Information sources and methods for better quality and safer healthcare service design: towards a more integrated approach

Gyuchan Thomas Jun* and P John Clarkson**

University of Cambridge, Engineering Department
Engineering Design Centre, UK
* gj225@cam.ac.uk
** pjc10@eng.cam.ac.uk

Abstract: Health care serv ices are con tinuously red esigned to m eet a ran ge of co mplex qu ality requirements: p atient safety; p atient exp erience; efficiency; and clinical ef fectiveness. People across va rious disciplines, i ncluding operations re searchers; syste ms engineers; er gonomists; and clinicians, use di fferent i nformation sources a nd m ethods t o design a service t o m eet di fferent quality requ irements. Un like product design pro cesses where tradeoffs between different d esign requirements are managed and design activities across disciplines are integrated, healthcare service design activities are very often carried out separately to meet disparate quality requirements.

As a first step toward s in tegrating healthcare se rvice design activ ities, th is st udy classified and compared va rious m ethods a pplied to im prove healthcare quality and s afety by systematically reviewing published literature. A dozen represe ntative methods were com pared i n term s of information sources, main purposes and application areas. Five different information sources were identified, in cluding p eople's b ehaviour, people's opinion, m edical reco rds, co mplaint/incident reports and literature. The objective of this paper is to present these methods and discusses how to make the most of them to move towards a more integrated approach to healthcare service design.

Key words: healthcare service, design, safety, quality, integration

1. Introduction

Healthcare services around the world are under pressure to reform and to improve the quality of service delivery, where care shoul d be safe, effective, patient-centred, timely, ef ficient and e quitable [1]. In a recent UK government rep ort, Lord Darzi, h ealth m inister for th e UK government, fu rther stated th at healthcare qu ality should include patient safety, patient experience and effectiveness of care [2].

In order to (re)d esign healthcare services that m eet these complex and often contradictory quality requirements, various professio ns h ave been invo lved i n im proving different qu ality asp ects u sing d ifferent ap proaches: medicine has been trying to make the best use of current clinical evidence (evidence-based medicine) to improve the ef fectiveness of i ndividual patient care [3]; ope rational m anagement has b een usi ng ab stract an d mathematical models to improve ef ficiency of ca re at the lev el of processes [4]; er gonomists a nd systems engineers have bee n a pplying sy stems app roaches t o work sy stem desi gn f or patient safety [5, 6]; and m ore recently, product designers have been applying user-focused approaches to improve patient experience [7].

Considering that healthcare service (re)design processes are driven by these multiple, intangible quality requirements involving various stakeholders with different concerns, it is very challenging to manage trade-offs between these interdependent quality targets. As a result, various healthcare service (re)design initiatives have been disjointedly implemented to address different quality requirements, but the effort to integrate different (re)design activities has been lacking.

Conversely, product designers have been managing product related trade-offs in more integrated ways. Ulrich and Eppinger proposed methods intended to facilitate problem solving and decision making by integrating personnel from a variety of backgrounds and perspectives on concept development [8]. Pugh also proposed a concept of 'total design' meaning 'the systematic activity necessary, from the identification of the market/user need, to the selling of the successful product to satisfy that need – an activity that encompasses product, process, people and organization [9].' Through these efforts, various design requirements such as design for manufacture or design for assembly have been included as explicit steps particularly in the early stages of design.

As a first step towards a more integrated approach to healthcare service design, the objective of this paper is to understand how healthcare service design activities have been carried out by investigating what types of healthcare quality and safety improvement methods have been used, for what purposes and in what application areas. Recommendations for a more systematic and integrated use of information sources and methods will also be presented.

2. Methods

Initial investigation revealed a huge corpus of papers on healthcare quality and safety improvement approaches, hence it was necessary to be selective about which papers could be chosen for full-paper review. In order to identify a manageable number of papers efficiently, a search was conducted on PubMed using MeSH terms, where PubMed is a bibliographic database covering much of the literature in the fields of medicine, nursing, dentistry and the healthcare system. PubMed provides for MeSH (Medical Subject Headings) searching using a controlled vocabulary to indexing articles. The following MeSH terms were used to identify potentially relevant articles.

