SAFETY SCIENCE Monitor

Issue 1 2011

Article 5 VOL 12

UNDERSTANDING THE SYSTEM IN RELATION TO SAFE MEDICAL WORK PRACTICES

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ABSTRACT

Within existing health care safety research, limited attention has been paid to the significance of "the system" in relation to team work, and the term system is also commonly considered to be something vague and therefore unapproachable. In light of this, we explore how different factors of the system influence interdisciplinary operations and safe work practices (research aim #1). We also focus on replicating existing methodological approaches, and on linking our findings to previous research (research aim #2). We find that two particular trends stand out from the data: (1) various combinations of system factors contribute to disrupt the "operational flow", but the particular operation continues and completes normally, and (2) various system factors compensate for the vulnerabilities and disruptions that arise during operations. We then compare the study findings to existing research, with a focus on identifying the similarities, nuances and differences between the study findings and existing findings.

1. INTRODUCTION

Current health care safety research suggests that further efforts are needed to reveal the specific and unique characteristics of team practices in the health care sector (Baker et al. 2006; Lyndon 2006). Intuitively, this includes an understanding of how different types of knowledge and skills are applied in actual team work practices (Greenhalgh et al. 2008; Smith et al. 2006). However, the research also points to the importance of exploring system factors in relation to team work practices (Catchpole et al. 2006; Infante 2006). Specifically, the "system" is commonly perceived as something vague and indefinable (Infante 2006), and currently only a handful of studies document original findings that can be related to system factors (Catchpole et al. 2007; Christian et al. 2006; Leach et al. 2009; Mackintosh 2009). Judging by the limited efforts that has gone into understanding the system factors surrounding interdisciplinary teams and safe work practices, there is a need for studies that not only reveal the character of the system factors but also relate the particular findings to existing research to support a continuation of research efforts. This represents our incentive for studying the system in relation to interdisciplinary team practices.

2. MAIN DEFINITIONS

In this article, the understanding of system includes "the local surroundings", defined as the team-related factors that exist within the operating room (such as staff, equipment and supply), and also "the outer structures", defined as all factors that exist outside of the operating room, anchored to structures and management (such as policies, workload and operating room size). When it comes to the definition of safe work practices, Vincent takes an indirect approach to the safety concept by seeing the study of failure as "…only a necessary step in the more general quest to understand how success is achieved and how safety can be gained and lost in the moment" (Flin R. 2009, xxiv). Derived from this understanding, safe work practices in this article is defined as an interdisciplinary health care team's ability to create and maintain work practices that promote safety and contribute to a successful patient outcome (patient safety).

3. RESEARCH APPROACH

Given the weaknesses in health care safety research identified above, we attempt to improve the current system understanding, by exploring how different factors of the system affect interdisciplinary team operations and safe work practices (research aim #1). We also attempt to replicate elements of existing methodologies, and link our findings to existing findings, in order to achieve a continuation of previous research efforts (research aim #2).

3.1 Overall methodology of the study

The study applied an ethnographic approach (Marcus 1998), grounded in a combination of detailed non-participant observations, conversations and a series of semi-structured interviews. The main benefit of ethnography is that it provides an insight into the actions and explanations of individuals that is hard to quantify, or as Silverman (2004) says: "… the phenomena studied cannot be deduced but require empirical observation" (p. 10). In this study, the particular phenomenon being explored is the nature of the system factors affecting interdisciplinary operations and safe work practices.

3.2 Ethical concerns

The study was conducted in one section of a Norwegian regional general hospital. Based on the approval and recommendations of the Norwegian Social Science Data Services (NSD), all potential participants of the study (sample) were informed via presentations prior to the field work. During these presentations, participants were handed a written information form (based on a template from NSD) that included information on the aim of the study and anonymity issues, and also a field for signing informed consent. Observations were only conducted when every member of the operating team had agreed to be observed. In situations where information had not been given and/or consent not obtained beforehand, this was taken care of before the operation began.

3.3 Selections

A typical operating team consists of 1-2 operators (surgeons), 2 operating room nurses, 2 nurse anesthetists, and 1 anesthetist physician. Table 1 illustrates the groups observed, the total sample size, the numbers who gave their informed consent, the numbers who were actually observed, and the numbers who were interviewed. The interviews lasted an average of 43 minutes.

