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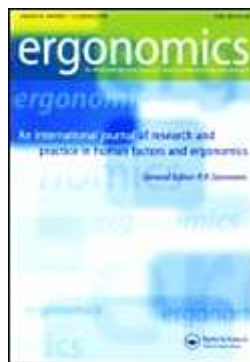
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### A Critical Review of the Systems Approach within Patient Safety Research

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8 **A Critical Review of the Systems Approach within Patient Safety Research**  
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14 Patrick Waterson<sup>1</sup>  
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45 **Address for correspondence:**  
46 Dr. Patrick Waterson  
47 Department of Human Sciences  
48 Loughborough University  
49 Loughborough, LE11 3TU,  
50 United Kingdom.  
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52  
53 Tel: 01509 228478  
54 Fax: 01509 223940  
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<sup>1</sup> Email: p.waterson@lboro.ac.uk.

## Abstract

The application of concepts, theories and methods from systems ergonomics within patient safety has proved to be an expanding area of research and application in the last decade. This paper aims to take a step back and examine what types of research have been conducted so far and use the results to suggest new ways forward. An analysis of a selection of the patient safety literature suggests that research has so far focused on human error, frameworks for safety and risk, and incident reporting. The majority of studies have addressed system concerns at an individual level of analysis with only a few analysing systems across multiple system boundaries. Based on the findings it is argued that future research needs to move away from a concentration on errors and towards an examination of the connections between systems levels. Examples of how this could be achieved are described in the paper.

## Statement of Relevance for Ergonomics Practice

The outcomes from the review of the systems approach within patient safety provide practitioners and researchers within health care (e.g., the UK NHS) with a picture of what types of research are currently being investigated, gaps in our understanding and possible future ways forward.

## Keywords

Complex Systems; Sociotechnical Systems; Patient Safety; Health Care Ergonomics; Work Organisation.

## 1. The systems approach within ergonomics

The use of the systems approach within ergonomics is well established (e.g., Singleton, 1974; Hendrick and Kleiner, 2002) and has been applied to a wide variety of application domains including aviation, rail transport and nuclear power (e.g., Reason, 1990; Wilson et al., 2007; Hollnagel et al., 2006). Chapanis (1996) defines a system as “an interacting combination, at any level of complexity, of people, materials, tools, machines, software, facilities and procedures designed to work together for some common purpose.” The historical roots of the approach cut across a range of disciplines (e.g., cybernetics, organisational behaviour, risk management, psychology) and trace their origins to the work of von Bertalanffy (1950) on general systems theory, as well as the sociotechnical movement of the 1950’s (Emery, 1959; Trist, 1959). A central idea of the approach is that complex systems, for example organisations, teams and types of technology, are composed of interrelated components, the properties of which are changed if the system is dissembled in any way (Katz and Kahn, 1966). In addition, adopting a systems ergonomic point of view often affords insights into how actions or occurrences at one level (e.g., an error made by a process operator) collectively interact with team (e.g., situation awareness) and organisational (e.g., safety culture) levels of analysis. In more recent years, the systems approach has staged something of a comeback and appears to be growing in popularity (e.g., Walker et al., 2008; Eason, 2008).

Defining the core components of the approach proves to be a difficult task since there appears to be no firm agreement amongst researchers. Other authors (e.g., Turner, 1978; Blockley, 1998) have attempted to be more specific and have included the following elements in their use of the approach (figure 1):

- Input-output processes – this relates to the stages that lead up to an accident or a disaster occurring (e.g., precipitating or trigger events), but also refers to the relationships that exist between inputs to a system and corresponding outputs. Multifinality in this context means that similar initial conditions can lead to different end effects.
- Whole-part relationships – the fundamental idea in this case is that in order to understand the functioning of the whole system one must first examine the parts

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3 (Gibson, 1979). It also follows on that the whole is more than the sum of the  
4 parts and that the relationship between these is dynamic and sometimes  
5 unpredictable or chaotic (Singleton, 1974; Sinclair, 2007).  
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9 • Connectivity between elements – system complexity arises from many simple  
10 interrelated processes that are highly connected. The principle of equifinality  
11 within general systems theory for example, states that the same result can be  
12 obtained with different types of inputs (e.g., rich/poor information as input to the  
13 system, depending on sub-processes – Katz and Kahn, 1966). The degree of  
14 coupling between system levels and components is also likely to have an impact  
15 upon the overall functioning of the system (Perrow, 1984).  
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Figure 1 about here

### 35 **1.1 The use of the systems approach within patient safety research**

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37 Over the course of the last decade the application of human factors and ergonomics  
38 within the domain of patient safety has proved to be a huge growth area in terms of  
39 both research and application within healthcare settings. More recently, the use of  
40 systems and macroergonomic concepts, theories and approaches has attracted the  
41 interest of research groupings drawn from the medical profession (e.g., clinicians  
42 and other healthcare professionals), medical sociologists and psychologists, as well  
43 as ergonomists and human factors engineers. This growth is partly reflected in the  
44 growing number of papers and journal special issues covering patient safety that  
45 have appeared in recent years (e.g., Bagnara and Tartaglia, 2007; Salas et al., 2006;  
46 Edworthy et al., 2006). The systems approach has also gained in popularity through  
47 many reports in the press and championing by high profile individuals (e.g., Naik,  
48 2006; Donaldson, 2007).  
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A number of models and frameworks have been proposed in order to organise and stimulate the development of theory and empirical research within the systems

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3 approach to patient safety. The System Engineering Initiative for Patient Safety  
4 (SEIPS) model of work system and patient safety (Carayon et al., 2006) for  
5 example, describes how the structure of an organisation (or more generally, the  
6 work process) affects the extent to which overall levels of patient safety are  
7 maintained. Perhaps the most widely known and well established systems-based  
8 model in patient safety research is James Reason's (1997; 2001a) "Swiss Cheese"  
9 model of safety. According to the model hazards within complex systems are  
10 prevented by a series of barriers. These barriers contain inherent weaknesses which  
11 can be thought of as analogous to holes in a piece of Swiss cheese. Such weaknesses  
12 are in themselves subject to change and when aligned a hazard may result in an  
13 accident or the occurrence of an adverse event. The Swiss cheese model is  
14 frequently seen by researchers in the field of patient safety as providing a basis for a  
15 common language through which medical accidents can be understood (US Dept. of  
16 Health, 2000). As Perneger (2005) points out, the model is itself based upon a  
17 number of other variations that aim to unpack the various system-level factors that  
18 may play a major part in determining the causes of accidents and errors (e.g.,  
19 Reason, 2001b), as well as variations that are tailored specifically for patient safety  
20 (Vincent, 2001, figure 2).  
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Figure 2 about here

46 These models of patient safety have much in common with the characteristics and  
47 components of the systems approach within ergonomics outlined above, in that they  
48 provide a basis for a broad coverage of system variables (e.g., individual issues,  
49 organisational factors) within the large health care system. Secondly, the models  
50 span a wide range of levels of analysis (e.g., organisational, social, individual),  
51 subcomponents (e.g., management decisions, technological factors) and linkages  
52 between these. These linkages are sometimes described as causal, or more usually  
53 contributory factors and are identified as selectively, or in combination, leading to  
54 an accident or adverse incident.  
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### 1.1 Motives and objectives of the review

Alongside the many calls for the application of the systems approach to patient safety, a number of criticisms of its use have been made. Infante (2006) for example, states that most empirical work is carried out in the absence of explicit theoretical models and does not adequately address issues relating to the relationship between different levels of analysis and the actors within these (e.g., organisation-team interrelationships). Similarly, Hoff et al. (2004) in their review of the links between organisational factors, medical errors and patient safety, found that research has so far focused on a limited range of social and organisational factors. Others have argued that the drive toward patient safety and the application of the systems approach may have encouraged the medical profession to seek out short-term solutions (e.g., Wears, 2005), whereas the real benefits of the approach may take decades rather than months or years to realise. Finally, there is evidence to suggest that medical professionals are themselves confused by what is meant by the term “system” and “error” and the impact these have within the context of patient safety (Waring, 2007; Elder et al. 2006).

These criticisms, alongside the fact that the systems approach has over the years sometimes proved to be misinterpreted and misconstrued by those purporting to be using it (Ashmos and Huber 1987), motivated the present review. Specifically, the objectives are:

- (1) To provide a better understanding, based upon an analysis of a selection of the patient safety literature, of the coverage of research purporting to adopt a systems approach – what has been so far the focus of research, how comprehensive is it, and what areas have not been addressed?
- (2) To provide a better understanding of how research so far has addressed the issue of connectivity and causality between system components and levels of analysis – how much research has looked at the issue of relationships between levels and system boundaries?
- (3) To use the findings from (1) and (2) as a basis for identifying research gaps and ways forward that could be explored in the future.



## 2. Review approach

In carrying out the review it was necessary to be selective about what types of publications could be judged to be adopting the systems approach within patient safety. In addition, the review aimed to cover research which could falls within the broad scope of ergonomics or human factors. The challenges involved in carrying out such a review largely relate to terminology and definition. The term “system” for example, has many different definitions (e.g., a technology, a method or technique, a biological entity). Likewise, system ergonomics is in itself broad in scope, covering research drawn from a wide variety of domains including many bordering mainstream ergonomics/human factors (e.g., organisation science, psychology, sociology), as well as different traditions and approaches within ergonomics (e.g., macroergonomics, sociotechnical systems theory). In order to overcome these problems it was decided to keep the analysis of publications as inclusive as possible at the beginning and then to filter out articles judged to be outside the scope of the systems approach to patient safety. This approach contrasts with other research which has used keywords and database filters at the outset, in order to review specific and relatively well-defined constructs (e.g., Tzeng and Yin, 2007).

