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Technostress in Nuclear Medicine: A Qualitative Study of Causes, Mitigators, and Resolution Levels

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Abstract

Background – In contemporary healthcare, information and communication technology enables specialized treatment and efficient information sharing. However, it also causes stress and frustration, so-called technostress, among healthcare staff.

Purpose – To investigate the day-to-day occurrence of technostress, we ask the research question: What causes the stressful situations with technology, how are they mitigated, and to what extent are they resolved?

Method – We interviewed 15 healthcare providers in the department of nuclear medicine at a Danish hospital about their experiences with technology-induced stress in their daily work.

Results – The interviewees described 185 stressful situations with technology, mostly technology indispensable to their work. The two most frequent causes of stressful situations are system performance (46%) and technology-related organizational procedures (18%). To mitigate the situations, the most frequent strategies are accommodating (51%), consulting others for help (18%), and repeating previous task steps (13%). The mitigation strategies indicate that the stressful situations involve adapting work practices to the technology to a much larger extent than succeeding in adapting the technology to the work. Regarding the level of resolution, as much as 66% of the stressful situations are merely solved for now, that is, the concrete situation is resolved but the underlying issue remains unsolved. The underlying issue is resolved in only 10% of the situations, thereby indicating that the vast majority of the stressful situations are likely to recur later.

Conclusion – The staff at the studied hospital department repeatedly experience stressful situations with the technology they rely on in their work. This technostress is an extra stressor on top of those induced by the staff's responsibility for providing quality patient treatment. At the individual level, technostress leads to frustration and possibly burnout; at the organizational level, it calls for preventive action.

Keywords: technostress, information technology, healthcare IT, healthcare providers, nuclear medicine

1 Introduction

The provision of healthcare involves various information and communication technologies (ICTs), such as positron emission tomography (PET) scanners, radiology information systems/picture archive and communication systems (RIS/PACS), and electronic health records. These technologies enable specialized treatment and efficient information sharing, but they also cause stress and frustration among physicians [1,2], nurses [3,4], and other healthcare providers [5,6]. The widespread experience of stress caused by technology has been described as a "modern disease" [7] and spawned the term *technostress*, which denotes "stress experienced by end users in organizations as a result of their use of ICTs" [8]. In this study, we investigate technostress in a technologically advanced hospital department.

Technostress increases the strain on healthcare staff by adding an extra layer of concerns on top of the responsibility for the treatment and care of the patients. While healthcare staff accept the strains that come with the responsibility for treatment and care, they tend to experience the extra strain from technology as foreign to the proper content of healthcare work [9]. As a result, technostress has not only been associated with transient consequences, such as fatigue and frustration, but also with long-lasting consequences, such as burnout and job dissatisfaction [1,8,10,11]. The aim of this study is to investigate the day-to-day occurrence of technostress and, thereby, improve our understanding of how it is experienced by healthcare staff in their daily work. To this end, we ask the research question: *What causes the stressful situations with technology, how are they mitigated, and to what extent are they resolved?*

We answer this question through an interview study in the department of nuclear medicine at a Danish hospital. Because technostress is a multifaceted issue [12], the investigated causes of the stressful situations span technological as well as organizational stressors. Following prevalent technostress models [e.g., 8,13,14], we focus on how the individual technology user experiences these stressors and what mitigating strategies they apply to cope with them. Our analysis is at the level of the individual because they are the ones who experience the stressful situations. We do not mean to imply that they should be alone in shouldering the responsibility of reducing technostress. On the contrary, we hope that our analysis will inform organizational initiatives to reduce technostress.

2 Method

The National Committee on Health Research Ethics exempts this type of study from notification. The study was approved by the management of the studied hospital department. All interviewees gave their written informed consent to take part in the study.

2.1 Setting

This study was conducted at the department of nuclear medicine at a university hospital in Denmark. The department performs imaging tests such as PET scans in which patients receive an injection with a radioactive tracer before their tissue and organs are scanned to reveal cancer and infections. The department also performs clinical physiology tests such as duplex scans and pulmonary function tests. These tests involve the use of PET scanners, gamma cameras, and other specialized technologies. The scan images are stored, annotated, and communicated in the RIS/PACS, which was introduced two years prior to our study and is the latest major change in the department technologies. In addition, the staff use information systems such as booking systems, duty scheduling systems, and standard applications for email and online meetings. The department is staffed with about a hundred physicians, physicists, radiographers, medical laboratory technologists, researchers, and medical secretaries. It sees approximately 30,000 patients a year.

