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# Does Technological Innovation Decrease Workloads? A Study on Health Care

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## Abstract

### Objective
To identify the influence of technological innovation on the workloads of health care professionals.

### Methods
A multi-site case study was performed in Brazil and the Netherlands involving hospitals and primary health care units. The triangulation strategy and the resources of the Atlas.ti software for qualitative data analysis were used to analyze data. Data were collected by semi-structured interviews, field observation and documentary study. An intentional sample was used including 4 cases and 74 health care professionals.

### Findings
The majority of health care professionals have perceived advanced technology decreasing workloads, enhancing patient safety and improving quality of care. Furthermore, technological innovation has been found to increase workloads depending on staff training to handle that innovation, workers' participation in the decision-making process, the working conditions, and the institutional context and values orienting the innovation process.

### Conclusions
Advanced technologies increase or decrease workloads mainly depending on working conditions and the managing model. The research design was useful for an in-depth understanding of the phenomenon, but the research design and the intentional sample limits the generalizability of the findings.

### Descriptors
Occupational Health; Labor Force; Health Services Health; Sciences, Technology and Innovation Management.

### Descritores
Saúde Ocupacional; Força de Trabalho; Serviços de Saúde; Gestão de Ciência, Tecnologia e Inovação em Saúde.

### Descriptores
Salud Laboral; Fuerza de Trabajo; Servicios de Salud; Gestión de Ciencia, Tecnología e Innovación en Salud.

## Introduction

The relationship between technological innovations job market and labor process in several areas have been subject of intense debate [1-2].

From a sociological view, technology incorporates machinery, the physical arrangements of hardware, division of labor and organization of work built into or required for efficient operation [3].

The health sector has been influenced by new technologies. New machines and equipment, new materials and medicines, advances in genetics and informatics, and the new information and communication technologies (ICT) have influenced diagnostic and multiple therapeutic procedures [4-5]. The health care sector has also been influenced by changes in the organization of work, in the structure and management of institutions [6], sometimes accompanied by growth in outsourcing and precarious employment.

The introduction of new technologies is motivated to improve enterprises and institutions' efficacy and efficiency but little attention has been paid to the influence of this process on workers workloads. Workloads [7] synthesize the mediation between work and workers' wear and tear. Workloads do not act alone; rather, they act in combination with other demands that determine the conditions under which workers face the overall demands of the work process.

The literature contains many studies regarding technological innovations in the health sector [5-6,8] and regarding the health of health care workers [9-13] but the relation between new technologies and the health professionals' workloads have not been studied. To contribute in this field, we carried out a research aiming to identify the influence of technological innovation on the workloads of health care professionals.

A sociological perspective was used for research design and data analysis. Theories concerning Labor Process of Marx [14], workloads [7] and the services sector were particularly useful.

## Method

A multi-site case study was conducted in different political institutional settings to provide an in-depth understanding of the technological innovation influence on the health care professionals' workloads. It has been defined four cases: one in the Netherlands and three in Brazil, intentionally chosen as reference institutions using material and non-material technological innovations. The material and non-material technologies' concepts were oriented by the sociological perspective of technology [3] and the Oslo Manual definitions of technological innovation [15] mentioned above.

Case 01 was a trauma room/shock room (SR), located in the emergency department (ED) of a reference hospital in the Netherlands. Case 2 was performed in two intensive care units (ICUs) located in a city from the Southern region of Brazil. Case 3 was composed by two interdisciplinary teams - one geriatric team (GT) responsible for elderly care and another responsible for palliative care (PC) for people diagnosed with cancer. Case 4 was composed by three family health teams (FH) working in two different cities from the South of Brazil.

In all cases, participants were chosen considering the following inclusion criteria: health care professionals directly involved in using new technologies for patients care, diverse health care professionals within health teams, and agreeing to participate in the study.

Sample included 74 health care professionals: 11 from case 1; 33 from case 2; 19 from case 3; and 11 from case 4.

Data was collected and analyzed using the qualitative research strategy of triangulation [16]. The triangulation analysis had articulated data collected by semi-structured interviews, field observation and documentary study.