"Total Quality Management/methods" OR "Safety Management/methods"

A Subheading 'methods' was used in conjunction with two subject headings 'total quality management' and 'safety management' to retrieve articles concerned with techniques, procedures and programs. A total of 3,464 articles were initially retrieved. The following criteria were additionally used to filter out articles from those initially retrieved:

- Papers published in non peer-reviewed academic journals;
- Papers without abstracts in the PubMed;
- Papers published earlier than 2000;
- Papers published in languages other than English;

The year 2000 was taken as a starting point since the publication of 'To err is human' report initiated modern patient safety research [1]. A total of 511 articles were retrieved through the above criteria and their abstracts were content analysed to additionally filter out less relevant papers. A total of 82 papers were finally selected for full-paper reading and these were further content analysed using a review template designed to capture consistent information (method types, main purposes, application areas, etc) from each paper. Through the comparative

analysis of the information filled in the review templates, a variety of methods were identified, compared and classified.

3. Findings

Forty different improvement methods were identified, with some of them proving to be methodologies, i.e. collections of methods, or differing only in their names. These methods were first categorised according to their primary information source, namely people's behaviour, people's opinion, medical records, reports and literature as illustrated in Table 1. This table also summarises the main purposes and application areas of the methods. For example, people's behaviour has been captured either through direct observation or by video-recording in order to understand how clinical systems actually work and achieve safety improvements mostly in very confined settings. Conversely, people's opinion has often been used to identify general quality and safety issues in a wide range of settings. Medical records have been assessed either through trained reviewers or via electronic trigger systems to identify medication-related errors. Complaint and adverse event reports have been used to gain an overall understanding of general quality and safety concerns, whereas published literature provided general evidence for the effectiveness of both clinical and process interventions. The advantages and limitations of each source and method are further compared in the sections that follow.

3.1 People's behaviour

People's behaviour is one of the most direct sources for understanding how care processes actually work, what factors make them work well (or not so well), and why adverse events occur. This source has been utilised with an increasing popularity through naturalistic direct observation, either with real time observers or via video data recording and analysis [10-16].

Direct observation

Direct observation is used to gain an in-depth understanding of contexts, e.g. interactions and relationships among staff members [17] or adverse events, e.g. types, frequencies, severity and causes. This method is considered more suitable to processes where clinical tasks have a clear start and end and where there are clear and consistent team roles, e.g. operating theatre [10] and elective care [11]. Care settings such as A&Es and ICUs can generate difficulties to observers owing to unpredictability and the greater movement of staff, nonetheless this method has been applied to such cases [12, 14].

Video recording

Video recording has the advantage over direct observation that you can create a permanent record that can be analysed offline as often as required. Such a record can be used for the purpose of clinician education [15] as well as quality and safety improvement [16]. However, the more difficult task is getting hospitals and clinicians to agree to let you videotape actual patient care. The issues of human subject consent, privacy, confidentiality, medicolegal concerns, and logistics are often obstacles to using video recording [16].

Table 1. Classification and comparison of quality and safety improvement methods

Sources	Particular methods	Main purposes	Application areas	Resources required & related techniques
People's behaviour	**Direct observation**	Understanding how clinical systems actually work, what factors make them work well and why adverse events occur.	Drug administration, operating theatres, anaesthesia, obstetrics, intensive care units and emergency departments	Task analysis, competent observer, bench mark visits
	Video-recording		Critical events, trauma resuscitation, anaesthesia, and surgical tasks	Video recording systems, video-data management s/w
People's opinion	**Survey**	Identifying areas of improvement, especially of cultural or management issues	Region, trust or department-wide	Questionnaires
	Interview	Identifying general areas of improvement	General	Critical incident technique, executive walkthrough, patient stories
	Focus group	Identifying general areas of improvement	General	Brainstorming, process mapping, FMEA
	Peer review	Assessing and improving quality	General practitioners	-
Medical records	**Secondary review**	Evaluating the effectiveness of interventions	Medication errors	Trained reviewers
	Electronic trigger	Identifying errors at real time	Medication errors	Classification of errors
Reports	**Incident reports**	Learning from Incidents	General patient safety	Incident reporting systems, risk managers
	Complaint reports	Identifying care concerns	General	Complaints reporting systems, quality managers
Literature	**Literature review**	Investigating the potential effectiveness of interventions	General	PubMed or Google

3.2 People's opinion

People's opinion is on e of the easiest and widely-used sources of information for healthcare quality and safety improvement, and has been utilised by different methods such as surveys, interviews and focus groups.

