Implementation of software to control the sterilization department of the Dental School of Positivo University

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ABSTRACT

This study aims to describe a method for controlling the sterilization of materials used by dentistry students and to compare its efficiency against the former control method. A *software* was developed by the Information Technology Management Department at the Positivo University, motivated by an internal demand to improve the sterilizing department control. The new method allows the placement of labels with bar codes on the external surface of the students' boxes, controls the entire entrance-and-exit flow of materials and provides greater safety and agility for the sterilization process. Furthermore, the system allows professors to access the list of materials sterilized by students, and the date, time, and number of the autoclave in which the material was sterilized. Questionnaires including subjective questions about the new and former method of control were administered to final-year dentistry students to evaluate their satisfaction toward the methods. The new method decreases delays in patient care and the number of damaged and lost materials, increases safety, and reduces the time spent in material drop-off and withdrawal ($p < 0.05$). Generally, the new method is considered better when compared to the former one ($p < 0.001$). Therefore, we can conclude that the method implemented to control sterilization resulted in greater student satisfaction and provided greater safety.

Descriptors: Sterilization. Academic Institutions. Exposure to Biological Agents. Software Validation.

1 INTRODUCTION

Currently, the term biosafety is emphasized in health domains, including denstistry[1]. Several methods can be used to ensure the interruption of the transmission of pathogenic microorganisms to prevent cross-contaminations[2]. Infections can be transmitted by several routes in the dental office: (1) direct contact with blood, oral fluids, or other infected materials, (2) indirect contact with contaminated objects such as instruments, environmental surfaces, or equipment (3) conjunctival, nasal, or oral mucosa contact with droplets, such as splashes containing microorganisms from an infected person that are expelled by coughing, sneezing, or speaking, or (4) inhaling microorganisms that can remain suspended in the air for long periods. Two considerations must be considered when addressing these problems: how dental surgeon and his team can be safeguarded from disease acquisition and transmission to patients, and what measures should be taken to minimize cross contaminations by prosthetic devices[3].

Brazilian studies collecting data on cross-infection control found that both dental students[4] and professionals in the area do not adequately implement biosafety measures in their daily practices and that sterilization procedures are flawed and do not follow a standard protocol[5,6]. Thus, the establishment of biosafety rules and routine in higher-learning dental schools is essential to train the students to follow these measures and practices[1]. The standardization of procedures to control sterilized materials, the use of technological resources, and the practice of continuing education are the best alternatives to reduce occupational exposures. Furthermore, it is necessary to provide quality care to patients, ensure that dental materials are sterile, and undergo maintenance procedures during storage and handling[7].

The sterilization department (SD) is responsible for providing the sterilized material to the students in the university. It is also responsible for subjecting the material already washed and prepared by students to sterilization, storage, and distribution. The control of sterilized materials and their distribution to students is challenging, in which the concern relates to improving these processes to reduce the risks to the operator and patients[8], and to solve the internal problems in the process such as sterilization, which results in delays in patient care. However, the literature on the protocols of sterilization and the storage of materials used by universities is still scarce.

In 2015, the Univille University reported the implementation of a new method to control the sterilization process of the students' dental materials[9]. Students access a software with their individual *login* information and subsequently generate labels with bar codes to identify the materials that are handed over to the SD. Subsequently, these labels containing the information on the student and the sterilization process are attached to the patient's record along with the information on the respective materials used.

The SD of the Positivo University experienced difficulties in withdrawing and handing over the materials, and in storage time. The materials were handed over in a nonstandardized manner in the former system. Some materials were packed individually in sterilization wraps, rendering it difficult to place them in the autoclave and causing damages to the package. The method to control the withdrawal of materials by students consisted of using paper stubs with the student's registration number and the number of packages handed over to the SD. In cases where the paper stub was lost, the students were required to sign a control notebook to withdraw the material; this slow and unfavorable handover process resulted in long waiting lines. Therefore, a

new systematized method was implemented to improve the control of sterilized materials, and to accelerate the handover and withdrawal of materials by the students in the sterilization control department.

The objective of this study is to describe a new method for controlling the sterilization of materials used by dentistry students and to assess the students' satisfaction toward the new method compared to the former method.

2 METHODOLOGY

Description of the sterilization control method

A software called "sterilization system" was developed by the Information Technology Management (IT) department of Positivo University, with the primary objective of controlling the entry and exit of materials of the SD. Four computers, two Zebra GC420t label thermal printers, and four high precision bar code readers (Honeywell International Inc., MS9520 model) were purchased to use the software. This software provides exclusive access to the staff responsible for sterilization and to professors and requires a login and password. Materials and students are identified by bar code reading.

The student must have a bar code linked to his/her registration number in his/her student identification card (ID) to begin the sterilization protocol. The student ID card is already used by all students enrolled at the Positivo University for the library's book loan system. When the employee reads the bar code in a student's ID card (Figure 1), the system generates exclusive bar codes to that student. These codes are printed on labels that will permanently identify the boxes of each student (Figure 2). These labels are called BOPP, measuring 60 mm × 40 mm, are white and can withstand heat and steam during the sterilization process. Thus, it is established that all sterile material must be packaged within the boxes identified. All student information, such as full name, registration number or individual taxpayer registration number (CPF), and locker number are registered in the bar code of these labels.