Table 1: Distribution of observations and interviews

Groups obs.	Sample	Inf.	Obs.	Int.
Anesthetist physician	9	5	5	2
Nurse anesthetist	15	14	11	3
Operating room nurse	22	15	15	2
Operator	45	16	16	4
Manager (interviews)	NA	NA	NA	4
Total (% of sample)	91	50 (55)	47 (52)	15 (16)

Interviews and observations were sampled to cover variety. In interviews this was achieved by ensuring variety across different types of professions, as shown in table 1. Variety was also achieved through age groups (33-54 years, 43.9 years on average), sexes (5 females, 10 males), and levels of experience as a specialist (2-36 years, 12.6 years on average). In terms of the observations, variety was achieved within the two main categories of elective (planned) and immediate (within 72 hours) surgery, and by attending different types of operations within the main categories, as listed in table 2.

Table 2: Distribution of observation type and duration

Type of obs.	Elective	Immediate	Total/Hours
Variants of fracture	1 (00:45)	11 (21:50)	12 (22:35)
Variants of revision	2 (03:30)	1 (02:00)	3 (05:30)
Achilles extension	3 (06:30)	NA	3 (06:30)
Back stabilization	2 (12:30)	NA	2 (12:30)
Other	7 (15:20)	NA	7 (15:20)
Total/Hours	15 (38:35)	12 (23:50)	27 (62:25)

3.4 Creating and realizing a research protocol

To ensure that the study and findings later could be compared to existing health care safety research, a methodological replication strategy was selected. The goal of the replication was to mimic elements of how previous ethnographic research in a health care setting has been executed. With this goal in mind, we conducted an extensive review of existing health care safety literature, and identified one article that stood out from the rest in terms of methodological detailing; Smith, Goodwin et al (2003). The field research protocol of the study was shaped by the elements in Smith et al (2003), from the overall methodology to the specific practical steps to be taken during observations and interviews. Specifically, the protocol was given a sectional layout, directly reflected in the sub-headings next (3.4.1-3.4.3).

3.4.1 Practical methodology for observations

At the beginning of each observation, the operation was numbered (1-n) and specified in terms of type of operation and participants. A principal researcher (SH) and a co-researcher (JGH) were present at the majority of the operations, to ensure comparison and internal validity of the observations. During the observations, the nursing background of JGH clarified technical aspects and helped to improve the precision of the field notes taken by SH, while SH provided clarifications on safety issues that helped improve JGH's understanding and notes in this regard. This added to internal validity. Given the nature of the observed operations, where one operation replaced the previous in immediate transitions (shift began 07.30 and lasted in average to 15.00), the opportunity to fully transcribe notes occurred in the afternoons. The transcriptions were done individually, and focused on identifying emergent themes. This was followed by comparison of transcriptions and themes between observers, by means of discussions, to confirm, adjust or dismiss the understandings. To further address validity concerns, respondent validation also occurred during conversations and interviews, to confirm, adjust or dismiss emerging themes and understandings.

3.4.2 Practical methodology for interviews

The main priority in the design of the interviews was to achieve a working synergy between the observations and the interviews, given our interest in respondent validity. This required that the interviews had an open nature that allowed for the inclusion of observational findings. Hence, a semi-structured interview guide was constructed from original findings in existing health care safety research. The guide was systemized into different sub-themes of "system" (supported by Catchpole et al. 2007; Christian et al. 2006; Leach et al. 2009; Mackintosh 2009). One sub-theme focused on the local surroundings, including the influence (on work practices) of unexpected patient anatomy, weaknesses or defects in equipment, and interruptions from mobile phones or people entering the operating room. Another sub-theme emphasized the outer structures, such as the relevance of high workload, and conflicting or competing demands from other parts of the hospital. In practice, the guide appeared

both flexible and relevant during the interviews, by triggering reflections in the respondents and also by enabling the researcher to naturally relate his observations to the particular question. Both the principal researcher (SH) and the co-researcher (JGH) conducted the interviews, mainly individually but also in tandem (2 interviews).