Survey

Surveys are applied in assessing safety culture [18], effectiveness of potential interventions [19] and patients satisfaction [20] as well as capturing potential quality improvement recommendations from service providers [21]. Surveys can be very instrumental when respondents, bound by an implicit ''code of silence'' and a fear of challenging the institutional hierarchy, are uncomfortable with exposing weaknesses in processes for which they are responsible. The process of developing questionnaire requires several iterative revisions and pilot trials by various stakeholders.

Interview

Interviews have been used to identify general areas of improvement in conjunction with many other techniques, such as critical incident technique, executive walkthrough and patient stories. Semi-structured interview techniques have been applied along with the critical incident technique[22] to identify failure processes and potential recovery processes. Less formally, and in conjunction with executive walkthrough, interviews were used with frontline providers to identify general opportunities to improve care processes [23]. In addition, interviews have been applied along with storytelling to develop understanding based on patients' and carers' experiences, enabling healthcare providers to create better and new ways of meeting their needs [20].

Focus group

Focus groups, such as multidisciplinary team approaches, have very often been used to identify general areas of quality and safety improvement. They have been used, with less formality like brainstorming [24] to generate ideas for general improvement, or with very specific guidelines like FMEA (Failure Mode and Effects Analysis) [25] to analyse risks and identify recommendations for improving safety.

Peer review

Peer review groups are one of the most widespread methods of achieving quality improvement where peers from other practices critically discuss personal medical practices and make plans for change by audit, guideline setting or adaptation [26].

3.3 Medical records

Medical records have been reviewed to help understand the source of errors and to generate new improvement ideas. They have been reviewed either manually or by electronic triggers.

Secondary manual medical record review

This method has been used to investigate the effectiveness of new interventions in care processes, e.g. before and after mandatory drug use reviews [27]. While secondary manual reviews are usually labour-intensive, time-consuming and potentially inaccurate, electronic triggers can make this reviewing task much more efficient and accurate.

Electronic trigger

Electronic triggers have been developed to reliably identify, quantify, and track events related directly to patient harm. They have been integrated with hospital information systems to isolate adverse events [28-30]. In these systems, specific events—including the ordering of certain drugs, orders for antidotes and certain abnormal laboratory values—serve as triggers to initiate a more detailed concurrent audit. Each time a trigger event was identified in the pharmacy or physician order sheet of the medical record it was counted and referenced. Every day the reports of the patients identified with possible adverse events were provided to a pharmacist for further

in d epth co ncurrent review. Th is electronic in itial sc reening strateg y, cou pled with real tim e ev aluation, accomplishes a rapid review of a patient's current record for the occurrence of adverse events [31].

3.4 Reports

Many healthcare institutions have encouraged service providers and service users to report their complaints as well as near misses and adverse events. The reporting patterns can help identify and prioritise areas for quality or safety improvement and generate new improvement ideas.

Incident reporting

Incident reporting has been carried out both locally and nationally; patterns and trends in patient safety incidents were an alysed n ationally [3 2] o r in-d epth i nvestigation after incide nt re porting we re c arried out by l ocal risk managers. Reporting can help identify and prioritise where interventions should be made.

Complaint reporting

Complaints fr om bot h healthcare w orkers an d se rvice users (patients or c arers) highlight di fferent aspects of patient care. Th ese complaints are usually rev iewed by quality managers and ev aluated fo r formal p eer rev iew [33]. Frequently raised concerns facilitate the need for new ideas for interventions.

3.5 Literature

Literature rev iew has b een conducted to i dentify potential clin ical o r process in terventions as wel l as fi nd evidence of the effectiveness of them [19]. Various literature types from academic and grey literature have been searched through PubMed and Google and a systematic review has been widely adopted [34].

