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Implementing an Antibiotic Stewardship Information System to Improve Hospital Infection Control: A Co-Design Process

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Abstract: HAITooL information system design and implementation was based on Design Science Research Methodology, ensuring full participation, in close collaboration, of researchers and a multidisciplinary team of healthcare professionals. HAITooL enables effective monitoring of antibiotic resistance, antibiotic use and provides an antibiotic prescription decision-supporting system by clinicians, strengthening the patient safety procedures. The design, development and implementation process reveals benefits in organizational and behavior change with significant success. Leadership commitment, multidisciplinary team and mainly informaticians engagement was crucial to the implementation process. Participants' motivation and the final product delivery and evolution depends on that.

Keywords: Antimicrobial Resistance, Antibiotic Stewardship, Co-design, Implementation, Information system, Decision-Support System.

Introduction

The global health capacity to sustainably tackle infectious diseases is at risk, by the rising of antibiotic resistance (AR) [1]. HAITooL (Healthcare-associated Infections Tool) a surveillance and decision support system for effective antibiotic stewardship programs (ASP), leverages the healthcare professionals (HP) work. The design, development and implementation process reveals benefits in organizational and behavior change, in spite of some inherent barriers.

Healthcare-associated Infections (HAI) are an important cause of morbidity and mortality [2], worldwide. HAI and Antibiotic Resistance (AR) impact populations, weakening their health, socially and economically, with human losses of thousands of people per year [2], overloading the system with direct and indirect costs [3], being a global public health priority.

In general, we can act on one or both antibiotic-resistant HAI and AR dissemination and antibiotics consumption reduction. To prevent and control it, several

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strategies have been described such as hand hygiene, surveillance and decision-support information systems or ASP development [4].

The HAI and AR control essentially lies on human behavior, where humans work together, for the health and safety of others. Human behavior multi-factors are significantly associated to key indicators of the control system's performance [5]. There is the opportunity to develop innovative approaches, conducting to an effective HAI and AR control behavior change, by combining the socio-cultural, political and organizational dimensions, which involves the participation of all the HP [5].

The problem is originated on infection control team work overload, with time-consuming tasks, dealing with all the ward organization complexity, and experiencing difficulty in accessing evidence-based information, real-time, whenever needed [6]. Computerized surveillance and decision support systems, can be effective by enabling overviews of complexity, with interactive and simple alerts and reminders, allowing the professional to be at the forefront of action [6]. The prevention, management and control of HAI and AR require readiness for response and action, with the immediate and clear communication between all the involved HP. Interactive and integrated data visualization technology-based systems can help address the issue, with success [7].

HAITooL is a contextualized and validated information system for surveillance and decision support [6], underpinning the operationalization of an effective ASP, leveraging the professionals' role and strengthening their capacity and quality of work.

The co-design of HAITooL followed the strategy of well-adjusting with the background where the system is being implemented. It has been designed and developed to optimize antibiotic therapy, giving decision-support to HP, leading to significant reductions in antibiotic resistance prevalence and costs [7].

1. Objectives

Surveillance and clinical decision-support systems have the potential to enhance ASP by improving HP access to validated information [8], retrieving integrated pharmacy, microbiology, and clinical data, as HP need to improve their work with confidence.

The objective was to design and implement an information system - HAITooL - which could achieve that, aiming at impact on antimicrobial resistant HAI and antibiotic use. The focus was on better adjusting the process to Portuguese and local organizational, social and cultural context, leading HP to adequate behavioral change.

The information system development followed the framework of ASP to be able to: (a) monitor antibiotic consumption; (b) monitor antibiotic resistant bacteria; (c) promote antibiotic prescription based on laws and main guidelines; (d) improve physicians' prescription behavior.

2. Methods

The study has been conducted in three Portuguese Hospitals. A Design Science Research Methodology (DSRM framework) [9] for a teamwork-based intervention, aims to solve organizational problems by creating and evaluating the information system artefact. The DSRM establishes the base of a process with six sequential main steps [7]. The process counted on the full participative collaboration from the beginning. The researchers, together with the HP, set up what the problem and

priorities are, define objectives for the solution, pre-select important and necessary data, and design the system, proceeding with the implementation and demonstration and then evaluation and communication, in form of constant profiling and reporting. Several interviews and surveys have been performed [10], in addition to the process observation and intervention, under the principles of Österle for abstraction, originality, justification and benefit [11].

3. Results

The HAITooL decision-support systems proves to be of major importance to best manage patient safety, for medical work quality improvement.