3.4.3 Practical methodology for conversations

Identical to the semi-structured interviews, the main purpose for initiating conversations was to approve, adjust or dismiss existing observations. However, during the field stay, both the principal researcher (SH) and co-researcher (JGH) experienced that conversations not only provided an important source for validation, but also became an important means for gaining acceptance for the presence of the observers. This was evident from the fact that the respondents approached us more often, and from the fact that these conversations typically lasted longer.

3.5 A concern for "field blindness"

The observational period lasted 7 weeks in total, following a 4-4-2-2-1-1 "on-off in the field" system, where the first of the similar numbers in the sequence is the "on" state and the other the "off". Through the off periods in this yo-yo system (Wulf 2002), the intention was to achieve a distance to the field that would reduce the proneness to "field blindness" and stimulate to more "sober" reflections (Fangen 2005). The practical value of applying a field distancing strategy is described next.

3.6 Analysis

One aspect of the analysis process was the triangulation of findings from observations (including conversations), not only via researcher comparison of notes and transcripts but also via respondent validation during interviews and conversations (Patton 1990). This triangulation helped to identify, adjust and dismiss emergent themes, and also assisted in improving the general understanding and the specific details of what was going on in the operating room. The triangulation in the field provided a set of initial and "immature" emergent themes. A more thorough analysis was performed in the month following the first field stay (the "off in the field" period). Through analytical triangulation (Patton 1990), all three researchers (SH, KA, and JGH) were involved in the analysis process. Specifically, the analysis consisted of repeatedly reading the raw observational and conversational data, until the relationships between the series of events that occurred during the particular operation became clear. These events created an episode, defined as a series of related events that form a "bigger story". The episodes were then read and compared repeatedly by the researchers, individually and in tandem, until the particular emergent theme or trend became visible in the material. A trend is defined as a clear "red line" that runs through more than one episode. In cases where observational data did not provide a red line supportive of a particular trend, the researchers relied on the red lines identified in conversational and interview data. Combined, the two analyzing strategies for identifying episodes and trends complemented each other. Specifically, the emphasize on episodes are supported by Nielsen's (2004) story telling approach, providing *a rich and unique picture* of findings, while a focus on trends are comparable to the categorization techniques described by Miles and Huberman (1994), providing *a structured and transparent picture* of findings. The analysis process for identifying episodes and trends was repeated for all the off-weeks of the study (4-2-1). Based on field experiences in this study, the main benefit of the off-weeks analysis is that it provides an indication on the degree of success or failure of current research efforts in the field. This information, in turn, can be used to determine the ideal focus of the coming field stay.

4. FINDINGS

The study findings have been categorized into trends and episodes that demonstrate how different factors of the system affect safe work practices in interdisciplinary operations. The included episodes are representative of the particular trend (selection criterion).

4.1 Trend 1 – Various combinations of system factors contribute to disrupt the "operational flow", but the particular operation continues and completes normally…

A trend in the data material is the different ways combinations of system factors in the local surroundings and in the outer structures appear to disrupt the normal flow of the operational activities. However, the particular operation proceeds and ends normally. In this study, we define normal as when the individual team member focuses on his or her safe work practices throughout the operation, typically by running the necessary procedures, by monitoring patient status continuously, and by working together as a team. In the descriptions next, the first

three of the observed episodes are from immediate surgery. An analysis and comparison of the episodes are provided after the initial descriptions.

4.1.1 Episode 1 – "The operation schedule triggers discussions"

During preparations for this operation, the main operator enters the operating room and a discussion is triggered between the operator and the 1st operating room nurse (inexperienced) concerning the type of operation scheduled. The 1st operating room nurse has been informed of mobilization and testing in anesthesia, but the main operator claims that an open surgery is scheduled. The nurse seems annoyed, seeing how she now needs to obtain equipment unplanned for. Meanwhile, the main operator is seen walking restlessly across the floor. The discussion continues regarding which patient was assigned to the operating room (of two patients that arrived simultaneously). The 2nd operating room nurse (experienced) claims that they (the team) only followed the plan. She is supported by the nurse anesthetist, who explains to the main operator that she selected the patient from the list in Orbit. The main operator replies by placing the responsibility for the two patients on another individual, suggesting that he did not make the priorities. Despite a heated discussion, the operation proceeds as normal and concludes with no remarks.

