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Safety challenges of medical equipment in nurse anaesthetist training in Haiti

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ABSTRACT

Safety challenges related to the use of medical equipment were investigated during the training of nurse anaesthetists in Haiti, using a systems approach to Human Factors and Ergonomics (HFE). The Observable Performance Obstacles tool, based on the Systems Engineering Initiative for Patient Safety (SEIPS) model, was used in combination with exploratory observations during 13 surgical procedures, to identify performance obstacles created by the systemic interrelationships of medical equipment. The identification of performance obstacles is an effective way to study the accumulation of latent factors and risk hazards, and understand its implications in practice and behaviour of healthcare practitioners. In total, 123 performance obstacles were identified, of which the majority was related to environmental and organizational aspects. These findings show how the performance of nurse anaesthetists and their relation to medical equipment is continuously affected by more than user-related aspects. The contribution of systemic performance obstacles and coping strategies to enrich system design interventions and improve healthcare system is highlighted. In addition, methodological challenges of HFE research in low-resource settings related to professional culture and habits, and the potential of community ergonomics as a problem-managing approach are described.

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1. Introduction

1.1. Human Factors and Ergonomics in healthcare

The value of using Human Factors and Ergonomics (HFE) to study medical environments is well described in literature (Carayon, 2007). The HFE discipline is an expanding field in healthcare and has contributed significantly to a holistic understanding of user-medical device relationships and interventions, related to medical infrastructure and services. HFE is divided into subdomains that focus on different scales of the interface between people and other elements of the healthcare system. Macroergonomics is the subdomain focused on the overall work system at an organization scale (Carayon et al., 2013). The aim of macroergonomics models of healthcare quality is to integrate the entire system of an organization, guiding its integral analysis and redesign. The Systems Engineering Initiative for Patient Safety (SEIPS) model, complemented in this study, defines healthcare services composed of a work structure and care processes (Carayon et al., 2014). The work structure is a system of interrelated elements that influence each other and that are complementary for the safe functioning of the entire system (Rasmussen, 1997; Vincent et al., 2004). The arrangement of system elements can be either hierarchical or functional, but generally includes the following elements: Organization; Environment (physical and external); Tasks; Individual/Team; and Tools/Technology (Carayon, 2007; Rasmussen, 1997). These elements are involved in dynamic and non-linear care processes and their combination results in determined outcomes for patients and the healthcare institution.

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Sensitization and understanding of these system elements and their relationship is of particular importance to obtain a safety culture and manage the quality of healthcare provision (Vincent et al., 2004). A safety culture - or context - in healthcare promotes the continuous reduction and prevention of risks and medical incidents that result in patient harm and can have profound impact on the outcome of healthcare (Mitchell, 2008; Group of WHO Patient Safety, 2009). Medical incidents result from a sequence of associated failures in different system elements and care processes, and often lead practitioners or technicians to error (Reason, Jun. 2000; Vincent, 2004; Mahajan, Jul. 2010). Therefore, many efforts are made to understand and breakdown the systemic reasons behind medical incidents (Spath, 2011).

The identification of performance obstacles is an effective way to study the accumulation of latent factors and risk hazards and to understand its implications in practice and in the behaviour of healthcare practitioners (Carayon et al., 2014). Similar to what Tucker and Edmondson (2003) call a "problem", performance obstacles are factors related to the work structure of healthcare practitioners that disturb the execution of particular activities or tasks (affecting to a certain degree time, comfort or result), leading to a deviation from the safety standards (Carayon et al., 2014). Investigating performance obstacles is a proactive way to look at healthcare safety since it allows getting a rich understanding of the accumulating causes, not only of accidents but also of decreased quality of working life of healthcare practitioners (Gurses and Carayon, 2007; Holden et al., 2012). These performance obstacles are associated with either system limitations or incompatibilities (e.g. infrastructure, staff, and management) or with problem-solving mechanisms triggered by the impediment of treating patients and complying with the standards in the first place. Problem-solving mechanisms are named coping strategies in HFE literature and can include safety violations and workarounds (Carayon et al., 2014).