### 2.1 Identification and selection of publications

A search was conducted on the PubMed and Ergonomics Abstracts databases for the years 1999-2007 using the keywords “system” and “patient safety”. The year 1999 was taken as a starting point since many researchers regard the publication of the “To Err is Human” report in the United States (Kohn et al., 1999) as a landmark marking the beginning of modern patient safety research. PubMed and Ergonomics Abstracts were chosen for their coverage of literature relating to patient safety in medicine and ergonomics respectively. Search operators and wildcards were used in order to ensure that only publications using the terms system (or systems) and patient safety in titles, abstracts or keywords, were retrieved. A total of 4960 publications in total were retrieved (PubMed, n=4875, Ergonomics Abstracts, n=85).

A set of criteria were used to filter out articles from those retrieved from the databases. These included articles that focused on the following:

- The use of techniques, procedures or methods that were judged to be primarily medical were not included (e.g., the use of a technique or procedure in surgery).
- The use of a technological system without explicitly referring to its use within a safety context or providing data covering evaluation.
- Case studies which did not specify at least outline details of how, for example, a safety initiative was implemented, what data was gathered or what the outcomes from the initiative were.
- Legal or legislative aspects of patient safety.
- Calls for safety programs, the advantages of the systems approach or its importance – many papers, particularly those published between 1999-2003, “championed” the systems approach without providing details relating to examples or data.
- Papers published in languages other than English.

Articles were content analysed and selected if they addressed an issue that was likely to fall within the broad range of subjects matter within ergonomics/human factors, whilst at the same time directly addressing patient safety.

## *2.2 Framework for categorising publications*

The abstracts of each article was reviewed and then classified using Vincent et al's (1998) framework for contributory factors influencing clinical practice. As a result of carrying out this analysis it was decided to reorganise some of the elements of Vincent et al's framework. For example, the component “national health service executive” within the factor type “institutional context factors” is too specific to cover other types of health systems. The terms Health System (General) covering, for example, the UK NHS as well as US Healthcare systems and Health System (Local) covering hospital trusts and smaller geographical units (e.g., American states) were substituted. Similarly, many terms overlap in the Vincent et al. framework and for the purposes of the review were collapsed (e.g., knowledge and skills, competence). A number of other categories were added as a result of conducting the preliminary categorisation. For example, the category “safety and error” was added in order to cover the diversity and range of research using the

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3 systems approach to patient safety in this area. The final categorisation scheme with  
4 examples drawn from the literature search is shown in Table 1.  
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19 The review also categorised articles in terms of their coverage of broad levels of  
20 analysis within the larger system (i.e., inter-organisational, organisational, team and  
21 individual levels). The purpose of this analysis was to ascertain the number of  
22 articles that have attempted to cross boundaries between system levels and  
23 established links between them (e.g., organisation-team linkages). An analysis was  
24 also carried out of the types of medical domain (e.g., surgery, pharmacy) in which  
25 they were conducted.  
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### 32 33 **3. Findings**

34 A total of 360 papers were selected using the criteria, approximately 7.7% of the  
35 total number of articles yielded by the PubMed and Ergonomics Abstracts  
36 databases. A total of 289 articles were selected from the PubMed database and the  
37 remaining 71 from the Ergonomics Abstracts database.  
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#### 43 44 *3.1 Coverage of research issues and health care domains*

45 The results of the analysis concerning the primary focus of publications are  
46 summarised as percentages of the total number of articles reviewed in figure 3. The  
47 most frequent number of studies fell into the category of “Safety and Errors”  
48 (n=202, 56% of all articles) with the subcomponents “errors” (n=57) being most  
49 frequent, followed by “approaches/frameworks” (n=48), “incident reporting”  
50 (n=42), “safety/risk perceptions” (n=33) and “safety culture” (n=22).  
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58 Further analysis of the subcomponents showed that the majority of studies which  
59 focused on errors concentrated on individual errors (n=47) as compared to errors  
60 made by healthcare teams (n=10). It should be noted however, that it proved

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3 difficult in many instances to categorise, and distinguish between, articles using a  
4 distinction between individual/team errors. Similar problems occurred in trying to  
5 distinguish between individual and team safety/risk perceptions where the broad  
6 trend indicated that most research had focused on individual perceptions.  
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21 The second most frequently occurring focus of study fell into the category  
22 “individual factors” (n=42, 12.7% of all articles) with the subcomponents  
23 “training/education” (n=18) being the most frequent, followed by  
24 “workload/shiftwork” (n=14) and work design (n=5). Articles within the category  
25 “change management” (n=12, 3.3% of all articles) focus on describing experiences  
26 implementing safety programmes within healthcare (e.g., setting up a quality  
27 management initiative). Within the category “technology and design” (n=36, 11.9%  
28 of all articles), most articles focused on “system design” (n=12), followed by  
29 “patient labelling” and “design for safety” (each category n=5). Most of the articles  
30 in the category “team factors” (n=22, 5.9% of all articles) have focused either on  
31 “communication” (n=10) or “team handover/transfer” (n=7). Within the category  
32 “organisational and management” (n=23, 6.6% of all articles) most articles focused  
33 on aspects of “structure/culture” (n=13), with a few (n=3) on “communication” and  
34 “management/governance”. Finally, within the category “institutional context”  
35 (n=22, 6.1% of all articles) most articles focused on the “health system (specific)”  
36 (n=11) or the “health system (general)” (n=10). Fewer articles focused on  
37 “economic/regulatory” issues (n=1).  
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53 The results of the analysis concerning the clinical domains which were investigated  
54 are summarised as percentages of the total number of articles reviewed in figure 4.  
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Figure 4 about here

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5 Approximately half of the articles reviewed were carried out in hospitals and the  
6 various clinical specialisms which exist within hospitals (n=206, 57.2% of total).  
7 Articles which did not focus on a specific specialism (categorised as “general”)  
8 made up the majority of these (n=86). In terms of the specialisms a large proportion  
9 of the articles were within surgery (n=54), followed by emergency/acute medicine  
10 (n=20), pharmacy (n=14), paediatrics (n=11) and intensive care (n=11). A smaller  
11 number of articles were reviewed within other clinical specialisms and patient  
12 groupings (e.g., psychiatry, outpatients). Within the category “General Medicine”, a  
13 number of articles were categorised as focusing on the health system as a whole  
14 (n=86), with fewer concentrating on local health systems (n=11). Healthcare  
15 professional (e.g., nursing staff) make up the majority of articles in the category  
16 “Clinical Professions” (n=28), followed by clinicians (n=12), managers (n=3) and  
17 other professions (n=6).  
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### 30 *3.2 Coverage of system levels and boundaries*

31 The results of the analysis concerning coverage of the system are summarised as  
32 percentages of the total number of articles reviewed in figure 5. For the majority of  
33 articles reviewed it was not possible to identify what levels of the system were  
34 covered (n=123 articles). Many articles presented general views on the relationship  
35 between system factors and patient safety (e.g., outlined a safety program or  
36 emphasised the importance of incident reporting without providing specific details).  
37 A similar comment should be made about the difficulties in categorising system  
38 coverage and levels during the analysis. In many cases it proved difficult to clearly  
39 identify publications focusing on solely on individual, team or organisational levels  
40 within the system. For this reason, the analysis presented here is an indication of  
41 trends, rather than a complete picture of systems coverage within the articles.  
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3 Most of the articles that could be identified as relevant to one particular system level  
4 concentrated on individuals (n=98, 27.2% of all articles). The next highest category  
5 were articles referring to the team level of analysis (n=62, 17.2% of all articles),  
6 followed by the organisational level (n=50, 13.9% of all articles). A number of  
7 articles mentioned one or more levels of the system (i.e., multi-level, n=22, 6.1% of  
8 all articles). Few articles mentioned inter-organisational factors that may be  
9 involved in terms of the overall system (n=5, 1.4% of all articles).  
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#### 17 **4. Discussion**

18 A number of themes can be picked out from the review, these include: the  
19 dominance of studies concentrating on human error and incident reporting; system  
20 coverage limitations; and, coverage of medical domains.  
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##### 26 *4.1 Dominance of studies on human error and incident reporting*

27 The results of the literature review indicate that most of the research that has been  
28 so far carried out with systems and patient safety has concentrated on errors; the  
29 reporting of errors or safety/risk perceptions. In many respects this is unsurprising,  
30 with patient safety research placing a heavy emphasis upon the nature of errors and  
31 how best to manage and document them. However, what is perhaps more surprising  
32 is that adopting a systems approach to patient safety has not resulted in a more  
33 eclectic view of safety and error. Most of the articles focused on individual error,  
34 fewer on team errors and none on what might be labelled “organisational” errors.  
35 This could of course be due to limitations in the sampling procedure used to review  
36 articles. However, as outlined earlier on in the paper, adopting the systems approach  
37 usually means trying to gain some view of the larger picture and to think  
38 systemically rather than focus on one level within the system to the exclusion of  
39 others. The systems approach also attempts to understand the causes of error and  
40 the events that led up to it’s occurrence (sometimes referred to as the “aetiology” of  
41 error). The review that was carried out concentrated on classification and obtaining  
42 approximate numbers of papers falling into the categorisation framework. Despite  
43 this, a more even distribution of articles in other categories in the framework was  
44 expected, particularly covering research issues that have been shown in other  
45 domains to be contributory factors within human error (e.g., similar percentages of  
46 articles, or at least higher percentages, covering aspects of individual and team  
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3 communication). Other researchers have argued that the application of a systems  
4 approach towards safety issues needs to be sensitive to the social and organisational  
5 processes through which safe operation is created and maintained (Rochlin, 1999).  
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7 Within patient safety research, Dekker (2007) suggested that there is a need to move  
8 beyond “error counting” and toward a better understanding of the links between  
9 errors and “the systematic, lawful connection between ... assessments and actions,  
10 and the tools, tasks and environment that surrounded them”. The results of the  
11 literature review add some support for this point of view alongside some evidence  
12 that related topics such as organisational structure and culture, as well as safety  
13 culture, are being investigated. Perhaps the most important aspect of these findings  
14 is the limited number of factors linking these factors together and moving across  
15 levels as well as the boundaries between them (e.g., organisational-team linkages).  
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26 With regard to medical domains, hospitals proved to be the most popular domain of  
27 investigation. Most of the research conducted in hospitals was at a general level and  
28 either spanned a range of specialisms, wards or departments or did not directly  
29 report the background details of study participants. Studies involving surgery also  
30 feature prominently. The reason why surgery should prove to be such a fruitful area  
31 for research are not clear, possibly this is due to the complexity of the work, the  
32 degree of coordination between various specialisms (e.g., surgeons, anaesthetists,  
33 nurses) and its susceptibility to human error. Surgery is also sometimes seen as  
34 being the “apex” within healthcare organisations where the influence of decision-  
35 making is critical and organisational processes may have most impact.  
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46 Within the types of professions it is perhaps interesting that where a paper specified  
47 a profession, it was more likely to be nurses than doctors. Likewise, it is also worth  
48 noting that healthcare managers and administrators represented only a very small  
49 percentage of the types of professional roles studied. Within the UK NHS system  
50 the part played by managers and administrators in patient safety is crucial, as is the  
51 relationship these professions have with other healthcare professionals.  
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#### 58 *4.2 Limited studies examining system boundaries and linkages between levels*