4.1.2 Episode 2 – "Lack of equipment, inexperience… and mobile phones"

Early in this operation, the operator claims that the 2nd operating room nurse should have more equipment prepared for this type of surgery. The nurse leaves the room to obtain what he asks for. This event is followed by a call from a colleague on his mobile phone. The operator decides to address it properly, even though the conversation does not concern the operation. At a later stage of the procedure, the main operator continues to request equipment. The equipment is not directly available in the operating room, and is also hard to obtain right away. The operator seeks alternative solutions. He also becomes increasingly annoyed at the "instrument service", particularly when the 1st operating room nurse demonstrates trouble in obtaining the requested instruments. The annoyance seems to escalate with the nurse's displays of inexperience, when finally he decides to walk over and get the instruments himself. Again, the operation proceeds as normal and concludes with no remarks.

4.1.3 Episode 3 – "X-ray trouble"

At the beginning of the operation, the main operator request better positioning of the x-ray machine only to discover that the machine is malfunctioning. He criticizes the 2nd operating room nurse (experienced) for not making sure the x-ray machine worked. The nurse defends herself by explaining that she had not found any tags indicating a problem with the machine, so she assumed it was cleared. The operator then asks the nurse to contact the transporter, and comments on how time that becomes available should be spent on controlling the equipment. The 1st operating room nurse (inexperienced) agrees. The operator becomes impatient when the transporter does not show up, and suggests that the 2nd operating room nurse should obtain one if the delay is any longer. When the new x-ray machine arrives he decides that he cannot use it, but then reconsiders and asks that the machine is positioned at the opposite side of the previous x-ray machine. The 1st operating room nurse tries to maneuver the new machine into position, but she has to move equipment to make room. Again the operator becomes impatient, and orders her to move it into position immediately. The nurse complies and also tries to adjust the monitor of the x-ray machine. The operator barks at her to stay away. Despite the equipment trouble and the tense atmosphere, the operation proceeds as normal and concludes with no remarks.

4.1.4 Episode 4 – "Missing the check points"

At the beginning of this operation, a time out reveals that no blood-screening has been conducted before the patient arrived (this is important if blood should be required). The main operator informs that he expects a blood loss of about 500ml, and considers this a risk factor. The 1st nurse anesthetist proceeds to contact the blood bank, to get a definitive answer on the screening. She receives a negative response, and the main operator is asked to postpone the start of the operation until the 2nd nurse anesthetist has collected the samples and sent them to the blood bank. In a conversation, the 1st nurse anesthetist explains that blood samples should have been collected at the time the patient was admitted ("first check point"), and this should also have been checked at the ward before the patient was sent to operation ("second check point"). During the reception of the patient and the first part of the Safe Surgery Check List, this should also have been noticed ("third check point"). The reason for the "slip" at the last check point, the 1st nurse anesthetist explains, was due to a late shift the night before that had resulted in one individual being unable to assume his day shift (the individual has an 11 hour quarantine time). The following shift then became one individual short. As a consequence, one person on this shift became responsible for two patients simultaneously. The nurse believes that such situations increase the work load and stress levels, which can lead to mistakes. The operation proceeds as normal and concludes with no remarks.

4.1.5 When does an operation become vulnerable?

Judging by the four episodes, it would appear that for an operation to become vulnerable and experience disruptions in the normal operational flow, a combination of local and external system factors typically needs to be triggered simultaneously. Specifically, external structural factors include changes in the operating schedules (episode 1), lack of planning in preparing operational equipment (episode 2), less ideal ad-hoc team compositions, such as inexperience under immediate/demanding surgery (episodes 1-3), delays in equipment arrivals, once requested (episode 3), and lapses in individual control checks at several levels of the organization, enhanced by a late shift resulting in the next shift being one individual short (episode 4). Factors in the local surroundings include the mood of the team members (episodes 1-3), mobile phone disruptions (episode 2), equipment failure and lack of control (episode 3), and lack of equipment in the operating room (episode 2). The episodes suggest that once the external and local factors interact, in some way, the operations become vulnerable. Three of the four episodes also occurred during immediate surgery, implying that this type of operations, characterized by at <72 hours timeframe and naturally less time to plan, check and prepare (causing stress build-up), might be more vulnerable than elective (planned) operations.