A second label with the student's name, registration, and locker number is printed. The box type is defined according to the student's specialty (general practice, dentistry, prosthodontics, endodontics, periodontics, and surgery). Furthermore, colorful control labels defining the box type are used to facilitate the identification and to provide agility in the handover of materials by the staff (Figure 3). For example, the red label represents the surgery box.

After properly identifying the boxes and packing the material in sterilization wraps, the student can hand over their material for sterilization. Upon receiving the student's material, the employee reads his/her ID card to enter into the system (Figure 4). Subsequently, he reads the bar codes of the boxes and seals the packages in which the boxes are placed. After sealing, a simple sterilization protocol label with the date, batch, and the expiration date is affixed to the package. A control flap denominated "autoclave" is present in the software, and allows for identifying the autoclave in which the material will be sterilized. Thus, the bar codes are reread from the boxes after selecting the autoclave identification number, when they are entered into the sterilization process. This allows the SD to be in control over the entire sterilization process, including the autoclave in which the material was placed. If any problem is identified in the autoclave by physical, chemical or biological controls, it is possible to generate reports identifying the sterilized materials used in the last cycles.

After the sterilization cycle, the material is handed over to the clean area and placed in the students' lockers. The student must present his/her ID card to the SD to withdraw his/her materials. The employee reads the bar code of the card and the software searches for all stored materials (Figure 5). Information such as full name, registration number, date and time at which the material was handed over

to the SD, date and time at which the cycle was performed, box types already sterilized, and the student's locker number are displayed in the screen. Furthermore, beyond 30 days after the sterilization, the system informs that the expiration date has been reached, and the employee will return the open package with the material to the student. After verifying all these items, the employee reads the bar codes of all boxes handed over to close the protocol in the system.

Figure 1. Student's ID Card

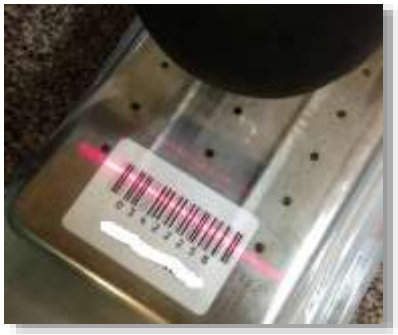


Figure 2. Label reading in the sterilization department

Figure 3. Example of box identification by color

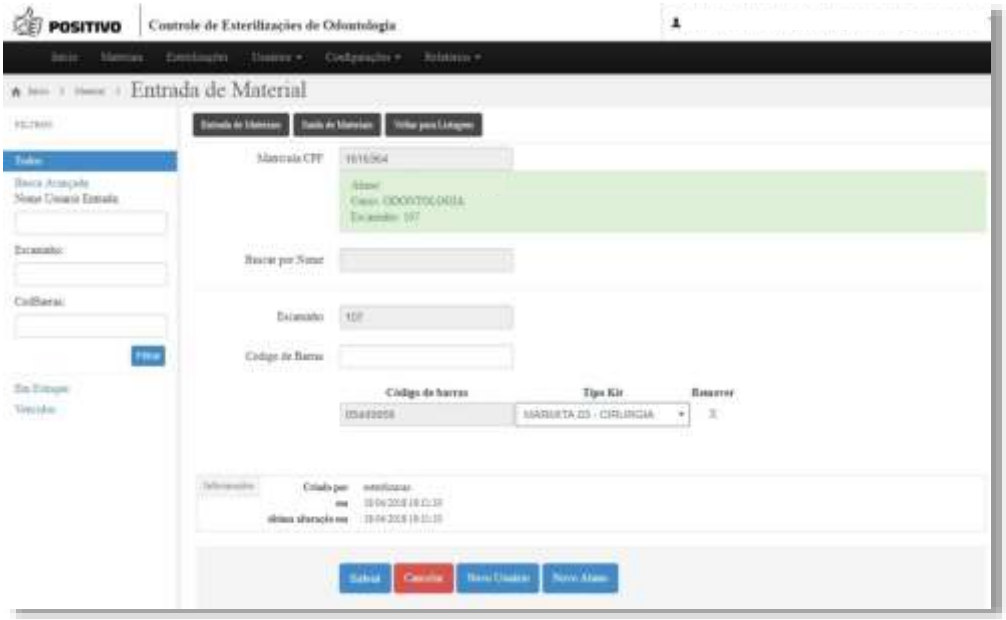


Figure 4. The screen of the software displayed after the student ID card was read for material handover