59 The results from the analysis of systems coverage also found that where a clear  
60 system level could be identified, most papers focused on individuals. Although team

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3 and organisational level investigations were carried out, few papers addressed issues  
4 across system levels or boundaries and even fewer reported interorganisational  
5 system interactions. The picture that emerges is one in which research has so far not  
6 looked in detail at the dynamics that exists across system boundaries and the  
7 interconnections that link decisions, policies and change in general at one level,  
8 with other levels of analysis. The reports from healthcare accidents and errors  
9 demonstrate that the way in which various system levels and components interact  
10 and how failures can “trickle down” from one level leading eventually to the  
11 occurrence of an adverse event (e.g., National Patient Safety Agency, 2001;  
12 Healthcare Commission, 2007). It is perhaps surprising then that more research has  
13 not followed up these linkages, particularly since cross-level system analyses are  
14 common in other related domains (e.g., rail systems ergonomics – Wilson et al.,  
15 2007; Santos-Reyes and Beard, 2006). One possible explanation is that this type of  
16 research is difficult to carry out and requires a longitudinal study design, multiple  
17 data collection methods and often involves the use of specialist statistical techniques  
18 (e.g., structural equation modelling). However, there are many good examples of  
19 management research on hospitals for example, that have spanned a number of  
20 levels of analysis and yielded interesting findings tracing through these levels and  
21 attempting to unpick the various interdependencies between them (e.g., Edmondson,  
22 1996; Tucker, Nembhard and Edmondson, 2007; Zohar et al., 2007). There is a need  
23 to plug this gap in our understanding and for more of this type of research within  
24 patient safety to be undertaken in the future.

## 43 44 **5. Summary, conclusions and ways forward**

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46 The results of the review provide a mixed picture of the systems approach to patient  
47 safety. The research so far appears to provide only partial coverage of the range and  
48 scope of issues we might expect using a systems ergonomics approach.  
49 Likewise, few studies appear to provide details of the connections that exist between  
50 different system levels. Given the amount of papers that use the term “systems  
51 approach”, as compared to those that cite research deriving from systems theory,  
52 sociotechnical systems or ergonomics, there is reason to believe that term “systems”  
53 is being used rhetorically and one might conjecture, inappropriately. The systems  
54 approach in patient safety research is still relatively new as compared to other  
55 domains and industries. In addition, it is clear that a certain degree of confusion and  
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3 ambiguity surrounds the constructs, concepts and methods associated with the  
4 systems approach. In short, there is no one prescribed systems approach, rather there  
5 are a set of shared characteristics and components (Figure 1). Within these,  
6 however, there is broad scope for a variety of applications within healthcare. In the  
7 final section of the paper a brief example from patient safety (infection control) is  
8 described in order to illustrate a way of looking at healthcare systems that aims to  
9 extend the coverage and connectivity of the systems approach, whilst embodying  
10 some of the common characteristics associated with the approach (figure 1).  
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### 19 *5.1 Extending coverage and connectivity – an example from infection control*

20 Infection outbreaks within hospitals have recently grabbed the attention of the  
21 general public and the media in the UK (e.g., The Guardian, 2007; BBC Panorama,  
22 2008). Partly because of this, they are now recognised as a central patient safety  
23 priority for health care systems within the UK and worldwide (Allegranzi et al.,  
24 2007). A recent review of the human, as compared to epidemiological or  
25 microbiological factors involved in infection control (Griffiths et al., 2008),  
26 demonstrates the wide variety of ergonomic issues that could be addressed by future  
27 research (Table 2). These issues go well beyond a focus on human error alone and  
28 extend the coverage of systems ergonomics issues to include a wide range of social  
29 and organisational issues in patient safety. The important point here is not that  
30 human error is irrelevant in this context, in many cases it may play an important role  
31 (e.g., the failure of an individual to follow hand washing guidelines), instead, error  
32 needs to be viewed in a wider light and subject to wider scale, or macro, system  
33 influences and factors.  
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51 Table 2 about here  
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58 The issues of how these influences or factors might be connected together can be  
59 illustrated with reference to the Maidstone and Tunbridge Wells NHS Trust  
60 *Clostridium difficile* (*C.diff.*) outbreak. As a result of the outbreak an estimated 90

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3 people died after being infected with *C.diff.*. The 2007 report from the Healthcare  
4 Commission on the outbreak at the trust revealed a complex set of social,  
5 organisational and technical factors that contributed to the spread of *C.diff.*  
6 (Healthcare Commission, 2007). Figure 6 is an adaptation of Rasmussen's (1997)  
7 risk management framework to describe some of the range of factors that were  
8 involved in the outbreaks (Waterson, 2008).  
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Figure 6 about here

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27 One way in which the connectivity between the various system levels in figure 6  
28 could be investigated is by adopting the strategy of "bracketing" across system  
29 levels (Hackman, 2003). This involves carrying out conceptual and empirical  
30 analyses of constructs that exist in two or more system levels. Karsh (2006) has  
31 argued the case for something similar and uses the term "mesoergonomics" to  
32 describe: "an open system approach to the development of macroergonomic theory  
33 and research whereby the relationship between variables in at least two different  
34 levels or echelons are studied, and one of the variables is a macroergonomic  
35 outcome of interest such as performance, stress, injury, technology acceptance or  
36 quality of worklife" (p. 3). In the case of infection outbreaks this might mean  
37 carrying out studies that investigate the impact upon infection control rates of macro  
38 level system factors (e.g., targets for bed occupancy set by the government and  
39 implemented through strategic health authorities and NHS trusts) upon meso level  
40 factors (e.g., leadership style). In other cases, it might involve studying the meso-  
41 micro system levels in the light of infection rates (e.g., the interaction between  
42 leadership/management styles and levels of job satisfaction). These types of cross-  
43 level investigations offer the potential to provide researchers and practitioners with  
44 better accounts of whole-part relationships, the connectivity between system  
45 elements (figure 1), as well as helping to scope interventions aimed at redesign or  
46 intervention (Karsh and Brown, 2008).  
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Government reports repeatedly cite the importance of a “whole systems” approach and all indications are that this is likely to increase, rather than decrease in importance (e.g., Healthcare Commission, 2008). The systems approach has the potential to play a major role in helping to make health care safer. If this is to be achieved, and the full benefits of the approach are to be exploited, then researchers need to extend their coverage of system issues and expand their powers of explanation across multiple system levels.

Word Count: (without figures) = 4, 743

## References

Alleganzi, B. Storr, J., Dziekan, G., Leotsakos, A., Donaldson, L. and Pittet, D. (2007), The first global patient safety challenge "Clean Care is Safer Care" from launch to current progress and achievements. Journal of Hospital Infection, 65 (supplement 2): 15.

Apker, J., Mallak, L.A. and Gibson S.C. (2006), Communicating in the "gray zone": perceptions about emergency physician hospital handoffs and patient safety. Academic Emergency Medicine, 14, 10, 884-94.

Ashmos, D.P. and Huber, G.P. (1987), The systems paradigm in organization theory: Correcting the record and suggesting the future. Academy of Management Review, 12, 4, 607-612.

Bagnara, S. and Tartaglia, R. (2007), Patient safety – an old and a new issue. Theoretical Issues in Ergonomics Science, 8, 5, 365-369.

Balka, E., Doyle-Waters, M., Lecznarowicz, D. and Fitzgerald, J.M. (2007), Technology, governance and patient safety: Systems issues in technology and patient safety. International Journal of Medical Informatics, 76, 1, 35-47.

Barenfanger, J., Sutter, R.L., Lang, D.L., Collins, S.M., Hacek, D.M. and Peterson, L.R. (2004), Improving patient safety by repeating (read-back) telephone reports of critical information. American Journal of Clinical Pathology, 12, 1, 6, 801-3.

Battles, J.B., Dixon, N.M., Borotkanics, R.J., Rabin-Fastmen, B. and Kaplan, H.S. (2006), Sensemaking of patient safety risks and hazards. Health Services Research, 41, 4:2, 1555-75.

