Can We Learn about Human and Organisational Factors from Past Transfusion Errors?

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Abstract Seven human factors models were evaluated using a small number of historical transfusion error reports to explore learning from human and organisational factors to decide the best model for a larger retrospective study. Insufficient information given in many reports led to subjectivity in categorisation, but the conclusion was that the systems engineering initiative for patient safety 2.0 may be the best single system to use. Analysing the human factors effectively in transfusion incidents could provide some insights into process improvement.

Keywords Transfusion, Healthcare, Incidents, Safety.

1. Introduction

Since 1996, transfusion errors and reactions in any healthcare organisation in the United Kingdom (UK) have been reportable to the UK haemovigilance scheme, Serious Hazards of Transfusion (SHOT) www.shotuk.org. However, the incident reporting questionnaires do not specifically include any examination of the human factors (HF) and systems problems that might contribute to an error. There has been very little HF research in transfusion, so a retrospective analysis of previously reported transfusion errors would highlight the system failings leading to errors and facilitate recommendations for safety improvements within the transfusion process.

The objective for this study was to elucidate which HF method(s) is/are the most effective to analyse historical transfusion error reports in order to gain the maximum learning from these incidents. Most HF methods are not designed for healthcare systems and have traditionally been used for examining incidents in high reliability organisations (HRO) such as aviation and the nuclear industry. Although these industries involve complex sociotechnical systems, they do not have the variability associated with healthcare.

2. Methods

A limited dataset of historical transfusion error reports (n=76) from calendar year 2014 was analysed using seven different HF models for incident investigation. These reports had already been fully analysed by SHOT's traditional techniques and published in the 2014 Annual SHOT Report (Bolton - Maggs, 2015). Therefore, the dataset was known to be validated and suitable for further research. The HF models and methods that were used are summarised in Table 1.

Table 1: Brief description of the sub-categories of HF models and how each characteristic was interpreted

HF models and application of each characteristic

SRK – Skills, Rules, Knowledge (Rasmussen, 1983) **Skills** - Operators performing role with little conscious control. **Rules** - Limited by regulations or standard operating procedures (SOP), low levels of knowledge **Knowledge** - Application of knowledge and experience to complex tasks or changeable circumstances.
Active & Latent – Swiss Cheese Model (Reason, 1990) **Slips** - Skill-based slip - action not carried out as planned **Lapses** - Skill-based lapse, such as omission **Mistakes** - Rule or knowledge-based error. Faulty plan or intention, i.e. did something believing to be correct **Violations** - Acted against SOP or regulations **Latent** - Managerial, organisational and high level failures
AcciMap – Accident Mapping system (Rasmussen, 1997) **Government** - Department of Health (DH) level **Regulatory** - Transfusion regulators and guideline publishers **Company** - Trust management **Operational** - Departmental management **Staff** – People, including staff and patients **Equipment & surroundings** - Local equipment and direct environment
HFACS – Human Factors Analysis and Classification System (Shappell et al.,1997) **Unsafe acts (UA)** - Level 1 - errors and violations **Preconditions for UA** - Level 2 - Environment, personal (medical, tired, not capable etc) personnel (communication) **Unsafe supervision** - Level 3 - training, leadership, known problem, supervisory **Organisational** - Level 4 - HR, budget, equipment/facility, climate, operational
STAMP – Systems Theoretic Accident Modelling and Processes (Leveson, 2004) **Enforcement constraints** - Control actions = unidentified hazard, lack of control of known hazard, process doesn't enforce control **Execution of control action** - Communication, inadequate actuator e.g. IT component that moves/controls system **Missing feedback -** Inadequate or missing feedback in system
FRAM – Functional Resonance Analysis Method (Hollnagel et al., 2004) **Input** - Start of process **Output** - Result of what the function does e.g. by processing the input **Resource** - Something needed or consumed while a function is carried out **Controls** - e.g. SOP, guidelines etc. **Precondition** - Function cannot begin before preconditions established. **Time** - Temporal relationships, e.g. order of doing things, or if done in parallel
SEIPS 2.0 – Systems Engineering Initiative for Patient Safety 2.0 (Holden et al., 2013) **Person(s)** - Both patients and healthcare professionals **Tasks** - Specific actions within larger work processes. **Tools & Technology** - Objects that people use to do work or that assist in doing work. **Organisation** - External control of time, space, resources, activity etc. - i.e. management **Internal environment** - Physical e.g. light, noise, vibration, temperature, physical layout, available space, air quality **External environment** - High-level societal, economic, ecological, policy = factors outside an organization

The rationale for choice of incidents to be studied was:

1. Errors that led to an incorrect blood component transfusion (IBCT) which is the most dangerous of errors made in the transfusion process and can lead to patient death. Laboratory based IBCT errors (n=36) were analysed, due to the author's professional background facilitating a more accurate HF analysis from the scientific information given.