2.2 Procedure

To become sensitized to the work at the department, the study started with a half-day observation session. This session informed the main data collection, which consisted of semi-structured interviews conducted by the first author between October 2023 and January 2024. A chief physician at the department facilitated the recruitment of 15 interviewees by circulating an email invitation on our behalf and encouraging participation. The interviewees (8 female, 7 male) were five physicians, two physicists, two radiographers, two medical laboratory technologists, two researchers, and two medical secretaries. They had worked in the studied department for an average of 8.5 years (range: 1-25 years).

All interviewees were initially asked briefly to describe their work tasks and the technologies they used (the interview guide is available as an online appendix). Then, they were asked to describe what they used each technology for and whether its use gave rise to stressful situations. If it did, they were asked for concrete examples of such situations. If the interviewees were uncertain about the notion of stressful situations with technology, it was explained. The interviewees were also asked follow-up questions about what caused each

stressful situation and how it was resolved. After this walkthrough of technostress situations, the interviewees were asked a few closing questions about the technology-related training and support provided by the department. Each interview lasted about 45 minutes. Five of them were conducted face to face at the hospital; the other ten were video meetings conducted online. All interviews were audio-recorded and subsequently auto-transcribed. The interviewees gave their written informed consent prior to the interview.

2.3 Data analysis

The interviews were analyzed by both authors in collaboration, following a six-step, content-analysis process [15]. First, the authors read the transcripts and met for an open-ended discussion about their contents. This discussion led to a focus on the causes, mitigators, and levels of resolution of the stressful situations described by the interviewees. To code these aspects of the interviews, we devised the coding scheme in Table 1. Its categories were derived from the contents of the interviews, with inspiration from previous studies [3,8,13,14]. Specifically, the first three categories in Table 1 were adopted from previous work; the other categories were devised by the authors. Second, all descriptions of stressful situations with technology were identified and marked up in the interview transcripts. By relying on the interviewees' self-reports about their technostress, we adhered to dominant technostress definitions, which conceptualize it as a phenomenon perceived by the individual technology user [e.g., 8]. There were 185 stressful situations. Third, three interviews were randomly selected and coded by both authors independently. Each stressful situation was coded with one category from each of the three classifications in Table 1, or with the category 'Other'. Fourth, the authors discussed all disagreements in their coding to reach a consensus and create a shared understanding of the classification categories. Fifth, both authors independently coded the remaining twelve interviews. Sixth, the authors discussed and reached a consensus about all disagreements in their coding. The kappa values of the agreement among the authors in their coding of these twelve interviews were .66, .64, and .76 for the classification of causes, mitigators, and resolution levels, respectively. All three kappa values were above the threshold of .60 recommended by Lazar et al. [15] as indicating satisfactory reliability.

All quotes in the following analysis were checked against the audio-recording of the interview to avoid inaccuracies caused by errors in the automatic transcription.

Table 1. The three classifications used in categorizing the stressful situations

Classification	Category definitions
Causes	
System performance *	Whether a system is responsive and reliable
System utility *	Whether system functionality matches user needs
System usability *	Whether a system is easy and satisfying to use
Organizational procedure	Whether an organizationally instituted system-related procedure is cumbersome
Collaborative practice	Whether those involved do their system-related tasks accurately and on time
Mitigators	
Accommodating	The user accepts the system as is and accommodates to it
Repeating previous steps	The user repeats previous task steps or asks others to repeat theirs
Replacing equipment	The user replaces equipment with seemingly identical equipment
Doing the task differently	The user switches to a different system or applies a workaround
Consulting others	The user seeks assistance from others who know how to resolve the issue
Levels of resolution	
Solved	The concrete situation and its root cause have been resolved
Solved for now	The concrete situation has been resolved but its root cause remains unresolved
Unsolved	The concrete situation and its root cause remain unresolved

* Definition adopted from Hertzum and Hornbæk [14]

