID), the updated DeLone and McLean model of Information System success [6].

A list of job roles related to blood transfusion was prepared. This list consisted of clinical staff (doctors and nurses), paraclinical staff (laboratory technicians and phlebotomists), IT technicians, porters and patients. A matrix of relativity between the values for blood transfusion management systems and the above roles was generated. The respondents were gathered via pseudo-proportionate opportunistic sampling.

According to King and Epstein a rating scale can be as reliable as a ranking scale [7]; to measure perceived importance of generated values a questionnaire was created using Likert-type scaling.

Table 1 – List of questions in value measurement questionnaire

Question Group	Question
System Specifications	The ability to track products across the hospital in real time
	Improving product information due to electronic storage and delivery of information
	The system is easy to use
	The system is fast
	The system is responsive
	The equipment is durable and hard wearing
	The system is flexible and is able to absorb any changes in processes
	The system is secure from unauthorized access
	Compliance with standards and legislation
	Data recovery from error e.g. if there is a problem with the power supply
Implementation	Involving patients in the ordering process
	Involving patients in the checking process
	The requirement for adequate training
	Terminals and equipment are readily available to use
Technical Support	The implementation of a formalized change management plan including training on the new system
	Improved system auditing and control
	If there's a problem with the system, there is immediate support
	Availability of online help
	Availability of back up devices in case of device failure
Outcome	Reducing the number of blood samples rejected by the lab
	Time savings for staff involved in blood transfusions via the automation of processes
	Decreasing the number of manual labor intensive systems

Table 1 (continued)

Question Group	Question
Outcome (Continued)	Having guided steps in any given process involved with blood transfusion
	Improving access to patient transfusion history and any special requirements
	Patient information is accurate and complete at the time of enquiry due to quick and easy information updating
	Providing early alerts to blood labs for product requests and special product requirements
	The system is reliable and does not experience substantial "down time"
	Removing paper-based processes and providing information electronically
	Improving the wristband technology to assist the checking process

Based on the recommendation from Kahle and Kennedy [8], a zero to positive rating model was chosen for this value survey. To prevent the middle point effect being interpreted as a neutral point, we chose a six item scale according to recommendation from Fowler as shown in Table 2.

Table 2 – Classification of Likert-type response used in this questionnaire

Importance level	Description
1	Not important
2	Not so important
3	Slightly important
4	Important
5	Very important
6	Extremely important

Demographic questions concerning and age and gender were included for further classification of responders.

Regarding the internal validity of this questionnaire, a review of the literature was performed to ensure that all proposed elements about importance of such a system were covered. A semi-structured questionnaire was also carried out to give the responders the opportunity to express other values which were not included in the questionnaire. To verify external validity the same study should be performed in other sites to check if similar results will be obtained.

A paper-based questionnaire was designed and completed during individual interview sessions with respondents.

For checking the reliability of information obtained, a random sample of 10% of responses was checked by another member of team before data analysis.

All recruitment was carried out at the Mayday Healthcare NHS Trust.

Results

SPSS 16 was used to analyze data obtained in this study. A pre-analysis data preparation process was performed for further validation of data.

Outlier Control

This study included 29 variables. Two methods of multivariate outlier control were used; if any response failed in both methods it was excluded from final analysis. The first method used was Mahalanobis Distance which evaluates the distance of each case from centroid of the remaining cases. Mahalanobis Distance Test was performed on the 29 questionnaire items. The maximum residual statistic was 35.673. The related value in table of Chi Square (degrees of freedom = 28) and P value of 0.05 is 41.34. The second method used was Cook's Distance. In this test one of the records had the value of 3.7 and as this value was more than 1 it was considered to be an outlier and excluded from final analysis (see Figure 1).

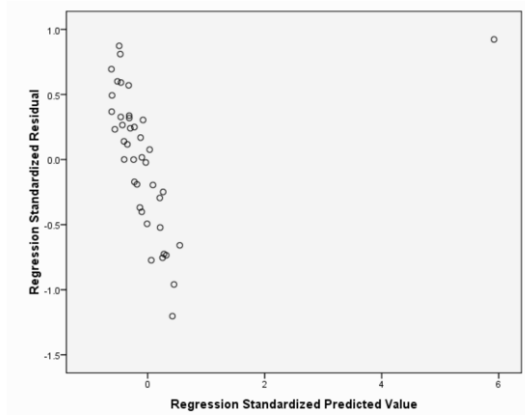

Figure 1– Distribution of responses based on residual and predicted values

After deleting the single outlier record, the distribution of respondents based on their role was presented in Table 3.

Table 3 – Frequency of participants according t role-based classification

Respondent Group	Frequency of respondents
Clinical Staff	45 (54.22%)
Para-clinical Staff	9 (10.84%)
Porters	9 (10.84%)
Patients	20 (24.10%)

Reliability

This is the first time that a value questionnaire has been implemented in this field. To validate this questionnaire the reliability of the items were evaluated using Cronbach's alpha test shown in Table 4.