4. Discussion and conclusions

The classification and c omparison of t he methods a pplied for healthcare quality and safety improvement provides an overall picture of the types of methods, their purposes, their application areas and the information sources t hey are base d on. It i s im portant t o be a ware of t hese various m ethods, and t heir a dvantages an d limitations so that th e m ost ap propriate meth ods can b e used for m anaging different quality requ irements. I n order to sho w th ese m ethods an d inform ation so urces in m ore sim ple an d clear m anner, Fi gure 1 i llustrates more structured summary. First, two distinct types of sources are presented in the two rows of Figure 1: one from people (top row) and the other from documents (bottom row). Second, two distinct types are identified according to the location of the information source and shown in the columns of Figure 1: one existing within an institution (the first two columns); the other existing outside of an institution (the third column). For example, behaviour or opinion of th e p eople within an in stitution can b e utilised to i nvestigate ho w th e system in ternally wo rks, whereas behaviour and opinion of the people in other institutions can provide new ideas through benchmark visit or peer re view. C onversely, medical recor ds a nd reports (i ncidents a nd c omplaints) t end t o exi st within a n institution, whereas literature is lo cated outside an institution and provides more general ideas. As a result, the overall awareness of these information sources and methods depicted in Figure 1 can provide guidance on how comprehensively we are using such sources and methods, and which have to be utilised more.
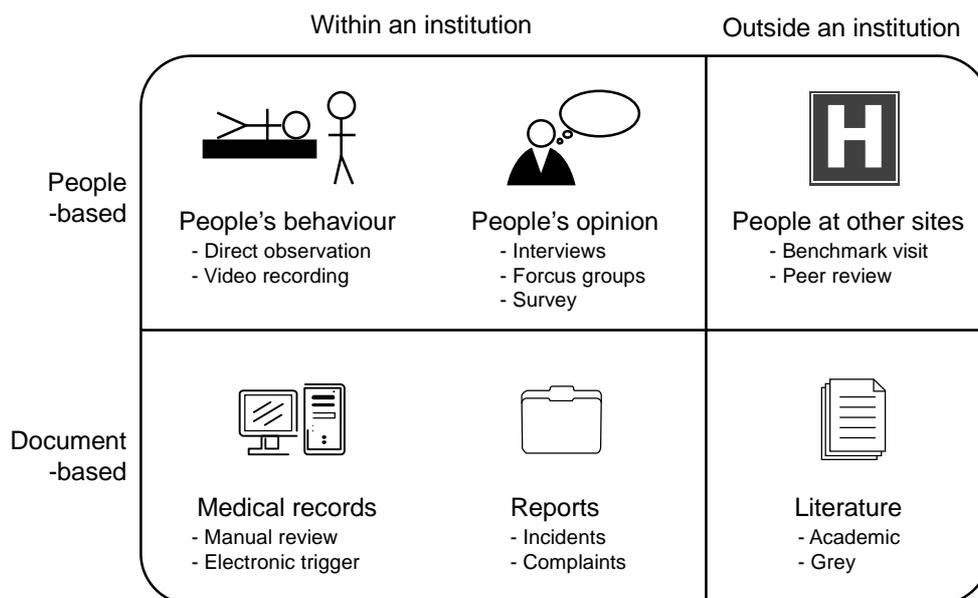
Figure1. Methods and information sources for healthcare quality and safety improvement

In addition to the overall awareness of these methods and information sources, it is also important to understand their main purposes so that they can be selected appropriately to be fit for purpose. The findings showed that the different information sources and methods have been applied for different purposes and in different application areas as illustrated in Table 2. In general, issues around patient experience have been tackled mostly using the people-based sources, since experience is the internal and subjective response individuals have to any direct or indirect contact with service providers [35]. Issues around patient safety have been addressed from both the people-based sources and the document-based sources, since safety problems occur in human components within complex socio-technical systems [36]. Issues around effectiveness of care have been mostly tackled from the document-based sources through either medical record review or systematic literature review. Such high-level links between the information sources and main purposes aids the appropriate selection of methods. However, in order to deal with multiple quality requirements in a systematic and integrated manner, the use of these various information sources and methods in healthcare need to be better integrated.

Table 2 Quality issues and appropriate information sources

Quality issues	Appropriate information sources	Methods
Patient experience	People-based	Observation, interviews, patient stories
Patient safety	People and document-based	Observation, video recording, surveys, interviews, focus groups, secondary medical record review, electronic trigger, incident reports
Effectiveness of care	Document-based	Secondary medical record review, literature review

Integration efforts made in product design can guide a more integrated and systematic use of methods and information sources. For example, stakeholders from a variety of backgrounds and perspectives (clinical and non-clinical staff, engineers, ergonomists and designers) need to be encouraged to collaborate on decision-making at the early stage of healthcare service design. Quality requirements, such as patient experience, might need to be included as explicit steps in the early phase of service design processes, as manufacturability has been in product design. In summary, healthcare service design processes have much scope for improvement, taking a lead from more integrated product design processes.

In conclusion, this paper, as a first step towards a more integrated approach to healthcare service design, has shown how healthcare service design activities have been carried out by classifying various quality and safety improvement methods and comparing them according to their information sources and main purposes. Different information sources and methods have been utilized to address different quality issues in different application areas. In addition, classifying methods and information according to their location and type provides a structured overview, which could encourage more systematic use. Further research is proposed to investigate more take-up of integration practices from product design to develop a more integrated healthcare service design process.

