



## Original Article

# Workflow Interruptions and Failed Action Regulation in Surgery Personnel



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## ARTICLE INFO

## Article history:

Received 8 October 2013

Received in revised form

22 November 2013

Accepted 26 November 2013

Available online 5 December 2013

## Keywords:

cognitive failure  
occupational stress  
patient safety

## ABSTRACT

**Background:** Workflow interruptions during surgery may cause a threat to patient's safety. Workflow interruptions were tested to predict failure in action regulation that in turn predicts near-accidents in surgery and related health care.

**Methods:** One-hundred-and-thirty-three theater nurses and physicians from eight Swiss hospitals participated in a cross-sectional questionnaire survey. The study participation rate was 43%.

**Results:** Structural equation modeling confirmed an indirect path from workflow interruptions through cognitive failure in action regulation on near-accidents ( $p < 0.05$ ). The indirect path was stronger for workflow interruptions by malfunctions and task organizational blockages compared with workflow interruptions that were caused by persons. The indirect path remained meaningful when individual differences in conscientiousness and compliance with safety regulations were controlled.

**Conclusion:** Task interruptions caused by malfunction and organizational constraints are likely to trigger errors in surgery. Work redesign is recommended to reduce workflow interruptions by malfunction and regulatory constraints.

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## 1. Introduction

Workflow interruptions are common stressors in health care [1]. The consequences of workflow interruptions are not bad *per se* [2]. Sometimes the need to switch from one task to another more “critical” task is positive even when the first task is delayed [3]. Although such workflow interruptions are sometimes helpful in surgery (e.g., a note about adhering to the principles of asepsis), a majority of interruptions (e.g., nonpatient-related private conversation) are not [4]. Workflow interruptions interfere with the pursuit of tasks and can cause errors in carrying out actions, even in routine tasks that have been finished without error many times previously [5,6]. Thus, workflow interruptions are an avoidable threat to surgery outcomes and patient safety.

In their recent review of 33 studies, Rivera-Rodriguez and Karsh [4] reported only seven studies of interruptions and cognitive function in health care and concluded that more studies should focus on cognitive function because “these cognitive implications of

interruptions are at the heart of why the study of interruptions is important” (p. 309). The current study on workflow interruptions tests cognitive failure in the action regulation of routine tasks as the critical link between interruptions and near-accidents.

Workflow interruptions may trigger failure in action regulation [7]. When there is an interruption, attention must be diverted to the interruption agent and away from the current task at hand. The goal of the interrupted action and its position in the action sequence must be stored in working memory. Moreover, the additional goal of restarting the interrupted task at hand at a later time must be stored in prospective memory [7]. The negative consequences of interruptions arise from these growing costs of action regulation while performing routine tasks. A typical error that is caused by workflow interruptions is the error of omission: for example, a theater nurse is interrupted by a nonpatient-related question and forgets to fill out the form while preparing a device because the restart of the action sequence is misplaced (a place-losing error, p. 29) [7]. Wallace and Chen [8] suggested adverse work conditions,

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including workflow interruptions, make cognitive failure during routine tasks more likely.

It is not only interruptions at work that can cause concern about cognitive failure and near-accidents, but also individual differences in conscientiousness and safety compliance. Indeed, the first conceptualizations considered cognitive failures primarily as randomly appearing or based on individual trait-like cognitive failure proneness [9,10]. Wallace and Chen [8] showed that work-related cognitive failure not only corresponds to work demands, but is also negatively related to individual conscientiousness. Wallace and Chen [8] supposed that conscientiousness was negatively related to workplace cognitive failure, presumably because “individuals higher on conscientiousness should be more attentive to work tasks and thereby not commit as many cognitive failures” (p. 618). In this study, we controlled for individual differences in conscientiousness and safety compliance by including both in the prediction model. We assumed an indirect path from workflow interruptions through failure in action regulation to near-accidents during surgery beyond personal conscientiousness and safety compliance. Therefore, for this study on workflow interruptions in surgery we hypothesized that workflow interruptions are positively associated with failure in action regulation (H1) and near-accidents (H2). Moreover, we expected a significant indirect path from workflow interruptions through failure in action regulation to near-accidents in surgery (H3).