In the next step, the mean value of responses for each category of questions was calculated. A Kolmogorov-Smirnov test showed normal distribution of these calculated mean values. Also there was a high internal consistency between these grouped variables, with Cronbach's alpha equal to 0.864.

Table 4 – Reliability test results for value questionnaire

Values	Cronbach's alpha
System	0.906
Implementation	0.714
Support	0.846
Outcome	0.816

The overall results obtained for level of importance in each aspect of the system is presented in Table 5.

Table 5 – Descriptive analysis of mean of value in each aspect of system

Mean of Values	Minimum	Maximum	Mean	Std. Dev
System	2.90	6.00	4.95	0.91
Implementation	2.50	6.00	4.73	0.84
Support	1.20	6.00	4.56	1.03
Outcome	3.00	6.00	4.55	0.72

Comparing the results between the respondent role groupings by using ANOVA analysis showed significant difference among the mentioned groups as presented in Table 6.

Table 6 – Comparison of results between the respondent groups

Values	F	P Value	Eta Squared
System	13.18	0.000	0.34
Implementation	2.54	0.062	0.09
Support	3.61	0.033	0.11
Outcome	3.28	0.044	0.10

Post hoc tests showed significant difference in clinical staff responses compared to answers from porters and patients in importance of the system. Clinical staff gave overall lower scores for importance in the survey items. The effect size test showed this was a large effect for "system" values and medium effect for the rest of the items according to the Cohen classification.

Most of the people involved in blood transfusion process at the Mayday Hospital were female. In our survey 8 of participants did not respond to the question about gender but a similar pattern was found in the respondents presented in Figure 2 which demonstrates proportionate sampling based on gender.

There was a significant difference between the responses from two gender groups on "system" values with t (73) = 3.702 and P = 0.000, with lower average by females.

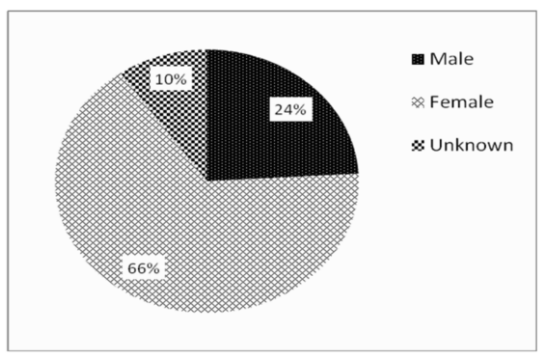

Figure 2– Distribution of responses based on gender

The other demographic factor that was used to classify the participants was age. We discretized the participants by age based on quartiles in four buckets as shown in Figure 3.

A one way ANOVA test showed a significant difference among the mentioned groups in the "outcome" category as presented in Table 7.

Post hoc analysis was not possible because of limitations in sample size.

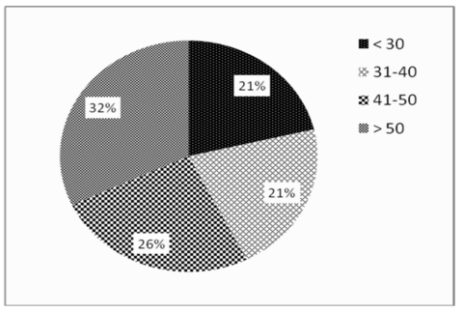

Figure 3– Distribution of responses based on age groups

The effect size test showed a large effect in "support" and "outcome" values and a medium effect in the rest of the items according to the Cohen classification.

Table 7 – Comparison of results between the age groups

Values	F	P Value	Eta Squared
System	2.13	0.110	0.13
Implementation	2.15	0.107	0.13
Support	1.81	0.170	0.17
Outcome	2.98	0.049	0.26

Discussion

The results presented appear to express a relatively high level of importance placed in all aspects of a potential blood transfusion management system by end users. The highest importance was given to "system" values and the lowest to "outcome". This implies that the end users it is important for this system to be more of a process facilitating tool rather than something to produce effective final outcomes in blood transfusion.

There was a significant difference in importance placed in different factors between the clinical staff compared to porters and patients. Clinical staff expressed lower importance in all aspects of the system. Some of these differences might be explained by the type and amount of involvement in the process of blood transfusion. For example, clinical staff are more directly involved at the point of transfusion and may rate their own self-efficacy in the process comparatively highly, thus additional technology as superfluous. It may be a factor that clinical staff see additional technology as an unnecessary complication in a job they consider as fairly routine.

For most factors, males and females have similar views, but males placed higher importance in the system itself. Different age groups have generally no significantly different views but outcomes were considered more important in respondents over 50 years of age.

Conclusion

Although this was the first time that value-based model was applied to a blood transfusion management system, the designed questionnaire appears valid and provided statistically reliable results. All four categories relating to the new system were rated as at least "important" on average, with "system" variables rated most important overall.

According to value theory, the outcomes of this importance survey are related to perceived effectiveness of the system. Disproportionately high expectations may result in dissatisfaction with the system. This is a subject for the next phase of evaluation, to be investigated at the end of the project.

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