However, besides the time-delays and personal mood changes none of the described disruptions resulted in any observable or outspoken concerns for patient-related errors. As for why the operations progressed in this way – seemingly unaffected and with emphasis on safety – an explanation can be found in that the nature of operations, besides being vulnerable and prone to disruptions under circumstances where certain system factors interact, are also a product of various compensating system factor. These factors are described next, and discussed in relation to trend 1.

4.2 Trend 2 – Various system factors compensate for the vulnerabilities and disruptions that arise during operations

In each of the episodes above, the outcome of the related operation was normal, meaning that the focus on the "job" and on safety was present throughout the operations. This suggests that the hospital section has "built-in" certain system factors that enables it to compensate for vulnerabilities and disruptions that arise during operations. The compensating nature of these system factors represents a second trend in the data material, supported by conversational and interview data described next. The reason why conversations and interviews are used to support this particular trend, instead of the observational episodes described in relation to trend 1, has to do with the difficulty associated with observing these particular system factors directly.

4.2.1 Conversation 1 – "On becoming one section"

The nurse anesthetist approaches the researchers, and begins to discuss the current organization of the surgical unit (where operating and anesthesia personnel have belonged to the same section for ten years). He believes that this has improved the individual confidence levels among nurse anesthetists. Specifically, it is easier to know what type of equipment is required, compared to the uncertainty characteristic of the earlier separate organization where they moved around a lot more. This uncertainty often resulted in bringing either too much or too little equipment to the operating room. He sees the benefit of getting to know the specific routines, operations, and equipment at one section – this improves the ability to use the right equipment at the right time. As if underlining his point, he explains that this particular operation will be long and require a good amount of fluids. Because of this, he has prepared a liquid warmer to prevent the fluids from cooling down the patient.

4.2.2 Conversation 2 – "More on becoming one section – specialization and staffing"

A conversation with the nurse anesthetist brings more insight into what the results has been of the organization into one section. One of the benefits, he explains, is a higher specialization within a specific area, such as the particular type of surgery being carried out at the section. The conversation is later continued with the nurse, who describes that he has never witnessed any medication errors, and claims that the "system" contributes to this. This includes, he specifies, the good staffing. Even under less ideal circumstance, such as weekends where only one nurse anesthetist is present, the operations almost always turn out fine. He believes the fact that one operator always is on duty, contributes to this outcome.

4.2.3 Summary and interview perspectives

Based on the two conversations, it is clear that the history of this particular hospital section plays a direct role in the ability to compensate for operational vulnerabilities and disruptions. Specifically, according to the team members longer exposure to the particular operations, practices and organizing at this section has (1) improved the confidence in finding the right equipment for the particular operation, (2) improved the ability to use the right

equipment at the right time, and (3) strengthened the specialized knowledge within a specific area of competency. In addition, a respondent believes that (4) the staffing level contributes to why he has never witnessed medication errors. This impression is strengthened by interviews with a team member and a manager at the section.

The manager discusses the current staffing: "At the section we work day and evenings, and then we are on call duty at home from half past midnight. And those that are on this call duty, if they are called in during the night… given that they are required to have eleven hours of rest before they come back… [this] will of course have consequences the next day when they should have begun the morning shift… if they cannot be there it will have consequences for when we can begin with the next day's patients. So it was decided that [our section] should have a staffing level that would ensure that even if [those on call duty at home] had been called in, we would be sufficiently staffed to startup operations in all operating rooms." The researcher adds that he sees this as an operational buffer: "*That* is a buffer, yes. Of course if [those on call duty] had not been in [during the night], and gone home at the usual time, they will return to work at the normal hour in the morning, and then we have a buffer of two operating room nurses and one nurse anesthetist… every day. This is a very, very, very good way of organizing [that also] gives us a buffer in terms of sickness… and it strengthens the working environment of course, [since] several people share the work load." Later in the interview the manager addresses the availability of operating rooms: "So the section has in recent years increased its capacity from three operating rooms in the day and one in the evening… to guaranteed startup of operations every day, plus four operating rooms Monday, Wednesday, Friday, and two operating rooms Tuesday evening. So we have had quite a large increase in capacity in recent years".