BBC Panorama (2008), How Safe is Your Hospital? (Broadcast on 27<sup>th</sup> April, 2008), (available at:

[http://www.bbc.co.uk/mediaselector/check/player/nol/newsid\\_7370000/newsid\\_7371100?redirect=7371116.stm&news=1&nbram=1&nbwm=1&bbram=1&bbwm=1](http://www.bbc.co.uk/mediaselector/check/player/nol/newsid_7370000/newsid_7371100?redirect=7371116.stm&news=1&nbram=1&nbwm=1&bbram=1&bbwm=1)

accessed 28<sup>th</sup> April, 2008)

1  
2  
3  
4  
5 Blockley, D. (1998), Managing proneness to failure. Journal of Contingencies and  
6 Crisis Management, 6, 2, 76-75.  
7  
8

9  
10 Blough, C.A. and Walrath, J.M. (2007), Improving patient safety and  
11 communication through care rounds in a paediatric oncology outpatient clinic.  
12 Journal of Nursing Care and Quality, 22, 2, 159-63.  
13  
14

15  
16  
17 Brand, C., Ibrahim, J., Bain, C., Jones, C. and King, B. (2007), Engineering a safe  
18 landing: engaging medical practitioners in a systems approach to patient safety.  
19 Internal Medicine Journal, 37, 5, 295-302.  
20  
21  
22

23  
24 Broom, M., Slater, J. and Ure, D.S. (2006), An observational study of practice  
25 during transfer of patients from anaesthetic room to operating theatre. Anaesthesia,  
26 61, 10, 943-5.  
27  
28  
29

30  
31 Brown, A.D., Alikhan, L.M. and Seeman, N.L. (2006), Crossing the strategic  
32 synapse: aligning hospital strategy with shared system priorities in Ontario, Canada.  
33 Health Care Management Review, 31, 1, 34-44.  
34  
35  
36

37  
38 Brown, Y., Neudorf, K., Poitras, C. and Rodger, K. (2007), Unsafe student clinical  
39 performance calls for a systematic approach. Canadian Nurse, 103, 3, 29-32.  
40  
41  
42

43  
44 Buckle, P., Clarkson, P.J., Coleman, R., Ward, J. and Anderson, J. (2006), Patient  
45 safety, systems design and ergonomics. Applied Ergonomics, 37, 4, 491-500.  
46  
47  
48

49 Carayon, P. and Alvarado, C.J. (2007), Workload and patient safety among critical  
50 care nurses. Critical Care Nursing Clinics of North America, 19, 2, 121-9.  
51  
52  
53

54 Carayon, P., Hundt, A.S., Karsh, B.T., Gurses, A.P., Alvarado, C.J., Smith, M. and  
55 Brennan, P.F. (2006), Work system design for patient safety: The SEIPS model.  
56 Quality and Safety in Health Care, 15 (Suppl. I), 50-58.  
57  
58  
59  
60

1  
2  
3 Catchpole, K.R., Giddings, A.E., Wilkinson, M., Hirst, G., Dale, T. and de Leval,  
4 M.R. (2007), Improving patient safety by identifying latent failures in successful  
5 operations. Surgery, 142, 1, 102-10.  
6  
7

8  
9  
10 Chapanis, A. (1996). Human Factors in Systems Engineering. New York: John  
11 Wiley & Sons, Inc.  
12

13  
14  
15 Clarke, J.R. (2006), How a system for reporting medical errors can and cannot  
16 improve patient safety. American Surgeon, 72, 11, 1088-91  
17  
18

19  
20  
21 De La Fuente, J. and Bix, L. (2005), Applying universal design to child resistant  
22 packaging. Proceedings of Include 2005, London 5-8 April, Royal College of Art,  
23 London, CD-ROM, 11.  
24  
25

26  
27  
28 Dekker, S. (2007), Doctors are more dangerous than gun owners: A rejoinder to  
29 error counting. Human Factors, 49, 2, 177-184.  
30  
31

32  
33  
34 DePalma, R.G. (2006), Surgical quality programs in the Veterans Health  
35 Administration. American Surgeon, 72, 11, 999-1004.  
36  
37

38  
39 Donaldson, L. (2007), Safety First in 21st Century Healthcare, Public Lecture given  
40 by the UK Chief Medical Officer, Loughborough University 1<sup>st</sup> February 2007.  
41  
42

43  
44 Durbin, J., Hansen, M.M., Sinkowitz-Cochran, R. and Cardo, D. (2006), Patient  
45 safety perceptions: a survey of Iowa physicians, pharmacists, and nurses. American  
46 Journal of Infection Control, 34, 1, 25-30.  
47  
48

49  
50  
51 Eason, K.D. (2008), Before the internet: the relevance of socio-technical systems  
52 theory to emerging forms of virtual organisation. Manuscript submitted for  
53 publication.  
54  
55

56  
57  
58 Edmondson, A.C. (1996), Learning from mistakes is easier said than done: group  
59 and organization influences on the detection and correction of human error. Journal  
60 of Applied Behavioral Science 32, no. 1, 5-28.

1  
2  
3 Edworthy, J., Hignett, S., Hellier, E. and Stubbs, D. (2006) Editorial: Special issue  
4 on Patient Safety. Ergonomics, 49, 439-443.  
5  
6

7  
8  
9 Emery, F.E. (1959), Characteristics of socio-technical systems. The Tavistock  
10 Institute of Human Relations, January 1959, Document No. 527.  
11

12  
13  
14 Elder, N.C., Pallerla, H. and Regan, S. (2006), What do physicians consider an  
15 error? A comparison of definitions and physician perception. BMC Family Practice,  
16 7, 73, 1-9.  
17  
18

19  
20  
21 Evans, S.M., Berry, J.G., Smith, B.J., Esterman, A., Selim, P., O'Shaughnessy, J.  
22 and DeWit, M. (2006), Attitudes and barriers to incident reporting: a collaborative  
23 hospital study. Quality and Safety in Health Care, 15, 1, 39-43  
24  
25

26  
27  
28 Frush, K.S. and Alton, M. (2006), Development and implementation of a hospital-  
29 based patient safety program. Pediatric Radiology, 36, 4, 291-8.  
30  
31

32  
33  
34 Galvin, L., McBeth, S., Hasdorff, C., Tillson, M. and Thomas, S. (2007),  
35 Medication bar coding: to scan or not to scan? Computing, Informatics and Nursing,  
36 25, 2, 86-92.  
37  
38

39  
40  
41 Gibson, J. J. (1979) The Ecological Approach to Visual Perception. Boston,  
42 MA:Houghton Mifflin.  
43  
44

45  
46  
47 Gluck, P.A. (2007), Patient safety in women's health care: a framework for progress.  
48 Best Practice and Research Clinical Obstetrics and Gynaecology, 21, 4, 25-36.  
49

50  
51  
52 Grant, M.J., Donaldson, A.E. and Larsen, G.Y. (2006), The safety culture in a  
53 children's hospital. Journal of Nursing Care and Quality, 21, 3, 223-9.  
54  
55

56  
57  
58 Gregory, D.M., Guse, L.W., Dick, D.D. and Russell, C.K. (2007), Patient safety:  
59 where is nursing education? Journal of Nursing Education, 46, 2, 79-82.  
60

Griffiths, P., Renz, A. and Rafferty, AM. (2008), The impact of organisation and

1  
2  
3 management factors on infection control in hospitals: a scoping review. Kings  
4 College, London.

5  
6  
7 (<http://www.kcl.ac.uk/content/1/c6/04/08/39/Infectioncontrolreport.pdf>, accessed  
8  
9 15<sup>th</sup> September, 2008).

10  
11 The Guardian (2007), Deadly superbug infections widespread in UK hospitals, says  
12 expert. The Guardian newspaper, October 11<sup>th</sup> 2007.

13  
14  
15 Gurses, A.P. and Carayon, P. (2007), Performance obstacles of intensive care  
16 nurses. Nursing Research, 56, 3, 185-94.

17  
18  
19 Hackman, J.R. (2003), Learning more by crossing levels: evidence from airplanes,  
20 hospitals, and orchestras. Journal of Organizational Behaviour, 24, 905-922.

21  
22  
23  
24  
25  
26  
27 Healthcare Commission (2007), Investigation into outbreaks of *Clostridium difficile*  
28 at Maidstone and Tunbridge Wells NHS Trust.

29  
30  
31 [http://www.healthcarecommission.org.uk/db/documents/Maidstone\\_and Tunbrid](http://www.healthcarecommission.org.uk/db/documents/Maidstone_and_Tunbridge_Wells_investigation_report_Oct_2007.pdf)  
32 [ge Wells investigation report Oct 2007.pdf](http://www.healthcarecommission.org.uk/db/documents/Maidstone_and_Tunbridge_Wells_investigation_report_Oct_2007.pdf) (accessed October 10th 2007).

33  
34  
35  
36  
37  
38  
39 Healthcare Commission (2008), Not just a matter of time: a review of urgent and  
40 emergency care services in England.

41  
42  
43 [http://www.healthcarecommission.org.uk/serviceproviderinformation/reviewsandstu](http://www.healthcarecommission.org.uk/serviceproviderinformation/reviewsandstudies/servicereviews/ahpmethodology/urgentcare.cfm)  
44 [dies/servicereviews/ahpmethodology/urgentcare.cfm](http://www.healthcarecommission.org.uk/serviceproviderinformation/reviewsandstudies/servicereviews/ahpmethodology/urgentcare.cfm) (accessed October 1st 2008).

45  
46  
47  
48  
49  
50  
51 Helmreich, R.L. and Sexton, J.B. (2004), Managing threat and error to increase  
52 safety in medicine. In R. Dietrich and K. Jochum (Eds.), Teaming Up: Components  
53 of Safety under High Risk. Aldershot: Ashgate.

54  
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998  
999  
1000

Hendrick, H.W. and Kleiner, B.M. (2002, Eds.), Macroergonomics: Theory, Methods and Applications. London : Lawrence Erlbaum Associates

Hoff, T., Jameson, L. Hannan, E. and Flink, E. (2004), A review of the literature examining linkages between organizational factors, medical errors and patient safety. Medical Care Research and Review, 61, 1, 3-37.