1.2. A system of gaps

Healthcare provision is not homogeneous worldwide. Low-income countries are generally characterized by an uneven distribution of quality of healthcare services (public versus private, urban versus rural) and the prevalence of low-resource settings. These characteristics make healthcare management more complex and challenging. In low-resource settings, both healthcare structure and care processes are typically characterized by significant shortcomings, or functioning gaps, that result in worse healthcare outcomes and in a higher chance for medical incidents to occur.

The concept (theory and practice) of Community Ergonomics (CE) stems from the macroergonomics subdomain, and extends the application of HFE theories to complex societal systems (Taveira and Smith, 1997; Smith et al., 2002). CE focuses on distressed community settings where certain groups of people have disadvantaged access to resources and participation in their surrounding (societal) environment, for example due to inequities created by power hierarchies or social rules. CE offers a people-centred design approach of community–environment interfaces, bringing contextual relevant aspects to the integrated design of community (capabilities) and environment as a whole. Although it was not specifically formulated for healthcare in low-resource settings, its application is rather flexible to accommodate the uncertainty and unpredictability, inherent of such distressed settings. Fig. 1 illustrates the relation between the HFE domains, models and tools referred in this introduction. Given the potential offered by CE to address macroergonomic problems, the approach will be further discussed in Section 5.5.

2. Research focus and aim

2.1. Healthcare safety in Haiti

Haiti offers an interesting opportunity to study healthcare safety due to the prevailing poverty and socio-economic challenges that impact the healthcare system. Haiti has a long history of conflict and natural catastrophes and ranks as the poorest country in the Western Hemisphere and one of the 15 most susceptible countries to the impact of a natural disaster in the world (Guly, 2004; World Risk Index, 2011; United Nations Development Programme, 2014). After a devastating earthquake in 2010 and the following cholera outbreak, recovery is slow. Until today the main public hospital in the capital of Port-Au-Prince has not been rebuilt and there is limited information regarding existing healthcare infrastructure. Generally, the access of the population to healthcare is low due to a combination of financial affordability, remoteness, lack of functional services and cultural aspects (Guly, 2004).

2.1.1. Healthcare structure and care processes

The gaps in both healthcare structure and care processes in Haiti affect anaesthesia outcomes negatively. Regarding the healthcare structure in Haiti (i.e. expertize, tasks, technology, environment and organization) there is a large shortage of experienced medical staff. The existing staff is disproportionally concentrated in healthcare facilities in the Port-Au-Prince metropolitan area (United Nations Development Programme, 2014; Pan American Health Organization, 2012) resulting in a strong dependency of rural hospitals on the presence and donations of numerous international aid organizations. This contributes to a lack of standardization and reliability regarding skills and techniques (e.g. frequent exchange of visiting staff, short working week), but also of medical equipment and drugs (e.g. differing drug concentrations, recurrent supply shortages). Gaps in infrastructure include insufficient facilities and accessibility and lack of diagnostic and therapeutic means, or even basic resources (e.g. fuel, telephone). The distinction between care processes, such as emergency and elective cases is in the given context, largely undefined due to, for example, delays in seeking care. The lack of coordination resources also contribute to an uncertain planning, record-keeping and follow-up of medical procedures.

2.1.2. The 'technology' system element

HFE show that innate human factors influence work performance on a daily base and that the most effective way to overcome this potentially negative influence is to systemically minimize the chances of human error to occur, through the design of user-friendly, fail-safe medical devices, implementation of standard operating procedures and improvement of workspace layout (Shah and Alshawi, 2010; Martin et al., Jan. 2012; Buckle et al., 2006). In HFE, medical devices and supplementary medical equipment make up the 'Technology' system element. The study of technology in healthcare is important, because medical equipment have become essential in modern healthcare for the diagnosis, treatment, monitoring and follow-up of patients (European Commision, 1994). Furthermore, studying medical equipment is an effective vehicle to evaluate the performance of a system, especially if the interrelationship of micro- and macro-ergonomic aspects are considered (e.g. infrastructure, maintenance and supply inventorization) (Mittermeyer et al., 2011; Liem and Brangier, 2012). However, the application of HFE in healthcare in low-resource settings has been rather poorly explored (O'Neill, Dec. 2000; Shahnavaz, 2009; World Health Organization, 2010). In low-resource settings, the reliance on donated medical equipment of various origins is one of the factors determining the extent to which care is delivered. There is

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