When asked about the outer structures and work load at the section, an anesthetist physician comments: "I have to say, we rarely lack anything on the equipment and personnel front… I rarely experience that my work load becomes too high. [The exceptions] are sickness or unexpected things… some days can be very busy, but this is not a problem." The researcher comments that it is quite a positive impression he provides. "Yes, but this is not the case at [other sections]… there is supposed to be flexibility [at our section], it is a buffer that enables us to increase our capacity suddenly, since the need fluctuates… it is [organized in this way] because we need emergency readiness 24/7"

In sum, the data from conversations (episodes) and interviews demonstrate several facets of the system's ability to compensate for vulnerabilities and disruptions during operations. Specifically, buffers in terms of staffing, equipment, and operating rooms constitute the outer structures and factors of the system, and part of the compensating ability during operations. The anesthetist physician suggested that these buffers can reduce the individual work load, and thereby strengthen the working environment in this respect. These buffers also help to explain why the operations continue as normal, despite disruptions such as less ideal ad-hoc team compositions under demanding surgery (trend 1, episodes 1-3) interacting with the mood of the team members (trend 1, episodes 1-3). Another compensating system factor appears to lie in operating personnel's exposure to one section, over time, boosting both the specialized knowledge and confidence levels, and also the ability to become proficient with the equipment and use the right equipment at the right time.

5. DISCUSSIONS

Given the focus on vulnerabilities and disruptions, the first trend can be linked to findings in a study by Catchpole et al (2007). Specifically, the authors attempt to identify system factors that can be improved, and find that complications during operations resulted from an escalation of smaller problems, caused by the context in which the operation took place. This includes unnecessary distractions (telephones, pagers), difficulties with equipment (availability and function), unexpected problems with patient anatomy, and conflicting demands on team members from other parts of the hospital system. Our findings support the findings in Catchpole et al (2007) related to factors in the local surroundings, such as distracting mobile phones and difficulty with equipment. In addition, we find that the mood of team members plays a role. In terms of outer structural factors, however, our findings do not support the relevance of conflicting demands on team members from others parts of the hospital in Catchpole et al (2007). Instead, relevant outers system factors in our findings include (1) changes in the operating schedules, (2) lack of planning in preparing operational equipment, (3) less ideal ad-hoc team compositions, (4) delays in equipment arrivals, and (5) lapses in individual control checks at different organizational levels.

In another study, by Leach et al (2009), the focus is on understanding the nature of surgical teams and their performance. While this perspective is not directly transferable to the understanding in our study that various system factors compensate for the vulnerabilities and disruptions during operations (trend 2), the core system factors in both studies are highly related, but reversed, in terms of impact on the particular organization. Specifically, while Leach et al (2009) identify problems with operating schedules, the availability to operating rooms, and a shortage of staff, equipment and supply, our findings suggest that the operating room, staffing and

equipment represent the main strengths of the section we studied. This is in itself an important finding, suggesting that the conditions for conducting operations might differ significantly from one setting to another, and so also the ability to ensure safe work practices. Besides the above similarities, we also found a relevant system factor to be the operating personnel's exposure to one section, over time.

In sum, our findings support existing findings, but also provide new insights into how the system relates to safe work practices in interdisciplinary operations.

6. CONCLUSIONS

The concept of system vulnerabilities is nothing new in organizational safety research, and is commonly seen in the understanding of latent failures that can build up in a system (Reason 1997), or in descriptions of the importance of being vigilant and mindful of one's role and surroundings (Weick 2001). What this study adds is (1) an insight into the rich nuances of the vulnerabilities and disruptions caused by different combinations of system factors, unique to this particular hospital section and setting, and also (2) an insight into how the organization uniquely compensates, through various system factors, to prevent the vulnerabilities and disruptions from affecting work practices and patient safety. In other words, although it initially may seem daunting to look at the system as a feature of an organization that can be explored, our findings demonstrate that it is possible to gain both a rich picture, via episodes and conversations, and an overall understanding, via trends, of how the system affects interdisciplinary operations.

7. ACKNOWLEDGEMENTS

We wish to thank the participants at the regional hospital for their contributions to this study. Special thanks go to each of the "door openers" in the hospital organization, whose assistance was critical in gaining field access and in realizing the study.

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