1  
2  
3  
4  
5 Hollnagel, E., Woods, D. D., and Leveson, N. (Eds.) (2006). Resilience  
6 Engineering: Concepts and Precepts. London: Ashgate  
7

8  
9  
10 House, R., Rousseau, D.M. and Thomas-Hunt, M. (1995), The meso paradigm: a  
11 framework for the integration of micro and macro organizational behaviour.  
12 Research in Organizational Behaviour, 17, 71-114.  
13

14  
15  
16  
17 Infante, C. (2006), Bridging the “system’s” gap between interprofessional care and  
18 patient safety: Sociological insights. Journal of Interprofessional Care, 20, 5, 517-  
19 525.  
20  
21

22  
23  
24  
25 Johnsson, C., Kjellberg, K. And Lagerstrom, M. (2004), A direct observation  
26 instrument for assessment of nurses' patient transfer technique (DINO). Applied  
27 Ergonomics, 35, 6, 615.  
28

29  
30  
31  
32 Karsh, B-T. (2006). Meso-ergonomics: a new paradigm for macroergonomics  
33 research. Proceedings of the International Ergonomics Association 2006 Congress.  
34

35  
36  
37 Karsh, B-T. and Brown, R. (2008) Macroergonomics and patient safety: the impact  
38 of levels on theory, measurement, analysis and intervention in medical error  
39 research. Manuscript submitted for publication.  
40  
41

42  
43  
44 Katz, D. and Kahn, R. (1966), The Social Psychology of Organizations. New York:  
45 Wiley.  
46

47  
48  
49 Kiekkas, P., Brokalaki, H, Manolis, E., Samios, A., Skartsani, C. and Baltopoulos,  
50 G. (2007), Patient severity as an indicator of nursing workload in the intensive care  
51 unit. Nursing and Critical Care, 12, 1, 34-41.  
52  
53

54  
55  
56 King, T. and Byers, J.F. (2007), A review of organizational culture instruments for  
57 nurse executives. Journal of Nursing Administration. 37, 1, 21-31.  
58  
59  
60

1  
2  
3 Kohn, L., Corrigan, J. and Donaldson, M.E. (1999), To Err is Human. Washington,  
4 DC: National Academy Press.  
5  
6

7  
8  
9 Landry, M.D. and Sibbald, W.J. (2002), Changing physician behavior: a review of  
10 patient safety in critical care medicine. Journal of Critical Care, 17, 2, 138-45.  
11  
12

13  
14 Leonard, M., Graham, S. and Bonacum, D. (2004), The human factor: the critical  
15 importance of effective teamwork and communication in providing safe care.  
16 Quality and Safety in Healthcare, 13, Suppl. 1, 85-90.  
17  
18

19  
20  
21 Lin, L. and Liang, B.A. (2007), Addressing the nursing work environment to  
22 promote patient safety. Nursing Forum, 42, 1, 20-30.  
23  
24

25  
26 Lingard, L., Espin, S., Whyte, S. Regehr, G., Baker, G.R., Reznick, R., Bohnen, J. ,  
27 Orser, B, Doran, D. and Grober, E. (2004) Communication failures in the operating  
28 room: an observational classification of recurrent types and effects. Quality and  
29 Safety in Healthcare, 13, 5, 330-4.  
30  
31  
32

33  
34  
35 Lee, A.C., Leung, M. And So, K.T. (2007), Managing patients with identical names  
36 in the same ward. International Journal of Health Care Quality Assurance, 18, 1, 15-  
37 23  
38  
39

40  
41  
42 McLoughlin, V., Millar, J., Mattke, S., Franca, M., Jonsson, P.M., Soemkh, D. and  
43 Bates, D. (2006), Selecting indicators for patient safety at the health system level in  
44 OECD countries. International Journal of Quality and Health Care, 18, Suppl 1, 14-  
45 20.  
46  
47  
48

49  
50  
51 Moody, L.E., Slocumb, E., Berg, B. and Jackson, D. (2004), Electronic health  
52 records documentation in nursing: nurses' perceptions, attitudes, and preferences.  
53 Computing Informatics and Nursing, 22, 6, 337-44.  
54  
55

56  
57  
58 Morath, J.M. (2006), Patient safety: a view from the top. Pediatric Clinician North  
59 America, 53, 6, 1053-65.  
60

1  
2  
3 Naik, G. (2006), A hospital races to learn lessons of Ferrari pit stop. Wall Street  
4 Journal, November 14<sup>th</sup> 2006.  
5  
6

7  
8  
9 National Patient Safety Agency (2001), External Inquiry into the Adverse Incident  
10 that occurred at Queens Medical Centre, Nottingham, 4<sup>th</sup> January 2001.  
11 [http://www.archive.npsa.nhs.uk/site/media/documents/824\\_toftqueensmedical.pdf](http://www.archive.npsa.nhs.uk/site/media/documents/824_toftqueensmedical.pdf)  
12 (accessed March 30th 2007).  
13  
14

15  
16  
17 Nowinski, C.V. and Mullner, R.M. (2006) Patient safety: solutions in managed care  
18 organizations? Quality and Management in Health Care, 15, 3, 130-6.  
19  
20

21  
22  
23 Perneger, T.V. (2005), The Swiss cheese model of safety incidents: are there holes  
24 in the metaphor? BMC Health Services Research, 5, 71, 1-7.  
25  
26

27  
28 Perrow, C. (1984), Normal Accidents: Living with High-Risk Technologies. New  
29 York: Basic Books.  
30  
31

32  
33 Reason, J.T. (2001a), A systems approach to organizational error. Ergonomics, 38,  
34 8, 1708-1721.  
35  
36

37  
38 Reason, J.T. (2001b), Understanding adverse events: the human factor. In C.  
39 Vincent (Ed.), Clinical Risk Management: Enhancing Patient Safety, 2<sup>nd</sup> Edition.  
40 London: BMJ Publications..  
41  
42

43  
44 Reason, J.T., Carthey, J. and de Leval, M.R. (2001), Diagnosing “vulnerable system  
45 syndrome”: an essential prerequisite to effective risk management. Quality and  
46 Safety in Healthcare, 10 (Suppl. II), 2, 21-25.  
47  
48  
49

50  
51  
52 Rochlin, G.I. (1999), Safe operation as a social construct. Ergonomics, 42, 11,  
53 1549-1560.  
54  
55

56  
57  
58 Rose, J.S., Thomas, C.S., Tersigni, A., Sexton, J.B. and Pryor, D. (2006), A  
59 leadership framework for culture change in health care. Joint Commission Journal  
60 on Quality and Patient Safety, 32, 8, 433-42.

1  
2  
3  
4  
5 Salas, E., Baker, D., King, H. and Battles, J. (2006), Special section commentary:  
6 Opportunities and challenges for human factors and ergonomics in enhancing  
7 patient safety. Human Factors, 48, 1, 1-4.  
8  
9

10  
11 Santos-Reyes, J. and Beard, A.N. (2006), A systemic analysis of the Paddington  
12 railway accident. Proceedings of the Institute of Mechanical Engineering, Part F:J,  
13 Rail and Rapid Transit., 220, 121-151.  
14  
15  
16

17  
18 Scalise, J. (2006), Clinical communication and patient safety. Hospitals and Health  
19 Networks. 80, 8, 49-54.  
20  
21  
22

23  
24 Seiden, S.C. and Barach, P. (2006), Wrong-side/wrong-site, wrong-procedure, and  
25 wrong-patient adverse events: Are they preventable? Archives of Surgery, 141, 9,  
26 931-9.  
27  
28  
29

30  
31 Sinclair, M.A. (2007), Ergonomics issues in future systems. Ergonomics, 50, 12,  
32 1957-1986.  
33  
34

35  
36 Singleton, W.T. (1974), Man-Machine Systems. Penguin Books: Harmondsworth.  
37  
38

39  
40 Stone, P.W., Mooney-Kane, C., Larson, E.L., Horan, T., Glance, L.G., Zwanziger,  
41 J. and Dick, A.W. (2007), Nurse working conditions and patient safety outcomes.  
42 Medical Care, 45, 6, 571-8.  
43  
44  
45

46  
47 Tartaglia, R., Belandi, T. And Albolino, S. (2006), Organising patient safety: The  
48 experience of the Tuscany's clinical risk management centre. Paper presentation  
49 16<sup>th</sup> World Congress of the International Ergonomics Association, Maastricht, The  
50 Netherlands.  
51  
52  
53

54  
55 Trist, E.L. (1959), Socio-technical systems. The Tavistock Institute of Human  
56 Relations, January 1959, Document No. 572.  
57  
58  
59  
60

1  
2  
3 Tucker, A.L., Nembhard, I.M. and Edmondson, A.C. (2007), Implementing new  
4 practices: An empirical study of organizational learning in hospital intensive care  
5 units. Management Science, 53, 6, 894-907.  
6  
7

8  
9  
10 Turner, B. (1978), Man-Made Disasters. London: Wykeham Publications.  
11

12  
13  
14 Tzeng, H-M. and Yin, C-Y. (2007), No safety, no quality – synthesis of research on  
15 hospital and patient safety (1996-2007). Journal of Nursing Care and Quality, 22, 4,  
16 299-306.  
17  
18

19  
20  
21 United States Department of Health and Human Services (2000). Blood Safety  
22 Transcripts. Advisory Committee on Blood Safety and Availability, 11<sup>th</sup> meeting.  
23 (<http://www.hhs.gov/bloodsafety/transcripts/20000425.html>). Accessed 12<sup>th</sup>  
24 November 2007.  
25  
26  
27

28  
29  
30 Vincent, C. (2005), Patient Safety. London: Churchill-Livingstone.  
31

32  
33 Vincent, C., Taylor-Adams, S. and Stanhope, N. (1998), Framework for analyzing  
34 risk and safety in clinical medicine. British Medical Journal, 316, 1154-1157.  
35  
36

37  
38  
39 Vogus and Sutcliffe, K. (2007), The impact of safety organizing, trusted leadership,  
40 and care pathways on reported medication errors in hospital nursing units. Medical  
41 Care, 45, 10, 997-1002.  
42  
43

44  
45  
46 Vrendenburgh, A.G. and Weiniger, M.B. (2004), Communication of drug hazard  
47 information: A critical analysis of the relationship between the pharmaceutical  
48 industry, FDA, Clinicians, and patients, and the impact on patient safety.  
49 Proceedings of the Human Factors and Ergonomics Society 48<sup>th</sup> Meeting, New  
50 Orleans Louisiana, Conference Proceedings, 2040-2044.  
51  
52