5. Acknowledgement

References

[1] Kohn, L. T., Corrigan, J. M. and Donaldson, M. S. (eds.) (2000) *To err is human: building a safer health system*, National Academy Press, Washington, D.C.

[2] Darzi, L. (2008) *High quality care for all: NHS Next Stage Review final report*.

[3] Sackett, D. L., Rosenberg, W. M., Gray, J. A., Haynes, R. B. and Richardson, W. S. (1996) Evidence based medicine: what it is and what it isn't, *BMJ*, vol. 312, no. 7023, pp 71-72.

[4] Brandeau, M. L., Sainfort, F. and Pierskalla, W. P. (eds.) (2004) *Operations research and health care. A handbook of methods and applications*, Kluwer Academic Publishers.

[5] Clarkson, P. J., Buckle, P., Coleman, R., Stubbs, D., Ward, J., Jarrett, J., Lane, R. and Bound, J. (2004) Design for patient safety: a review of the effectiveness of design in the UK health service, *Journal of Engineering Design*, vol. 15, no. 2, pp 123-140.

[6] Carayon, P., Schoofs Hundt, A., Karsh, B. T., Gurses, A. P., Alvarado, C. J., Smith, M. and Flatley Brennan, P. (2006) Work system design for patient safety: the SEIPS model, *Qual Saf Health Care*, vol. 15 Suppl 1, pp i50-8.

[7] Bate, P. and Robert, G. (2006) Experience-based design: from redesigning the system around the patient to co-designing services with the patient, *Qual Saf Health Care*, vol. 15, no. 5, pp 307-310.

[8] Ulrich, K. T. and Eppinger, S. D. (2004) *Product design and development*, 3rd ed., McGraw-Hill/Irwin, Boston, Mass.

[9] Pugh, S. (1990) *Total design : integrated methods for successful product engineering*Addison-Wesley, Wokingham.

[10] Schaefer, H. G. and Helmreich, R. L. (1994) The importance of human factors in the operating room, *Anesthesiology*, vol. 80, no. 2, p 479.

[11] Stanhope, N., Vincent, C., Taylor-Adams, S. E., O'Connor, A. M. and Beard, R. W. (1997) Applying human factors methods to clinical risk management in obstetrics, *Br J Obstet Gynaecol*, vol. 104, no. 11, pp 1225-1232.

[12] Morey, J. C., Simon, R., Jay, G. D., Wears, R. L., Salisbury, M., Dukes, K. A. and Berns, S. D. (2002) Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project, *Health Serv Res*, vol. 37, no. 6, pp 1553-1581.

[13] Carthey, J. (2003) The role of structured observational research in health care, *Qual Saf Health Care*, vol. 12 Suppl 2, pp ii13-16.

[14] Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., Sprung, C. L., Pizov, R. and Cotev, S. (2003) A look into the nature and causes of human errors in the intensive care unit. 1995, *Qual Saf Health Care*, vol. 12, no. 2, pp 143-147.

[15] Mackenzie, C. F. and Xiao, Y. (2003) Video techniques and data compared with observation in emergency trauma care, *Qual Saf Health Care*, vol. 12 Suppl 2, pp ii51-57.

[16] Weinger, M. B., Gonzales, D. C., Slagle, J. and Syeed, M. (2004) Video capture of clinical care to enhance patient safety, *Qual Saf Health Care*, vol. 13, no. 2, pp 136-144.

[17] Ohlinger, J., Brown, M. S., Laudert, S., Swanson, S. and Fofah, O. (2003) Development of potentially better practices for the neonatal intensive care unit as a culture of collaboration: communication, accountability, respect, and empowerment, *Pediatrics*, vol. 111, no. 4, pp e471-481.

[18] Nieva, V. F. and Sorra, J. (2003) Safety culture assessment: a tool for improving patient safety in healthcare organizations, *Qual Saf Health Care*, vol. 12 Suppl 2, pp ii17-23.

[19] Rosen, A. B., Blendon, R. J., DesRoches, C. M., Benson, J. M., Bates, D. W., Brodie, M., Altman, D. E., Zapert, K., Steffenson, A. E. and Schneider, E. C. (2005) Physicians' views of interventions to reduce medical errors: does evidence of effectiveness matter?, *Academic Medicine*, vol. 80, no. 2, pp 189-192.