The initial survey participants, gave major relevance to the need for better access to hospital antibiotic susceptibility patterns and epidemiological data, among other pertinent daily information (e.g. clinical and pharmaceutical data) [10]. In its implementation first steps, it already could provide the HAI's information management for the involved hospitals, with implemented evidence-based practices and teamwork techniques, aligned with the objectives of the National Program for Prevention and Control of Infections and Antimicrobial Resistance, in Portugal.

HAITooL includes integrated views of patient, microbiology and pharmacy data, displayed in innovative layouts and graphics. Visualization of patient clinical evolution, antibiotic consumption trends, antibiotic resistant infections distribution, and local antimicrobial susceptibility patterns turns to be easy and clear for the professional. HAITooL is also a decision-support system, displaying alerts, for example in cases of excessive antimicrobial therapy duration and antimicrobial therapy not in accordance with microbiology results, among others.

Each hospital system was co-designed with HP, in order to come up with an effective surveillance and decision support system, well-adapted to Portuguese and local socio-cultural context (e.g. following national health directorate antibiotic guidelines and meeting local perceived needs) [12]. Based on the system architecture, we use DSRM to adapt it to other settings. HAITooL information system is now starting implementation in Cape Verde main hospitals.

3.1. Dealing with multifactorial barriers

The HAITooL process analysis is indicative that the information system and the participative process for developing and implementing it, meets the main requirements for an ASP, in the WHO's blocks rationale. It shows that each HP role can be leveraged by pushing further the ASP concept [6] and actually changing attitudes and professional behavior. It leads practitioners to become more concerned about the issue, ensuring greater accountability and helping bringing the issue to the public debate agenda, by taking a step forward in raising awareness of the global burden.

The HP's change of work habits, through education and organizational policies and measures is happening by improving HP's confidence in prescribing and making control decisions, where the surveillance and decision-support system could be an effective anchor to improve their work quality. The implementation of a new information system must have in account the HP relationship either with the information and communication technologies (ICT) and with the decision and prescribing tasks' changing [13].

There are seven stablished key-elements for the HAITooL ASP (Figure 1), being all of them essential. Yet, in a logic of chain-reaction, if we cannot ensure continuity of action and participation of the first two - Leadership Commitment and Multidisciplinary Team - all the process stays at risk. The role of informaticians was also very relevant, often the major bottleneck.

Figure 1. Key-elements for HAITooL ASP [7].

Due to possible multi-factors and the involved multi-actors, we can find important barriers at the different levels of leadership power and collaboration. During each process of implementation, there were observed and suggested conditioning factors such as: the political agenda unavailability, the game of economic and political interests, bad timing for a change in the organization (e.g. because of an administration council change). The multi-players' way of dealing with the challenging process of change and reorganization of their routines (due to their cultural background, among other reasons), or the recurrent lack of available time and of human resources within the hospitals (including of the information systems' staff), or even technical issues (such as delays for bureaucratic authorizations) are important factors to consider. The co-design process was a good instrument to maintain everyone engaged, and to find time to work in the system. Those are only examples of implementation obstacles often blocking the process of system evolution. The implementation can though be hampered, threatening the final product delivery, and risking to demotivate people that were in first place champions of the process.

Technology and organizational management have been main drivers for a healthcare service's delivery of quality. It is increasingly more important to address the problem focusing not only in physicians, nurses, but the rest of the HP as well, from technicians (pharmaceuticals, microbiologists, ICT staff) to management people (including administrative staff, decision-makers and the leadership). Each one of these elements are a part of the all, as contributors to the problem but to the solution too. That's why it is vital to guarantee multidisciplinary and full engagement at all implementation levels to address all the critical factors, where human variables must be considered. Continuous communication is paramount. Managers are key in promoting the engagement of all participants. Otherwise, motivation can be at risk, and frustration can condemn the process and freeze important work proceedings.

4. Conclusion

HAITooL enables effective monitoring of antibiotic resistance and antibiotic use, and helps antibiotic prescription, strengthening the HP work capacity. The close collaboration with clinicians, the Infection and Prevention Control Team, physicians, nurses, pharmacists, microbiologists and ICT technicians, under a participative approach, was the baseline for a successful implementation [7]. Pharmaceutical, microbiological, and clinical data, integrated all together within one main system, offer all the participants the possibility of giving their inputs, review clinical and technical information and participate actively throughout the entire process, on the behalf of patient's security and work quality improvement. However, leadership commitment and team engagement is crucial to the process health and continuity. Participant's motivation and the final product delivery and evolution depends on that.

When overcoming the barriers and after all the collaborative process, HAITooL turns to be unquestionably an important step forward to reduce antibiotic misuse and to control and prevent antibiotic-resistant HAI.

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