53  
54  
55  
56 Walker, G.H., Stanton, N.A., Salmon, P.M. and Jenkins, D.P. (2008), A review of  
57 sociotechnical systems theory: a classic concept for new command and control  
58 paradigms. To appear in Theoretical Issues in Ergonomics Science.  
59  
60

1  
2  
3 Walsh, K. and Jiju, A. (2007) Improving patient safety and quality: what are the  
4 challenges and gaps in introducing an integrated electronic adverse incident and  
5 recording system within the health care industry? International Journal of Health  
6 Care Quality Assurance, 20, 2-3,107-15.  
7  
8  
9

10  
11 Waring, J.J. (2007), Doctors' thinking about the "system" as a threat to patient  
12 safety. Health: An Interdisciplinary Journal for the Study of Health, Illness and  
13 Medicine, 11, 1, 29-46.  
14  
15  
16

17  
18  
19 Waterson, P.E. (2008), Systems analysis for infection control in acute hospitals.  
20 Manuscript submitted for publication.  
21  
22  
23

24  
25 Wears, R.L. (2005), Keep the celebrations short. Quality and Safety in Healthcare,  
26 14, 154.  
27  
28  
29

30 Weissman, J.S., Annas, C.L., Epstein, A.M., Scheider, E.C., Claridge, B., Kirle, L.,  
31 Gatsonis, C., Feibelman, S. and Ridley, N. (2005), Error reporting and disclosure  
32 systems: views from hospital leaders. JAMA - The Journal of the American Medical  
33 Association, 16, 293, 11, 1359-66.  
34  
35  
36

37  
38  
39 Westfall, J.M., Fernald, D., Staton, E.W., VanVorst, R., West, D. and Pace, W.D.  
40 (2004), Applied strategies for improving patient safety: a comprehensive process to  
41 improve care in rural and frontier communities. Journal of Rural Health, 20, 4, 355-  
42 62.  
43  
44  
45

46  
47  
48 Wilson, J.R., Farrington-Darby, T., Bye, R. and Hockey, G.R.J. (2007), The railway  
49 as a socio-technical system: Human factors at the heart of successful rail  
50 engineering. Proceedings of the Institute of Mechanical Engineering, Part F, 221, 1,  
51 101-116.  
52  
53  
54

55  
56  
57 Yule, S. Flin, R., Paterson-Brown, S, Maran, N. and Rowley, D. (2006),  
58 Development of a rating system for surgeons' non-technical skills. Medical  
59 Education, 40, 11, 1098-104.  
60

1  
2  
3 Zohar, D., Livne, Y., Tenne-Gazit, O., Admi, H. and Donchin, Y. (2007),  
4 Healthcare climate: a framework for measuring and improving patient safety.  
5 Critical Care Medicine, 35, 5, 1.  
6  
7  
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For Peer Review Only

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Table 2: Examples of systems ergonomics issues associated with infection control  
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### List of figures