## 2. Materials and methods

### 2.1. Study setting

The study design and its aim were presented to the nursing directors of eight hospitals within the German speaking part of Switzerland. All the hospitals agreed to participate in the study. Seven hospitals are from the German speaking part of Switzerland and one hospital is located in a region where half of the population speaks French or German; thus, in terms of language and region they are not representative for the French and Italian speaking parts of Switzerland. The eight hospitals are representative with respect to types of hospitals within Switzerland because the sample includes a large university hospital, three other public hospitals, two smaller, more regional semiprivate hospitals, and two smaller more regional private hospitals—a mixture that is common for hospitals in Switzerland. Two of the authors (P.K. and M.N.) distributed the questionnaires at the hospitals and responded to questions. The questionnaires included postage-paid envelopes. After 2 weeks, P.K. and M.N. sent a written reminder to all those who had received the questionnaire (with a note to ignore the reminder if the questionnaire had already been sent off in the postage-paid envelopes addressed to the first authors' university department).

### 2.2. Study sample

All participants gave their informed consent prior to when questionnaires were distributed. Questionnaires were addressed to 312 theater nurses and physicians from eight surgical units. The questionnaires were distributed during regular team meetings of theater nurses. In these meetings, members were predominantly theater nurses with only two or three anesthetists and surgeons as members. There was no difference in agreement to participate between nurses and physicians as members of the theater nurse team meetings. In the questionnaire, most participants (87%) did not fill out the text field that asked for their professional title, presumably to reduce their identifiability within surgery teams. Therefore, the exact number of physicians is unclear but with respect to group composition in theater nurse's group meetings, it

can be estimated to be between 10 and 15. The response rate was 42.6% with 133 questionnaires being returned. There were 21 male participants and 112 female participants. The mean age was 40.2 years [standard deviation (SD) = 11.7 years]. The mean job tenure was 15 years (SD = 10.6 years) and participants had worked for, on average, 9.2 years in their current position (SD = 8.1 years). This study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and was approved by the Ethics Committee of Kanton Bern, Switzerland (KEK No. Z001/13).

Sixty-five percent of the sample worked between 90% and full-time (42 contracted hours/week), 24% worked part-time for more than 50% and less than 90% of full-time hours, and 11% worked 50% or less of full-time hours.

### 2.3. Assessment of workflow interruptions

Interruptions in workflow were assessed using 15 items from the activity and work analysis in hospitals-self-report version (TAA-KH-S) [11]. The TAA-KH-S is theoretically based on the action regulation theory that emphasizes interruptions as work stressors that impede goal attainment. The TAA-KH-S is a condition-related work analysis instrument, developed for the analysis of work in hospitals. The internal consistency of the total interruption scale is adequate (Cronbach  $\alpha$  = 0.87). Three subscales measured interruptions by persons (six items, Cronbach  $\alpha$  = 0.74), interruptions by malfunctions (four items, Cronbach  $\alpha$  = 0.84), and interruptions by blockages arising from organizational constraints, such as interruptions because materials and instruments did not arrive in time (five items, Cronbach  $\alpha$  = 0.79). The response format was 1 = never to 5 = very often.

### 2.4. Assessment of cognitive failure in action regulation

The failure in action execution subscale of the Workplace Cognitive Failure Scale was used to measure slips and lapses in routine action execution [8,12]. The scale included five items (e.g., “Unintentionally press control switches on machines?”). The response format was 1 = never to 5 = very often. The internal consistency of the scale was satisfactory (Cronbach  $\alpha$  = 0.77). All were paper-pencil form of questionnaires.

### 2.5. Assessment of near-accidents in the past 4 weeks

For this study, a near-accident was defined as an occurrence that deviates from the normal course of events and might give rise to an accident [13]. The question about near-accidents was preceded by an annotation that was an adapted version of the statement Musahl and Bendig [14] introduced for describing near-accidents: “The following question refers to near-accidents during your work. Near-accidents characterize situations when you or the patient had a narrow escape from experiencing an accident.” The item was “How many near-accidents do you remember in the past 4 weeks?” The response format was a number.

### 2.6. Assessment of conscientiousness

Conscientiousness is part of the five-factor model of personality [15]. The five-factor model questionnaire used in this study was based on an adjective-rating list developed by Ostendorf [16] and Ostendorf and Angleitner [17]. Schallberger and Venetz [18] validated a shorter adjective-rating scale questionnaire that was fitting in its factorial structure and internal consistency of scales. The questionnaire consists of bipolar items on a six-point scale, with higher values indicating higher conscientiousness.

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