3 Results

All interviewees experienced multiple stressful situations (M = 12.33, SD = 3.40). About one third of the stressful situations were about the RIS/PACS, which was indispensable to the work in the department. The other situations involved a variety of systems. Initially, we tested whether the causes, mitigators, and resolution levels were evenly distributed across the classification categories. These tests served to ascertain that the categories in each classification occurred with sufficiently different frequencies to warrant further analysis. The distribution of causes was significantly different from an even distribution, $\chi^2(4, N = 184) = 85.78$, $p < .001$. This was also the case for mitigators, $\chi^2(4, N = 184) = 117.30$, $p < .001$, and resolution levels, $\chi^2(2, N = 182) = 97.00$, $p < .001$.

3.1 Causes

The most frequent cause of stressful situations was *system performance*, see Figure 1. For example, the RIS/PACS ran well on some computers but was "just so slow" on others (physician, #08), and the terminals for patients to self-register their arrival "often freeze with an error message on the screen" (secretary, #04). The interviewees were also stressed by problems with *system utility*, including that the RIS/PACS lacked functionality needed in nuclear medicine because it was "originally developed for radiologists" (physician, #08). These problems included shortcomings in how scans could be shown and compared to other information about a patient's condition. Technologies also caused stress because their *usability* was poor, that is, because available functionality was hard to use. For example, the interface for entering tracer-drug information on the scanners was complicated to the point of requiring assistance to work out how to do it properly (radiographer, #14).

Organizational procedures were the second most frequent cause of technostress situations. In these situations, the hospital enforced rules that made technologies cumbersome and time-consuming to use. Login was a common example: "We need to log on all the time, and our password must be a minimum of 15 characters long. You can mistype it so many times a day. Even without mistyping, you repeatedly type the same and the same and the same on your computer" (medical laboratory technologist, #13). At a more structural level, the department was about to narrow the scope of the medical laboratory technologists' work by assigning each of them to tasks defined by the technologies involved. This way, the technologists would, presumably, become experts in their technologies, but they "liked to have a variety of tasks" (medical laboratory technologist, #03) and would not like to do the same few tasks every day. Finally, several stressful situations with technology were caused by *collaborative practices*. These situations for example included being unnecessarily cc'ed on mails that developed into long threads (physician, #10) and forgetting to select the new patient before a PET scanning, thereby inadvertently recording the scan as another scan of the previous patient (physicist, #06).

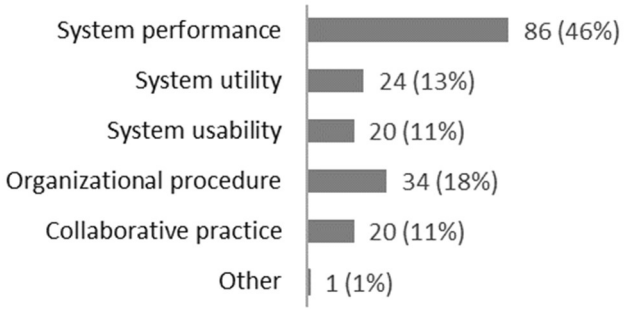

Figure 1. Distribution of causes, *N* = 185 stressful situations. Note that 130 (70%) of the situations concern technology (the three first categories) and 54 (29%) of them social aspects (the two next categories).

3.2 Mitigators

In mitigating the stressful situations, the interviewees most frequently *accommodated*, see Figure 2. That is, they accepted the stressful situations as inevitable and, for example, coped with slow system performance by waiting – impatiently – for the system to respond. In other situations, such as when technologies malfunctioned, the interviewees tried again by either *repeating previous steps* or *replacing equipment* and then repeating previous steps. It added to the stress that the repetition of steps caused delays for the patients (medical laboratory technologist, #03) and that it was unclear to the interviewees why a system, such as the RIS/PACS, would run well on one computer but not on another (physician, #10). On some occasions, the interviewees resorted to *doing a task differently* to get it done. For example, they registered the patients' arrival for them when patients could not work out the terminals for self-registering their arrival (secretary, #04), they increased the scan time for patients to compensate for the tracer-drug decay during delays in setting up the scanner (radiographer, #14), and they temporarily obtained extended access rights to be able to make system configurations they were formally barred from making themselves (physician, #12). Finally, they frequently *consulted others* for help. Assistance in mitigating stressful situations was, for example, sought from peers, super users, technical support staff, and system vendors.