Figure 1: Characteristics and components of the systems approach

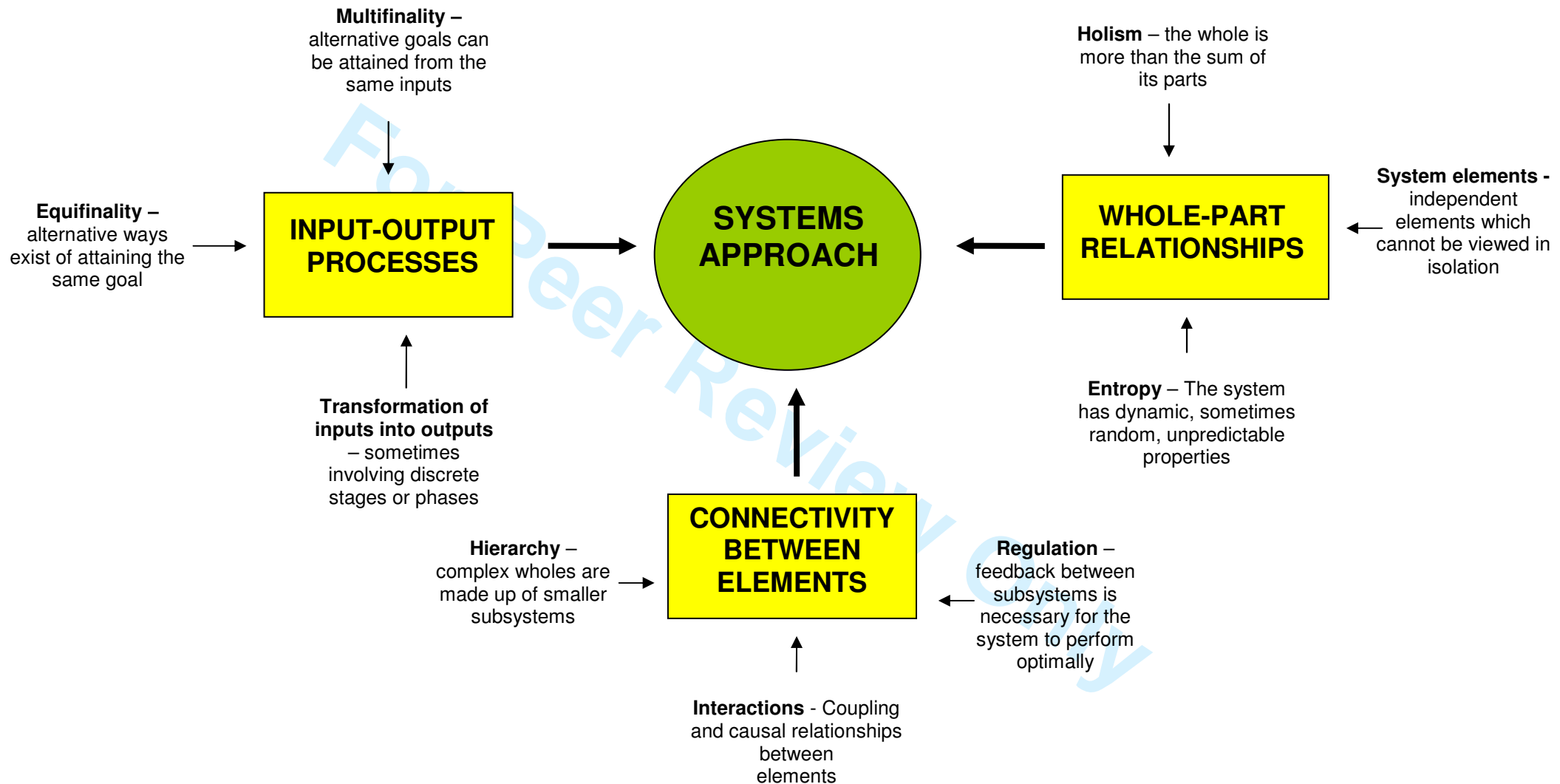
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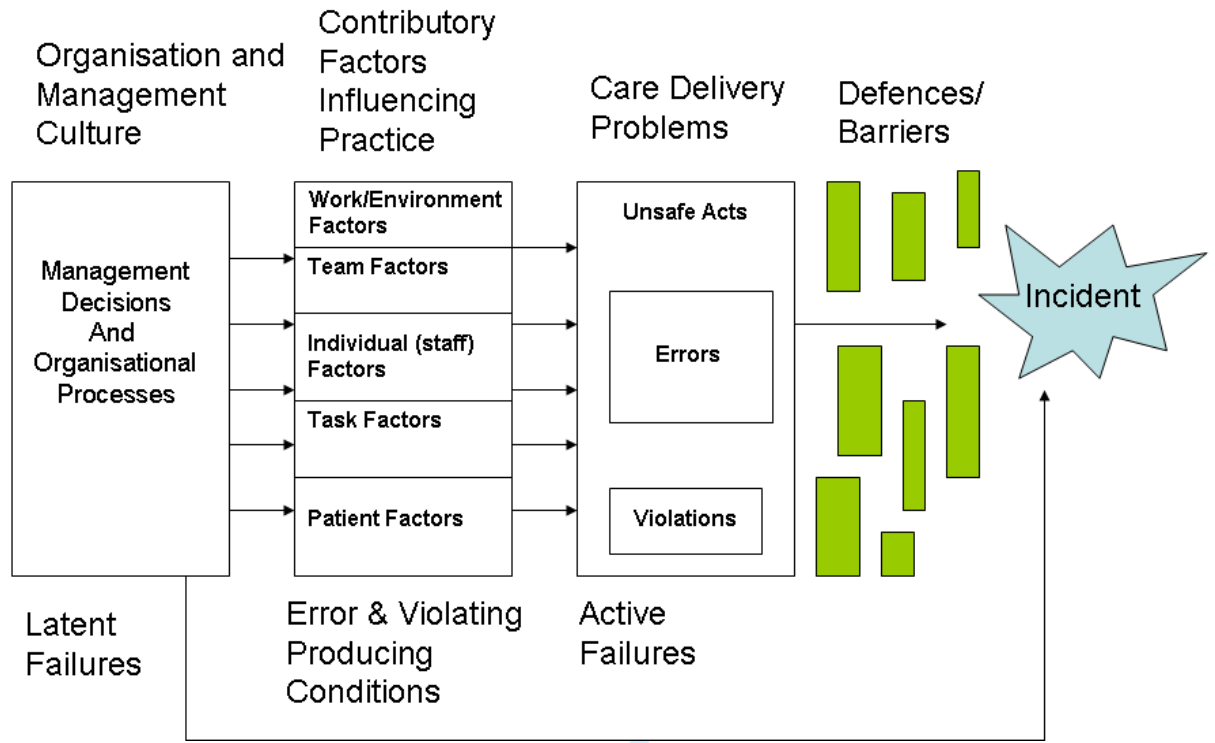
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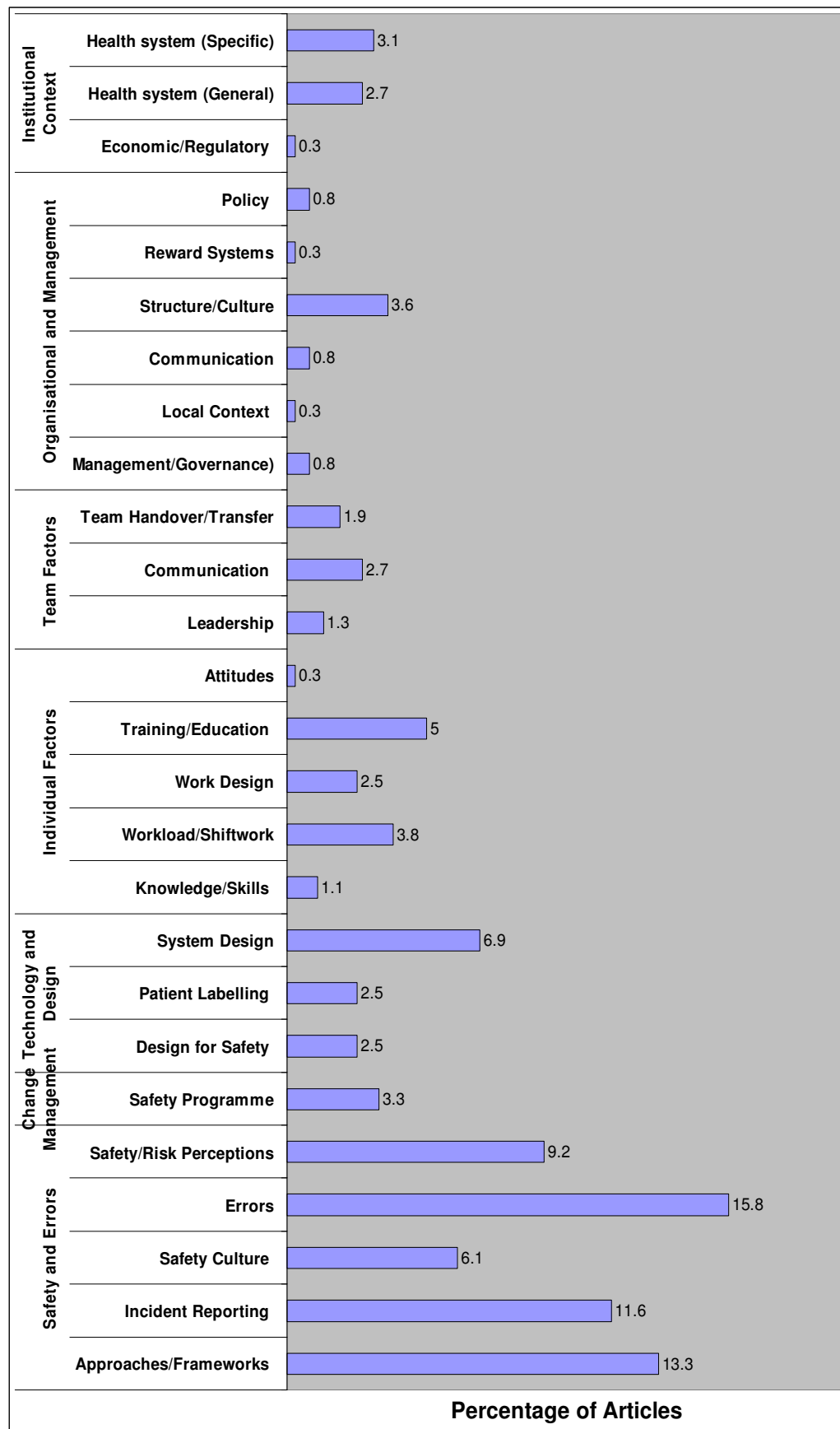
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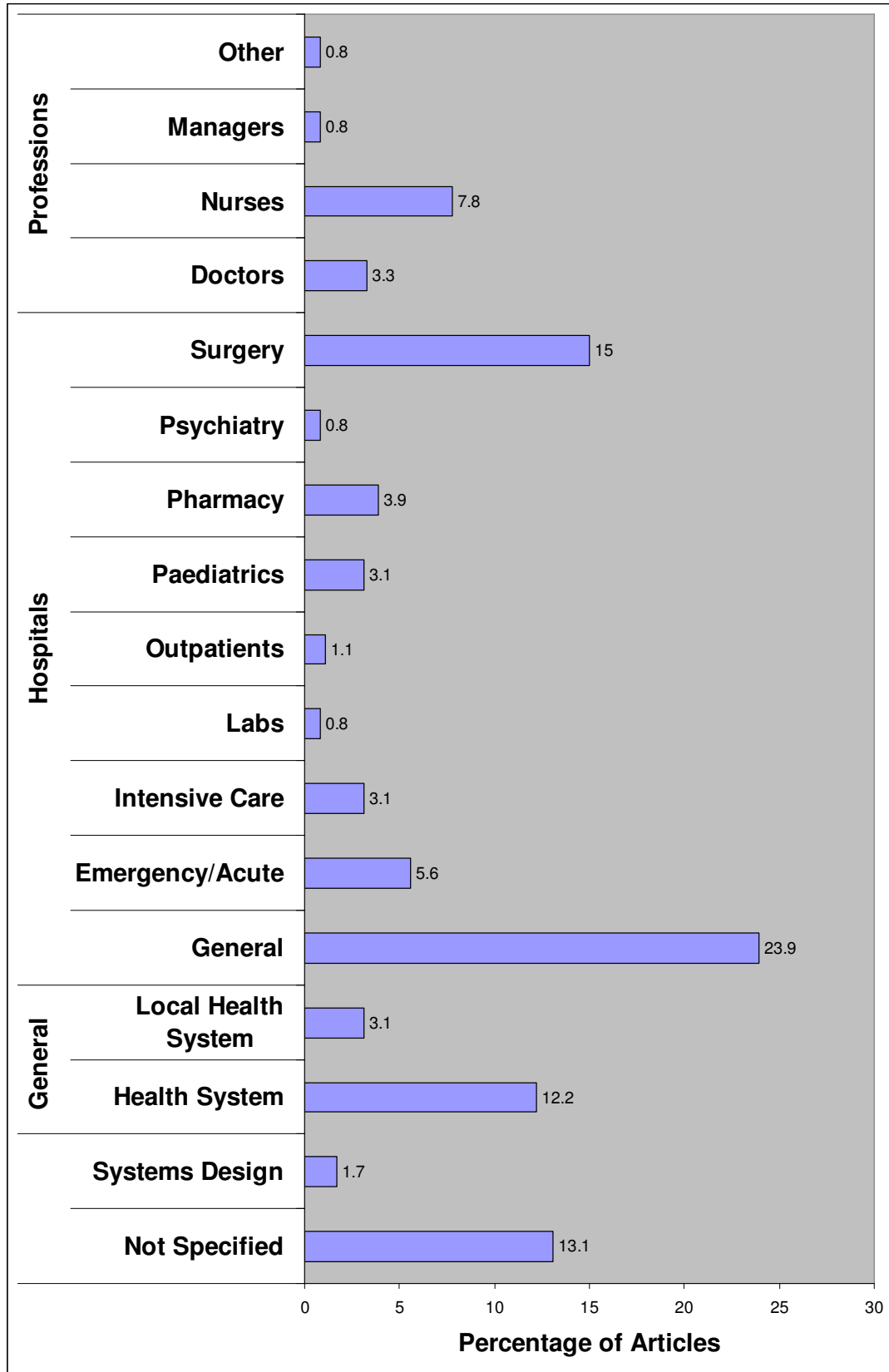


**Figure 3: Primary focus of study: Bar chart of percentage of articles in each category**



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Figure 4: Medical Domain; Bar chart of percentage of articles in each category



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**Figure 5: Systems coverage: Bar chart of percentage of articles in each category**