2. A similar number of near miss errors (n=40) were analysed as a comparison for the IBCT incidents. Near misses are defined by the error being discovered before the transfusion of a blood component actually took place. It was expected that as these errors were detected before any harm came to the patient, there might be better descriptions of how the error happened and what led to the discovery of the incident. It is anticipated that transfusion near miss errors will potentially be a source of information on Safety-II aspects, which can be compared to the current systems of transfusion error reporting that reflect a Safety-I culture (Hollnagel, 2014).

3. Results

Table 2 shows a breakdown of which errors were subcategorised including those where the details provided were not sufficient to make a categorisation at all, n=26/76 (34.2%).

Table 2: Summary of outcome of subcategorisation of error incidents

	IBCT	Near miss	Total
Errors subcategorised	27	23	50
Errors not assessable	9	17	26
Overall total	36	40	76

Figures 1 to 7 show the results of the subcategorisation of n=50 transfusion error reports using seven different human factors models.

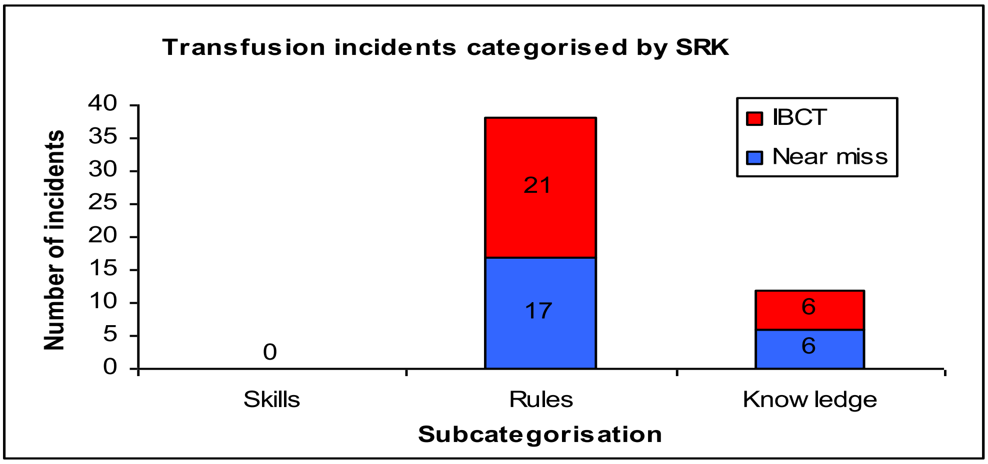

Figure 1: Transfusion incidents categorised by SRK

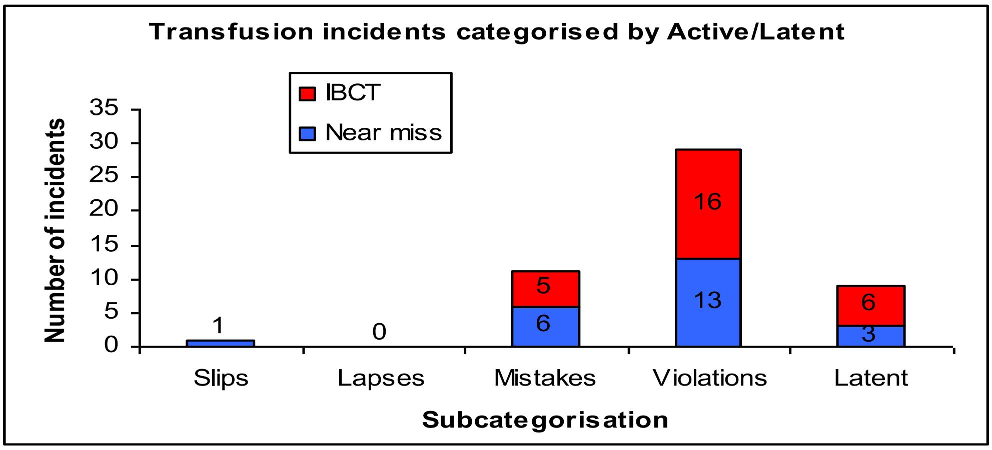

Figure 2: Transfusion incidents categorised by Active/Latent (Swiss cheese model)