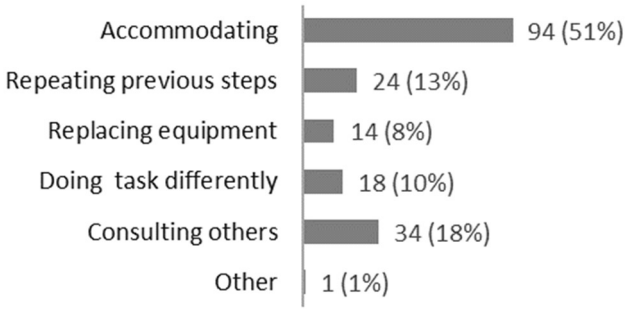

Figure 2. Distribution of mitigators, *N* = 185 stressful situations

3.3 Resolution levels

Regarding resolution levels, 66% of the stressful situations were solved for now, see Figure 3. The interviewees handled these situations in a manner that enabled them to get on with their work, but they could not resolve the underlying issue that caused these situations. The inability to resolve the underlying issue meant that it

would likely cause similar situations in the future, thereby adding to the stress and frustration. Solved-for-now situations were described with phrases such as “very frustrating or, at least, very cumbersome” (physicist, #01), “causing considerable delays” (physician, #05), and “you get afraid [that errors may ensue]” (physician, #08). In 22% of the stressful situations, the interviewees were unable to resolve the concrete situation as well as the underlying issue. For example, a physician mentioned a life-threatening situation in which the scans of a patient from a serious traffic accident did not show up in the RIS/PACS. The interviewees described these situations as “insanely frustrating” (physician, #05), “completely unnecessary” (secretary, #04), and “extremely stressful” (physician, #10). Only 10% of the stressful situations were handled in a manner that resolved both the concrete situation and its underlying cause.

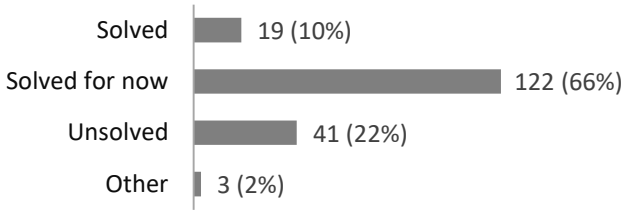

Figure 3. Distribution of resolution levels, *N* = 185 stressful situations

Table 2 shows the most frequent combinations of cause, mitigator, and resolution level. Across different causes, three of these top-six combinations involved accommodating and merely solved the issue for now. That is, the issue would likely recur later.

Table 2. The six most frequent combinations of cause, mitigator, and resolution level, *N* = 86 (46%) of the 185 stressful situations

Cause	Mitigator	Resolution level	N	%
System performance	Accommodating	Solved for now	22	12
Organizational procedure	Accommodating	Solved for now	19	10
System performance	Repeating previous steps	Solved for now	17	9
System performance	Consulting others	Solved for now	12	6
System usability	Accommodating	Solved for now	8	4
System performance	Accommodating	Unsolved	8	4

4 Discussion

4.1 Summary of findings

The interviewees are dependent on specialized technologies to do their work but repeatedly experience the use of these technologies as stressful. This overall finding concurs with previous studies of technostress in healthcare [e.g., 1–6]. More specifically, this study contributes four main findings:

First, the main cause of technostress is poor systems. As much as 70% of the stressful situations concern the technology (its performance, utility, and usability); only 29% of them concern social aspects (organizational procedure and collaborative practice).

Second, the main mitigation strategy is adapting to the technology. The interviewees adapt their work practices to the technology in 71% of the stressful situations (accommodating, repeating previous steps, and replacing equipment). In addition, consulting others (18%) often also results in adapting to the technology.

Third, most instances of adapting the technology to the work occur when the task is done differently, for example by applying workarounds. The interviewees generally give the impression that they cannot do much to make their systems better fit their work.

Fourth, the main resolution level is that the stressful situations are solved for now, but likely to recur in the future. In only 10% of the situations, the interviewees succeed in resolving both the concrete situation and its underlying cause.