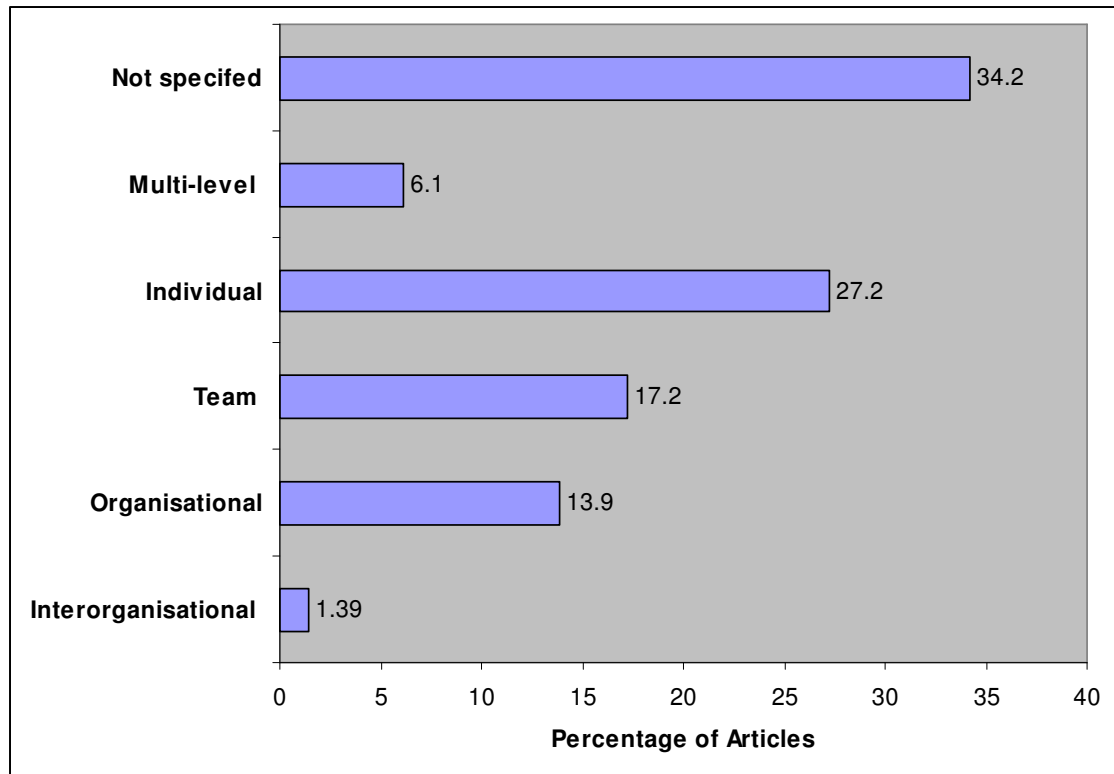
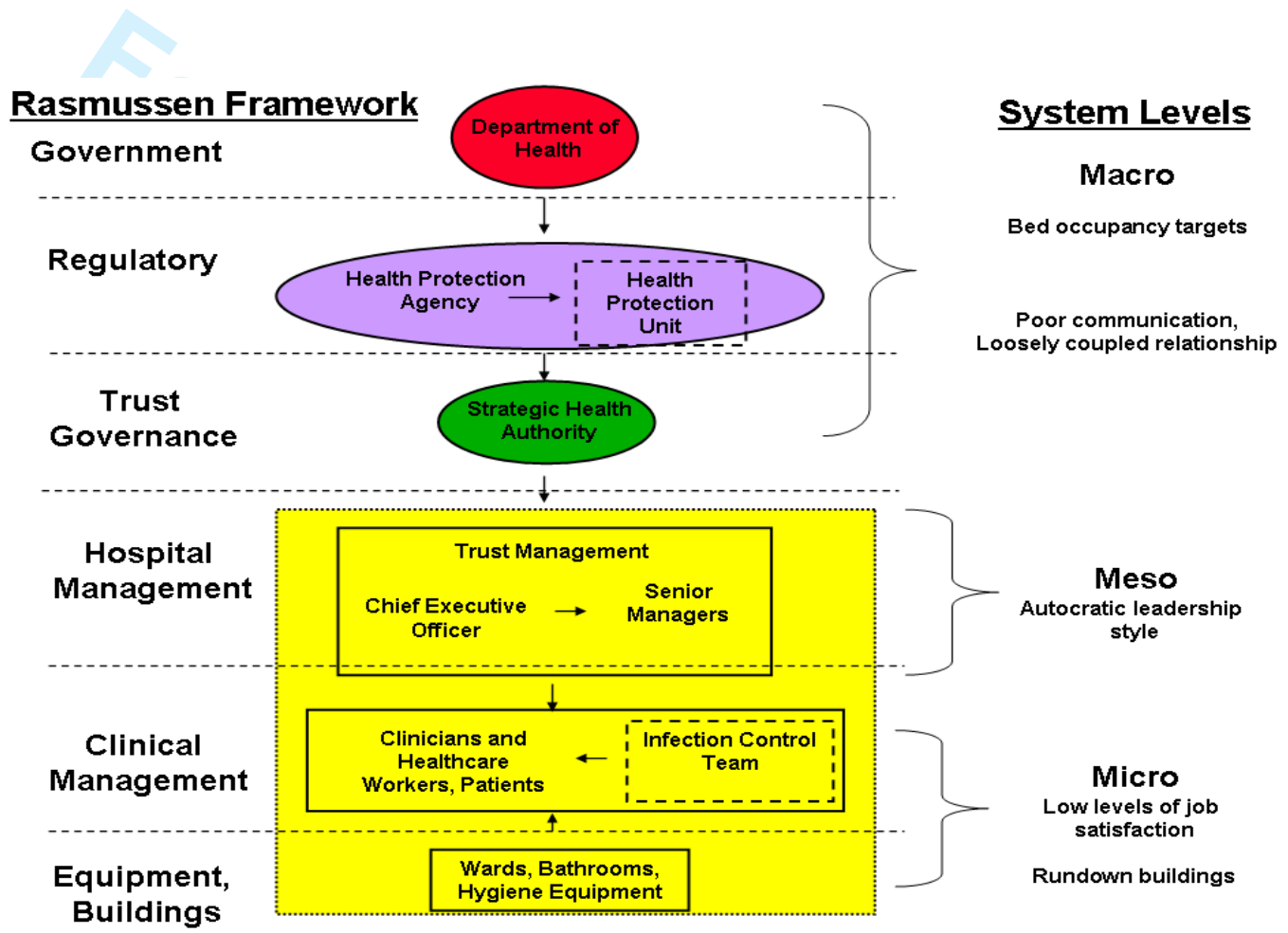


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**Table 1: Review categorisation scheme**

Category	Subcomponents	Examples
<b>Institutional context</b>	Economic/Regulatory	Communication between representatives from industry, clinicians and patients (Vrendenburgh and Weiniger, 2004)
	Health system (General)	Nationally-based healthcare systems (e.g., Walsh and Jiju, 2007), general patient groups in the healthcare system (e.g., women – Gluck, 2007)
	Health system (Specific)	Application of patient safety to specific medical domains (e.g., , paediatrics, general surgery – DePalma, 2006), types of specific healthcare (e.g., rural Westfall et al., 2004).
<b>Organisational and management</b>	Management/Governance	Frameworks for leadership of safety culture programs (Rose et al., 2006). Leadership perspectives on error reporting (Weissman et al., 2005)
	Local Organisational Context	Patient safety in a local geographical context (e.g. region – Tartaglia et al., 2006)
	Communication	Verbal communication of critical information (Barenfanger et al., 2004), general clinical communication (Scalise, 2006)
	Organisational Structure/Culture	Instruments for organisational culture (King and Byers, 2007)
	Reward Systems	Introduction of performance-related pay and impact upon patient safety (Nowinski and Mullner, 2006)
	Policy	Selecting patient safety indicators for the OECD countries (McLoughlin et al., 2006)
<b>Team factors</b>	Leadership	The impact of trusted leadership upon medical errors (e.g., Vogus and Sutcliffe, 2007); Requirements for leadership within patient safety (Morath, 2006)
	Communication	Using care rounds as a means of improving communication between ward personnel (Blough and Walrath, 2007); communication failures in the operating room (Lingard et al., 2004); use of surgical briefings to improve communication (Leonard et al. 2004)
	Team Handover/Transfer	Techniques for the observation of patient handover (Johnsson et al., 2004); transfer from anaesthetic room to operating theatre (Broom et al., 2006); perceptions of communication difficulties in handover (Apker et al., 2007).
<b>Individual factors</b>	Knowledge/Skills	Development of measure for non-technical skills (Yule et al., 2006); knowledge about the systems approach (Waring, 2007).
	Workload/Shiftwork	Nursing workload in intensive care (Kiekkas et al., 2007); workload amongst nurses in critical care (Carayon and Alvarado., 2007); working condition of nurses and safety outcomes (Stone et al., 2007)
	Work Design	Performance obstacles and work design in nursing (Gurses and Carayon, 2007); staff-patient ratios in nursing (Lin and Liang, 2007)
	Training/Education	Need for educational support to instruct the systems approach (Brand et al., 2007; Brown et al., 2007); patient safety education for the nursing profession (Gregory et al., 2007)
	Attitudes	Changing the attitudes of doctors towards patient safety (Landry and Sibbald, 2002)

Category	Subcomponents	Examples
<b>Technology and design</b>	Design for Safety	Designing for patient safety and ergonomics (Buckle et al., 2006); design of packaging for patient safety (De La Fuente and Bix, 2005)
	Patient Labelling	Practical recommendations for patient barcoding (Galvin et al., 2007); Naming and barcoding of patients (Lee et al., 2007)
	System Design	Sociotechnical and systems issues in system design (Balka et al., 2007); perceptions and views on electronic records (Moody et al., 2004)
<b>Change management</b>	Implementation of a safety program	Implementing a patient safety initiative within a geographical region (Brown et al., 2006); implementing patient safety within a hospital (Frush and Alton, 2006)
<b>Safety and Errors</b>	Approaches/Frameworks	Sensemaking as an approach for understanding patient safety (Battles et al., 2006); Frameworks for understanding human error and patient safety (Helmreich and Sexton, 2004).
	Incident Reporting	Improving patient safety using incident reports (Clarke, 2006); Attitudes toward incident reporting (Evans et al., 2006)
	Safety Culture	Organisational safety climate in nursing (Zohar et al., 2007); safety culture in a children's hospital (Grant et al., 2006)
	Errors	Latent failures in surgery (Catchpole et al., 2007); analysis of wrong site surgery (Seiden and Barach, 2006)
	Safety/Risk Perceptions	Perceptions of the term "error" (Elder et al., 2006); medics and pharmacist perceptions of errors and disclosure (Durbin et al., 2006)

**Table 2: Examples of systems ergonomics issues associated with infection control (summary based on Griffiths et al., 2008)**

Issue	Sub-issues
Leadership styles	<ul style="list-style-type: none"> <li>• Impact of positive and “laissez faire” leadership styles on staff and patient satisfaction</li> <li>• Rate of management turnover</li> <li>• Extent of bullying and harassment by managers</li> <li>• Number of staff being supervised by managers (“span of control”)</li> </ul>
Management structure and roles	<ul style="list-style-type: none"> <li>• Implementation of specific role (e.g., modern matron)</li> <li>• Extent of role conflict and tensions</li> <li>• Role clarity and ambiguity</li> <li>• Role overload</li> </ul>
Teamwork	<ul style="list-style-type: none"> <li>• Team make up (e.g., members from multiple disciplines)</li> <li>• Team functioning and outcomes</li> </ul>
Human resource management	<ul style="list-style-type: none"> <li>• Extent and nature of staff appraisals</li> <li>• Training policies and adequacy of training provision</li> </ul>
Clinical governance	<ul style="list-style-type: none"> <li>• Transparency of auditing, feedback and accountability</li> <li>• Degree of risk management focus</li> </ul>
Workforce and workload	<ul style="list-style-type: none"> <li>• Staffing and skill mix</li> <li>• Team stability, turnover and use of temporary staff</li> <li>• Job satisfaction and morale</li> </ul>