The data from the semi-structured interviews provided information about health care professionals' perception of the impact of new technologies on their workloads. In each case, field observations were performed before and during the interview period. The data acquired through the documentary study and field observation were used to provide a more perceptible and complete characterization of the health care teams' work management and organization, the technological innovations available, and the way innovations were used by health care professionals.

Atlas.ti software program for qualitative data analysis was used to store, manage and analyze data [17], and software resources were used to help the triangulation analysis process. Data from the interviews, field notes and selected documents - was assigned in the Atlas.ti software and the four cases were analyzed according to two macro categories concerning the influence of new technologies on increasing or decreasing workloads. The data saturation criterion was used to establish sample sufficiency.

The research project was approved by both the Dutch institution and the Human Research Ethics Committee of the Federal University of Santa Catarina, Brazil, and all required ethical precepts regarding research involving humans were respected. To preserve the anonymity of the research participants, the first letter of the professional category (P - Physician, N - Nurse, AN - Auxiliary Nurse, PT - Physiotherapist, D - Dentist) followed by the identification of institutions and teams (H - Dutch Hospital; PC - Palliative Care; GT - Geriatric Team; PH and PrH - Public Hospital and Private Hospital; FH - Family Health Teams) were

used to identify different speakers. Information obtained from the observation was identified by the letters OB followed by the initials from the institution.

## Findings

### Technological Innovation Reducing Workloads

Table 1 shows the most significant motives for decreasing workloads, according to the kind of technological innovation.

**Table 1.** Technological Innovation Reducing Workloads.

| Kind of Technology | Motives for Decrease Workloads |
|---|---|
| Material Technological Innovations | - Use of high-tech equipment decrease cognitive, emotional and physical workloads because they are considered safer, more ergonomic and effective, contributing to provide safer, more efficient and better quality care. |
| Non-Material Technological Innovations | - New work organizations forms including the interdisciplinary perspective and more collaborative practices, sharing knowledge with less fragmentation and less repetitive work improve health care professionals' satisfaction and motivation decreasing physical and emotional workloads. These characteristics of work organization provide greater safety and quality of care and more favorable outcomes improving job satisfaction and decreasing workloads. |
| Both, Material and Non-Material Technological Innovations | - Participative management, technical support, workers participation in the process of change; and skills to work with the innovation reduce workloads.<br>- Training/education to manage new equipment, and learn how to work within new organization decrease professionals workloads. |

Considering data from each case, the most significant motives for decreasing workloads were organized in four subcategories.

### High-Tech Equipment Improves Health Care, Decreasing Workloads

Computed tomography scanners (CT scans), ventilators, infusion pumps and electronic medical records contribute to providing safer, more efficient and better quality care, decreasing cognitive, emotional and physical workloads. They provide more reliable and more effective data and increase safety in medication administration and the monitoring of vital functions.

The health care professionals consider high tech equipment safer, more ergonomic and effective. The following data from the observation and the participants' interviews illustrate this finding.

*The changes in the SR have saved time, made staff more efficient and improved quality of care. Professionals and equipment were available in the same location or were moved to the SR when needed. The professionals were really positive about the new technologies, and they were confident that the new machinery is safe and works well, contributing to decrease their physical and emotional workloads. (OB/H)*

*The ventilators are getting more and more sophisticated with several ventilation modes already programmed.... This makes work easier and more pleasurable. (P8/PrH)*

Electronic Health Records (EHR) integrate all information relating to the patient; they increase the security of information, because they facilitate access to patient data for all healthcare staff, and the information is readily accessible in any sector of the hospital without physical transportation. The health care professionals said that the computer-based medical records make work easier and contribute to improve quality assurance:

*The information is in the computer using a patient data management system. We already have this in the ICU, and we are also going to have this in the Operating Room (OR) and in SR, so they can all communicate. All professionals will make notes on the same form on the computer. (P5/H)*

*The electronic medical record would allow us to better monitor the patient. (P1/FH)*

New equipment associated with changes in the work environment and new methods to organize work contribute to decrease physical and emotional workloads because they save time, promote interdisciplinary exchanges, and provide more confidence in care for patients. Health workers feel more satisfied and less stressed because they are providing the best-known treatment to patients, resulting in more favorable outcomes. They become more efficient at saving lives. The following quotation emphasizes this finding:

*It is better than before. In the first place, because logistically it is easier, everybody is in the same place. Secondly, and most importantly, it is because it is much better for patients. We save time, so much time. Previously, a patient could come in, and we would put her/him on the table for X-rays ... and to another table to be transported to the first floor for CT scanning.... So, these proce-*

*dures wasted time, caused problems, and were dangerous when patients were unstable. (P5/H)*

**Interdisciplinary perspective reduces workloads**

In all cases, an interdisciplinary perspective including collaborative practices, the sharing of knowledge and less fragmentation among different health professionals provided greater safety and quality of care. This perspective of caring for patients decreases workloads and improves job satisfaction. Each professional realizes the importance of the other's knowledge and understands that the participation of everyone positively impacts the process of care for patients. Satisfaction and motivation linked to this form of work organization reduce workloads, enhancing the delivery of safer care. The following quotations support this theme:

*When I started to work here, I was surprised because I had never seen a group like this.... It is a very good team to work with.... I can get to know my patients better.... I have contact with dieticians, physicians and nurses. So I think that these teams benefit the patient the most, but professionally it is quite rewarding as well. (PT/PC)*

*The whole team is involved ... while the physician examines the patient, the nurse or the nursing technician monitors the other [patients]. We work together.... It is a very positive experience. (P3/PrH)*

**Participative management, technical support, and skills to work with the innovation reduce workloads**

In all of the cases, it was found that it is crucial to be aware of the changes that will be implemented and to participate in the process of change. In addition, the workers must be trained to manage new equipment and learn how to work within the new organization. In relation to training and technical support, we found differences between the Netherlands and Brazil, as shown in the following quotations:

*The companies send their people to teach ... nurses and doctors how to use the equipment. When [the hospital] buys a piece of new equipment, somebody comes in and stays for a week or two to teach everybody how to work the machinery. (N5/H)*

*The technical support department helps to keep the equipment working, and our technical department is very good. (N5/H)*

*All stakeholders, and especially the managers, should understand the FH [program] and how it should work to provide more autonomy and to back up the team's decisions. (N3/FH)*

**Less repetitive work decreases workloads**

In cases 1 and 4, the professionals mentioned that working in the Shock Room and on the FH teams was challenging because of the diversification of activities, the constant contact with different health care professionals, and the unpredictability of what might occur every day at work. The diversification of activities and less repetitive work improves job satisfaction and decreases workloads. The following are examples of comments that support this theme:

*I like my work because it is really diversified ... Every day is different.* (P5/H)

*I like the diversity of the activities. All the specialties are found here: neurology, pediatrics, everything. I like this diversity a lot. I like the small things. I like to care for people who have hurt their finger in a door, and I also enjoy the big things, such as major trauma. There is always a diversity of activities.* (N4/H)

*In the FH model, it is possible to do several activities outside of the basic and normal [technical] procedures. This makes work interesting ... There is so much to do that it becomes very challenging.* (N2/FH)

**Technological Innovation Increasing Workloads**

The most significant motives for decreasing workloads were found in both kind of innovation and they are described in the Table 2.

**Table 2.** Technological Innovation Increasing Workloads.

| Kind of Technology | Motives for Increase Workloads |
|---|---|
| Both, Material and Non-Material Technological Innovations | - In the beginning, working with new technologies increase physical and emotional workloads, even when the health care professionals were trained to work with the innovation. They need to adapt with the new work environment and learn how to manage the new equipment.<br>- Lack of training/education and skills to manage with the innovation increase professionals' workloads.<br>- Poor working conditions play a significant role in increasing workloads specially related to workforce number and qualification.<br>- Non-participation in the decision-making process related to the introduction of technological innovations have negative consequences for both workers and work outcomes. |

Considering data from each case, the findings are described below.