Collectively, these four findings describe a work environment in which the hospital and the regional healthcare authorities partially fail to provide its staff with reliable, useful, and usable technologies. To avoid this situation, organizations may devote substantial resources to the procurement process and, thereby, seek to ensure that new technologies are of high quality from day one. However, the large number of troubled ICT projects indicates that this strategy is prone to error [e.g., 16,17], for example because many ICT systems need to go through an extensive configuration process to fit them to local needs. Another – and complementary – strategy is an effective process for gradually improving a technology after it has entered into use. However, some clinicians experience this strategy as unsatisfactory because it implies that the technology will be suboptimal at the outset [18]. The studied hospital has neither procured a RIS/PACS with which the interviewees are satisfied nor provided a process that subsequently made them satisfied with it. Instead, it is left to the department of nuclear medicine and the individual staff members to cope with stressful situations. Such circumstances increase the risk of staff experiencing attrition [13], burnout [10], distancing [19], uncertainty [20], and other kinds of distress.

4.2 Implications

We want to emphasize five implications of this study. First, non-use of the technologies is not an option because most of the stressful situations are caused by systems that are indispensable to the work. The interviewees cannot do their work without the RIS/PACS, the PET scanners, and the other technologies. This implication adds to technostress research that investigates situations where people appear to overuse technologies such as social media [e.g., 21].

Second, the stressful situations are not caused by those experiencing them, but are rather the outcome of previous decisions. This disconnect makes it an important first step to call attention to the situations and their causes. The next step is for the organization to pay attention and take action. Otherwise, the first step remains merely a way for individuals to vent their frustrations [19].

Third, training and technical support are not the solution because they can rarely resolve the underlying issues but merely alleviate the concrete situations. Alleviating the concrete situation helps in the moment, but to resolve the underlying issues the interviewees need better systems and less rigid organizational procedures.

Fourth, further research is needed because the day-to-day consequences of technostress are worrying and the decade-to-decade consequences largely unknown. The main challenge is not to detect stressful situations but to do something effective to prevent or resolve them. So far, prevention has been somewhat neglected in technostress models [e.g., 13,22].

Fifth, the consequences of the stressful situations reach beyond the persons experiencing them. Needed information is not available to the other clinicians involved in treating a patient. Patients may be negatively affected by techno-induced delays in their treatment. The workload of the peers consulted for help increases because providing assistance to colleagues is an extra task on top of treating their own patients and dealing with their own technostress.

4.3 Limitations

Three limitations should be remembered in interpreting the results of this study. First, the study was conducted in one department in one hospital. Future studies should validate the results in less technically advanced departments and in settings other than hospitals. Second, the interviewees constitute a convenience sample of modest size. While all the interviewees had technostress experiences, future studies may investigate whether some causes, mitigators, or resolution levels are more prominent for some staff groups than for others. Third, we identify stressful situations with technology through the interviewees' self-reports. This approach is consistent with dominant technostress definitions [e.g., 8], but we acknowledge that another group of interviewees may not be stressed by the same 185 situations.

5 Conclusion

The staff at the studied department of nuclear medicine experience a range of stressful situations with the technologies they rely on in their work. The causes of these situations are sociotechnical but poor technology is the most frequent cause. To mitigate the situations, the staff mostly accommodate to the technology. Our finding that most of the stressful situations can only be solved for now by the individual staff members, and thus must be expected to recur later, calls for an organizational response.

Summary table

What was already known on this topic

- Hospital staff spend a considerable amount of their time using technologies, some of which causing stressful situations.
- Techno-induced stress – technostress – has severe consequences, such as attrition, burnout, distancing, and uncertainty.

What this study added to our knowledge

- Most of the stressful situations are caused by poor technology, only a minority by ICT-related social issues.
- The staff's main mitigation strategy is to accept the technology as is and adapt to it, for example by waiting for slow systems to respond.
- It calls for organizational action that most of the stressful situations can only be resolved for now and, therefore, must be expected to recur.

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Authors' contribution

The first author collected the empirical data. The second author wrote the original draft. Both authors contributed equally to the conceptualization of the study, analysis of the data, and revisioning of the original draft.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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