[20] Wilcock, P. M., Brown, G. C. S., Bateson, J., Carver, J. and Machin, S. (2003) Using patient stories to inspire quality improvement within the NHS modernization agency collaborative programmes, *Journal of Clinical Nursing*, vol. 12, pp 422-430.

[21] Baker, G. R., King, H., MacDonald, J. L. and Horbar, J. D. (2003) Using organizational assessment surveys for improvement in neonatal intensive care, *Pediatrics*, vol. 111, no. 4, pp e419-425.

[22] Kanse, L., van der Schaaf, T. W., Vrijland, N. D. and van Mierlo, H. (2006) Error recovery in a hospital pharmacy, *Ergonomics*, vol. 49, no. 5-6, pp 503-516.

[23] Thomas, E. J., Sexton, J. B., Neilands, T. B., Frankel, A. and Helmreich, R. L. (2005) The effect of executive walk rounds on nurse safety climate attitudes: a randomized trial of clinical units, *BMC health services research*, vol. 5, no. 1, p 28.

[24] NHS Institute for Innovation and Improvement (2007) *Thinking Differently*.

[25] Esmail, R., Cummings, C., Dersch, D., Duchscherer, G., Glowa, J., Liggett, G. and Hulme, T. (2005) Using Healthcare Failure Mode and Effect Analysis tool to review the process of ordering and administrating potassium chloride and potassium phosphate, *Healthcare Quarterly*, vol. 8, special issue, pp 73-80.

[26] Beyer, M., Gerlach, F. M., Flies, U., Grol, R., Krol, Z., Munck, A., Olesen, F., O'Riordan, M., Seuntjens, L. and Szecsenyi, J. (2003) The development of quality circles/peer review groups as a method of quality improvement in Europe. Results of a survey in 26 European countries, *Family practice*, vol. 20, no. 4, pp 443-451.

[27] Briesacher, B., Limcangco, R., Simoni-Wastila, L., Doshi, J. and Gurwitz, J. (2005) Evaluation of nationally mandated drug use reviews to improve patient safety in nursing homes: a natural experiment, *Journal of the American Geriatrics Society*, vol. 53, no. 6, pp 991-996.

[28] Finlay, H. E., Cassorla, L., Feiner, J. and Toy, P. (2005) Designing and testing a computer-based screening system for transfusion-related acute lung injury, *American journal of clinical pathology*, vol. 124, no. 4, pp 601-609.

[29] Grzybicki, D. M., Turcsanyi, B., Becich, M. J., Gupta, D., Gilbertson, J. R. and Raab, S. S. (2005) Database construction for improving patient safety by examining pathology errors, *American journal of clinical pathology*, vol. 124, no. 4, pp 500-9.

[30] Szekendi, M. K., Sullivan, C., Bobb, A., Feinglass, J., Rooney, D., Barnard, C. and Noskin, G. A. (2006) Active surveillance using electronic triggers to detect adverse events in hospitalized patients, *Qual Saf Health Care*, vol. 15, no. 3, pp 184-190.

[31] Resar, R. K., Rozich, J. D. and Classen, D. (2003) Methodology and rationale for the measurement of harm with trigger tools, *Qual Saf Health Care*, vol. 12 Suppl 2, pp ii39-45.

[32] National Patient Safety Agency (2007) *Patient safety incident reports in the NHS: National Reporting and Learning System Data Summary. Issue 7: 1 October to 31 December 2007*.

[33] Griffey, R. T. and Bohan, J. S. (2006) Healthcare provider complaints to the emergency department: a preliminary report on a new quality improvement instrument, *Qual Saf Health Care*, vol. 15, no. 5, pp 344-346.

[34] Michaels, R. K., Makary, M. A., Dahab, Y., Frassica, F. J., Heitmiller, E., Rowen, L. C., Crotreau, R., Brem, H. and Pronovost, P. J. (2007) Achieving the National Quality Forum's "Never Events": prevention of wrong site, wrong procedure, and wrong patient operations, *Annals of surgery*, vol. 245, no. 4, pp 526-532.

[35] Meyer, C. and Schwager, A. (2007) Understanding customer experience, *Harv Bus Rev*, vol. 85, no. 2, pp 116-126.

[36] Vincent, C., Taylor-Adams, S. and Stanhope, N. (1998) Framework for analysing risk and safety in clinical medicine, *BMJ*, vol. 316, pp 1154-1157.