In case 1, the vast majority of the participants mentioned that, in the beginning, working with new technology increased their physical and emotional workloads, even when the health care

professionals were trained to work with the new equipment and new environment. This finding was also significant in the other three studied cases. The workloads increased because the workers needed to adapt to working in a new situation and had to learn how to manage the new equipment and work organization. In addition, in all cases we found a relationship between training/education and workloads. The participants in this research stated that the lack of skills necessary to work with new technology increased their workloads. Some participants' comments support this theme:

*Now we have a new ventilator… and people have to work with it and no one knows how it works…. I was there this morning, and everybody asked: Where is the cable, where do I have to put it? But it is always the same with new stuff. So it takes a lot of extra time.* (N3/H)

*I had no training.... I think that being trained would have been nice, especially for someone new to the place who does not know how to operate things, the routines, and everything else.* (N6/PrH)

*The workloads increase because of the lack of investment in training, in the preparation of teams to work in FH.* (P3/FH)

In all cases, the participants mentioned that, when technological innovation is not accompanied by an adequate number of staff, there might be an increase in workloads. This might occur in situations in which the same numbers of workers are needed to accomplish more activities in greater quantity and diversity than before the implementation of innovations. This situation can be illustrated by the following quotation:

*This Monday, we had a trauma patient …. We used to take one and a half hours even when we were working quickly. Now we might spend half of that time. I think I will treat more patients because we are quicker than before…. If we care for the same number of patients, we need less health care professionals, but if we receive more patients, we will need the same number of personnel, maybe even more…. If you look only at the trauma patients, they might decrease, but if you look at all the things I have to do, they might increase.* (P4/H)

Regarding to working conditions, we found a significant difference between Brazil and the Netherlands. In the Dutch hospital, the working conditions were not mentioned as a factor in increasing workloads. In all Brazilian cases, though, working conditions played a significant role in increasing workloads. Workers reported poor working conditions related to: equipment deficits, personnel deficits, lack of efficiency of supporting sectors, difficulties in the referral and counter-referral relationships between primary health care and hospitals, low wages, and long working hours. The participants' quotations regarding this theme are presented below:

*We had ventilators sent out to be repaired, and we had to provide mechanical ventilation. This is very frustrating, because… it is unacceptable to abuse a patient…for 6 to 12 hours.... This is very stressful.* (N8/PH)

*The main sources of workload increases for me are the salary, which I think is very low for 40 hours/week of work, and our physical structure.... Everything is inadequate, improvised.* (AN1/FH)

*The problem is the overwhelming demand; too many families, and you do not have enough personnel….* (N2/FH)

In all cases, we found that non-participation in the decision-making process had negative consequences for both workers and work outcomes. Investment in innovation might be inadequate or fail to correspond with the priorities identified by workers:

*It is humanly impossible to follow decision-making… when you do not know anything about it.* (PT/PC)

*When we want something…, it depends on who is there and if he/she thinks it is also important, if there is money. So they decide. We have a lot of computers, and we need more monitors, but they decided we need computers, so they buy computers and no monitors.* (N4/H)

## Discussion

The study showed that health care professionals perceive advanced technology as a positive factor in reducing their workloads. They also note that innovations might potentially increase or decrease workloads depending on multiple factors, such as the political and institutional context of the innovation process, starting to work with new technologies, the training of professionals to work with new technologies, working conditions, the participation of the professionals in the decision-making process, the perception of the professionals regarding the utility of the innovations in the performance of their work, and the political/economic basis for the innovation process.

### Innovations Contribute to Reduce Workloads

Technological innovation contributes to decreasing workloads because high-tech equipment helps to reduce physical efforts and saves time for bedside care. Advanced technology also contributes to the safety and quality of healthcare. In addition, an interdisciplinary approach and participative processes improve job satisfaction, provide greater safety for patients and professionals, and improve quality of care. The study also showed that the diversification of activities and the need to cope with new challenges stimulates continuous learning and contributes to increasing job satisfaction.

New equipment tends to be more ergonomic, more lightweight and easier to handle, reducing physical efforts and risk of injury and illness. High-tech equipment provides more reliable data with greater speed, helping to increase professionals' accuracy and efficiency in diagnosing and caring for patients. Machinery such as infusion pumps, mobile computerized tomography scanning and vital sign monitors contribute to improving safe care, saving time and also saving time for bedside care. In line with our findings, authors [13,18-19] have mentioned a positive relationship between high-tech equipment, workloads and patient safety.