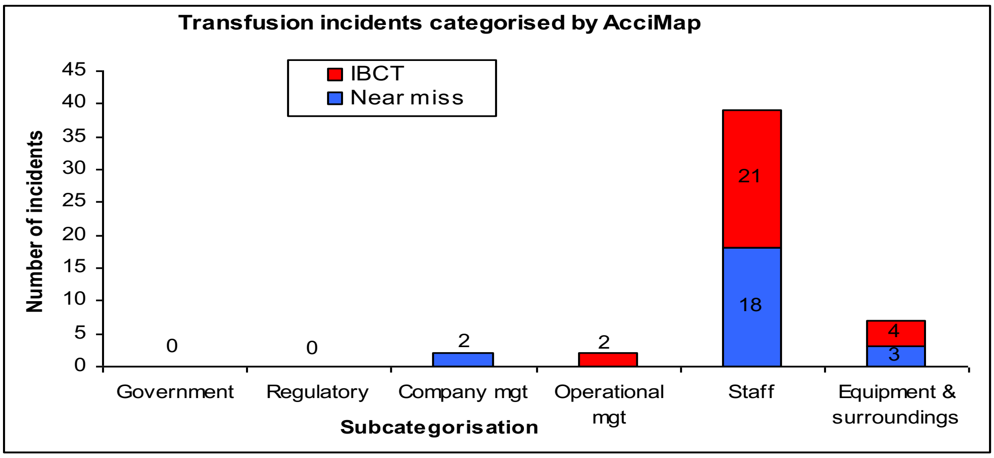

Figure 3: Transfusion incidents categorised by AcciMap

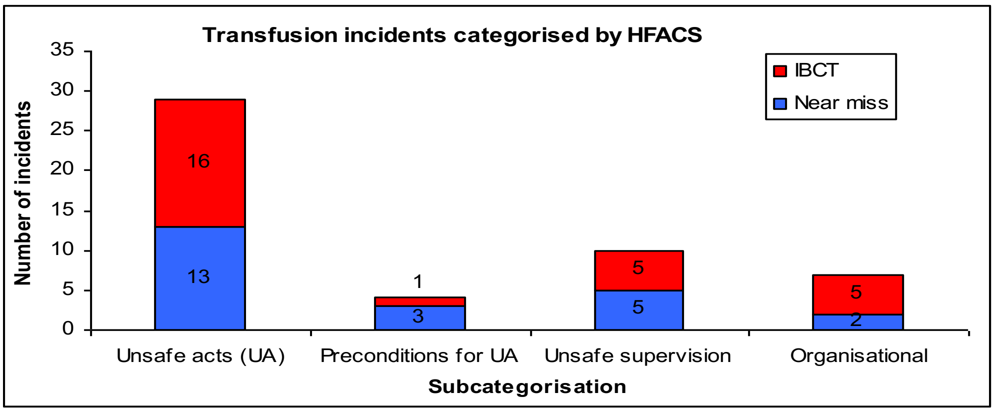

Figure 4: Transfusion incidents categorised by HFACS

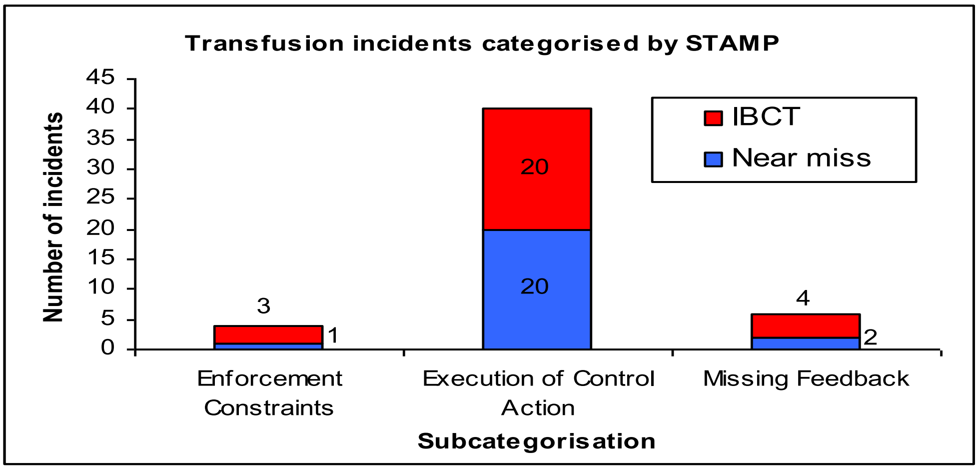

Figure 5: Transfusion incidents categorised by STAMP

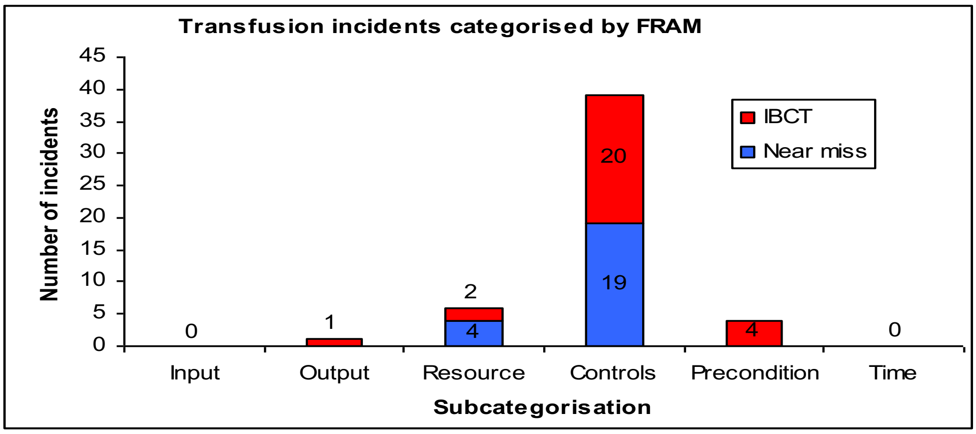

Figure 6: Transfusion incidents categorised by FRAM

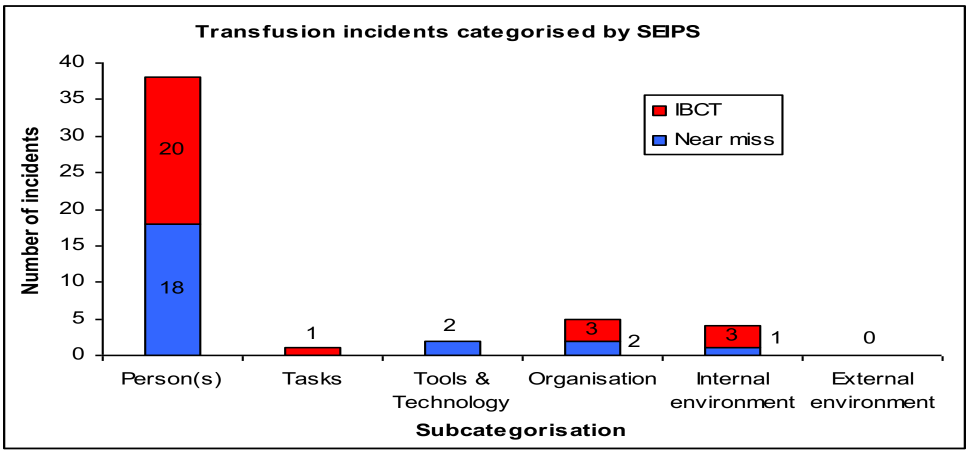

Figure 7: Transfusion incidents categorised by SEIPS 2.0

Each HF model was ranked against a set of criteria as given in Table 3.

Table 3: Ranking of HF models against pre-determined criteria designed to select the most useful method for classification
Scoring system: 0 - does not meet the criteria; 1 - barely meets the criteria; 2 - partially meets the criteria; 3 - fully meets the criteria.