High-tech equipment integrates the data that different groups of professionals used to provide separately. Integrated within the machine, the patient data are used by diverse professionals to monitor vital functions and to support the decision-making process. Similarly, electronic health records (EHR) organize and provide access to all of the patient information for different professionals in different sectors, contributing to the achievement of safer and higher quality care. Several authors have studied the implementation of EHR [8,18-19]. These authors predominantly point out the cost effectiveness and the improvement in patient outcomes associated with this technology. The impact of the EHR on the workloads of the health care professionals is significant for health service outcomes but this subject has been less studied. Instruments that facilitate work and contribute to better outcomes decrease the physical, cognitive and emotional workloads of health care professionals.

Interdisciplinary teamwork in health care might be considered a non-material technological innovation. This form of work organization purposes a participatory and collaborative practice improving relationships among team members and considers the needs of patients in their multiple dimensions [20].

New forms of work organization that contribute to improving working relations, to workers' autonomy and creativeness, and to higher quality of care, increasing job satisfaction. Greater control over work process and less alienation decrease workloads, particularly emotional ones [21].

The diversification of activities and contact with several types of health care professionals is a constant challenge leading to less mechanical work and stimulating professional creativity. Diversification of activities and face with challenges improve job satisfaction and reduce workloads [22].

### Technological Innovations Increase Workloads

The main causes of increased workloads were starting to work with new technologies along with deficits in training and education to work with the process of innovation, implementing innovations aimed only at cost reduction, non-participatory management, and poor working conditions.

The introduction of a technological innovation changes the practice. In the initial phase, these changes increase workloads. The negative effects on workloads occur because workers must be trained to manage new equipment or must learn to work in a different way. At first, the worker uses both the "new" and the "old" way of performing tasks, increasing the volume of their work; at the same time, he/she needs to manage the new technology and adapt to a new organization [21]. A behavioral and cognitive change is demanded of them.

Certain complex situations require immediate decision-making and involve risks to patient safety, such as those common in the ER and ICU. Handling unfamiliar technologies without the necessary knowledge to act safely sometimes leads professionals to believe they might be involving patients in a high-risk situation, causing anguish, emotional suffering and fear. This idea is approached by Christophe Dejours [22] regarding the relationship between job insecurity and psychological distress.

Non-participation in decision-making processes, having no control over proposed changes or having no influence on institutional decisions results in feelings of impotence. Workloads are greater when the process of change is associated with a lack of training and poor working conditions.

When the same number of workers performs more activities in higher quantity and diversity and/or when the same number of workers is asked to perform more tasks in a shorter period of time, there might be an increase in both physical and emotional loads. The literature [1] stated that, to increase productivity in the services sector, technological changes and cost reductions within the workforce might be used.

## Conclusions

Findings from this study have revealed a close relationship between technological innovation and workloads. The workloads are lower when the innovations contribute to reducing cognitive and physical efforts and decrease emotional demands, resulting in better outcomes. Technological innovations involving an interdisciplinary perspective and participative management also contribute to reducing workloads, particularly cognitive and emotional ones.

Working with new technologies might increase workloads in the context of non-participatory management, when the purpose of the innovation is predominantly to reduce costs, and when the working conditions are precarious.

Limitations of this study are related to its design. Other studies conducted in randomly selected institutions might strengthen these results; alternately, they may find predominantly negative or positive implications of technological innovation in relation to the workloads of health care professionals. The in-

stitutional context of the innovation seems to be a significant factor influencing the relationship between new technologies and workloads.

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### Authors' contribution for the manuscript

1. Denise Elvira Pires de Pires (DEPP) has designed the study and coordinated the research and the data analysis. DEPP collected data regarding Case 1.

2. Letícia de Lima Trindade (LLT) collected data regarding Case 4.

3. Eliane Matos (EM) collected data regarding Case 2.

4. Eliana Pinho de Azambuja (EPA) collected data regarding Case 3.

5. DEPP, LLT, EM, and EPA were responsible for the construction of the analytical categories and the data analysis process using the resources of the ATLAS.ti.

6. Flávia Regina Souza Ramos (FRSR) and Soraia Dornelles Shoeller (SDS) contributed to the data analysis and manuscript review.

7. All authors are responsible by the content and the final version of the manuscript.

### Declaration of Prior Dissemination

Part of the research was presented in the Atlas.ti Conference (2013), Belin, and will be in the online Proceedings.

### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, funding, and/or publication of this article.

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