	Human Factors Models (abbreviations are expanded in Figures)						
Criteria to rank HF models for study 1	**SRK**	**Active & latent**	**Acci Map**	**HFACS**	**STAMP**	**FRAM**	**SEIPS**
Simple to use with minimum training	2	2	0	0	0	0	0
Has a clear scope for analysis	3	3	2	3	3	0	3
Consistent classification between different types of incident	0	0	0	3	2	0	3
Focuses on patient safety	0	0	0	0	0	0	3
Searches for and reveals underlying causes	0	0	2	3	2	3	3
Provides a description of the incident	0	0	2	2	2	0	2
Contributes to understanding of corrective and preventative actions (CAPA)	0	0	2	2	0	0	2
Can classify multiple errors occurring in a single incident	0	0	2	2	2	2	2
Helps in generating recommendations	0	0	2	3	2	0	3
Is valid and reliable to provide a clear outcome	insufficient data to rank						
Total	5	5	12	18	13	5	21

4. Discussion and Conclusion

The results of the subcategorisation exercise show some inconsistencies and in particular some subcategories have a large number, whereas others have none. This can often be explained by the nature of the work done in the transfusion process, e.g. in the SRK subcategorisation there are no cases categorised as skills. This is likely to be because staff undertaking tasks within the transfusion process would be working at higher levels and will not usually be defined as ‘operators performing a role with little conscious control’.

HF models that consider external factors in depth, e.g. AcciMap, HFACS and SEIPS 2.0, should be useful in helping to get to the underlying causes of an error and from there should contribute to further understanding of corrective and preventative actions (CAPA). However, during this analysis of historical error cases there was often insufficient information given to expose the full impact of external factors. Those who report transfusion incidents have a tendency to put blame onto individual staff members, but don’t expand on possible underlying reasons for this, such as lack of training or shortage of suitable staff; e.g. it is common for non-transfusion personnel to be asked to work in transfusion laboratories, especially in out-of-hours and on call situations. Largely the reporters don't give specific reasons contributing to the error, such as if the individual was interrupted, tired, overworked etc. The report submitted to SHOT will simply indicate that the individual deviated from the standard operating procedure (SOP), which meant in this HF categorisation exercise there were a number of cases that had to be categorised as individual error, when that may not have been the whole story. Therefore, a disproportionate number of cases were categorised as 'violations' (Active/Latent), 'staff' (AcciMap), 'unsafe acts' (HFACS) or 'persons' (SEIPS 2.0). The finding that quite a high percentage could not be classified raises the issue of whether this approach is ideal. Since future analyses are planned, more work is needed to examine whether this bias will be significant in a larger sample, because satisfying SHOT requirements for incident reporting are quite different from the information needed for an accurate human factors analysis.

During the research it was noted that the incident reports for IBCT incidents generally had more HF-related information than the near miss reports, which was opposite to the expectation prior to analysis. The reasons for this are probably two-fold:

- The questionnaires for IBCT are much longer than those for near misses and they ask a lot of supplementary questions to help get a full picture of the incident. Although they do not specifically ask for HF information, it seems that the larger amount of general information can help with HF categorisation.
- IBCT incidents are the most serious errors, so the local incident investigators will want to try and understand the incident as fully as possible in order to prevent recurrences. This may lead to more information being available for further investigation.

There were some limitations of the research, such as the analysis against several HF models, that meant it was only possible to subcategorise the cases using one category in each model. Complex systems can lead to multifaceted errors, so more than one aspect of a model may be needed to describe the error fully.

Another limitation was that insufficient information was available in many reports so that 34.2% of cases were not classifiable. It was frustrating that a number of these cases indicated a root cause analysis (RCA) was available, but that document was then not attached to the incident report. Therefore, a further development might be to amend the reporting database to require an upload if the question about an RCA is answered positively.

Several of the more complicated HF models did not lend themselves to being used in this simple overview analysis and some, such as AcciMap, HFACS and FRAM may be far better suited to a prospective analysis of the end to end transfusion process.

All the HF models in this study produced constructive subcategorisations, but none of them proved to be an outstanding method. From the ranking process (Table 3) it appears that SEIPS 2.0 would be the most appropriate method for use in further research. A set of criteria were used for this ranking to select a single method to take forward for a further research project, but this was necessarily a subjective not objective process. It was refined by using a scoring system to rank from 0, does not meet the criteria to 3, fully meets the criteria, but it could be argued the top score for the SEIPS 2.0 method was only achieved by a disproportionate score for the criterion 'focuses on patient safety'. Adding a weighting to some criteria might improve the distinction between HF models, but it is currently difficult to weight the criteria on a small sample.

In conclusion, this research asked "Can we learn about human and organisational factors from past transfusion errors?" The question isn't fully answered yet, because the models being studied did not give a definitive answer, but the work has enabled the list of HF models to be narrowed down. This will inform a second study looking at incidents in more depth using a limited set of models.

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