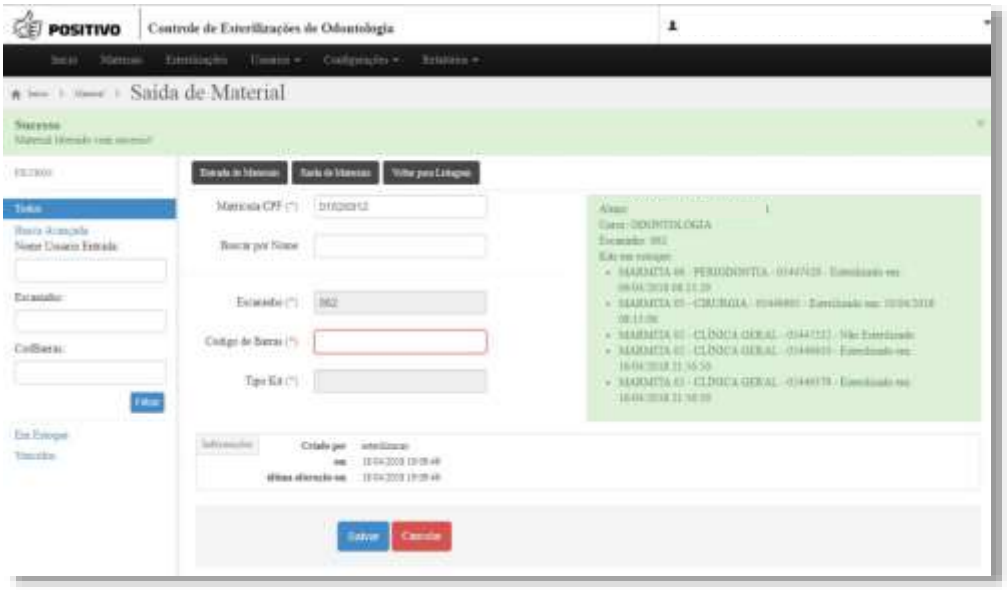


Figure 5. The screen of the software displayed after the student's ID card was read for material withdrawal

The material is handed over and transported by the student using a plastic tray to his or her clean closet, where it is stored until the moment of use. The material must remain only 30 days in the clean closet, and the student is responsible for verifying the expiration dates.

The software enables the use of other search controls, generates reports on the autoclaves, quantity and box types, as well as material sterilization dates per student throughout the university enrollment period. For example, if a professor wishes to check whether all his students have sterilized their material, the system can generate the relevant report.

Software evaluation by students

The research was approved by the Research Ethics Committee of the Positivo University under the CAAE protocol: 80721117.5.0000.0093.

A questionnaire was applied to final-year undergraduate dentistry students to evaluate the acceptance and quality of the new method, as these students had used both control methods (former and current/software), thus allowing both methods to be compared. We recruited all students who have both accepted to participate in the study and signed the informed consent form.

The students were questioned on delays in patient care due to the lines for the withdrawal of materials in the SD. They were also questioned about the loss or damage of materials, and whether they felt safe in leaving their materials for sterilization. They could answer yes or no to these questions. The mean time spent by students in placing and withdrawing materials in the EC was addressed. The response options were as follows: 10, 15, 30, or 40 min. Finally, the students were asked to assign a score of 1 to 10 for both systems and to rate them as great, good, fair, or poor.

The results were subjected to descriptive and statistical analyses. The Chi-square test was used to compare the dichotomous variables obtained from the "yes" and "no" responses for questions regarding both

systems. The Kolmogorov–Smirnov test was used to evaluate whether the numerical variables exhibited a normal distribution. The Mann–Whitney test was used to compare the medians of the time spent waiting for the handover and withdrawal of the systems, and the score assigned to each system. The Mann–Whitney test was used to compare the ordinal variables of the groups. P-values of <0.05 indicated statistical significance. The data were analyzed using the software IBM SPSS Statistics v.24.

3 RESULTS

Table 1 shows the percentage of students who reported the occurrence of delays in patient care, and loss or damage of materials in the former and the new control method. Most reported delays resulting from the former method. Delays were significantly less reported in the new method. The loss or breakage of materials was also lower in the new system compared to the old one.

Table 1. Prevalence of delays and problems with materials in the former and new sterilization control methods.

	Former Method **n (%)**	**New Method n (%)**	**P-value***
Delays in care	95 (85.6)	32 (28.8)	<0.001
Materials broken or lost	54 (49.1)	16 (14.5)	<0.001

* Chi-square test.

Additionally, 85.6% of the students were confident in leaving the materials for sterilization in the new system, while only 34.2% reported the same in the former system ($p < 0.001$).

The waiting time for material drop-off by the students was higher in the former method [median of 15 (5–40) min] than in the new method ($p < 0.001$), [median of 5 (5–30) min]. A median of 15 (5–40) min was obtained in the former method for the time required to withdraw the material, while a median of 5 (5–30) min was obtained in the new sterilization method, again indicating the greater agility provided by the new method ($p < 0.001$).

Finally, a median score of 5 (1–10) min was assigned to the former method, while the new method demonstrated a higher score, namely 9 (5–10) ($p < 0.001$).

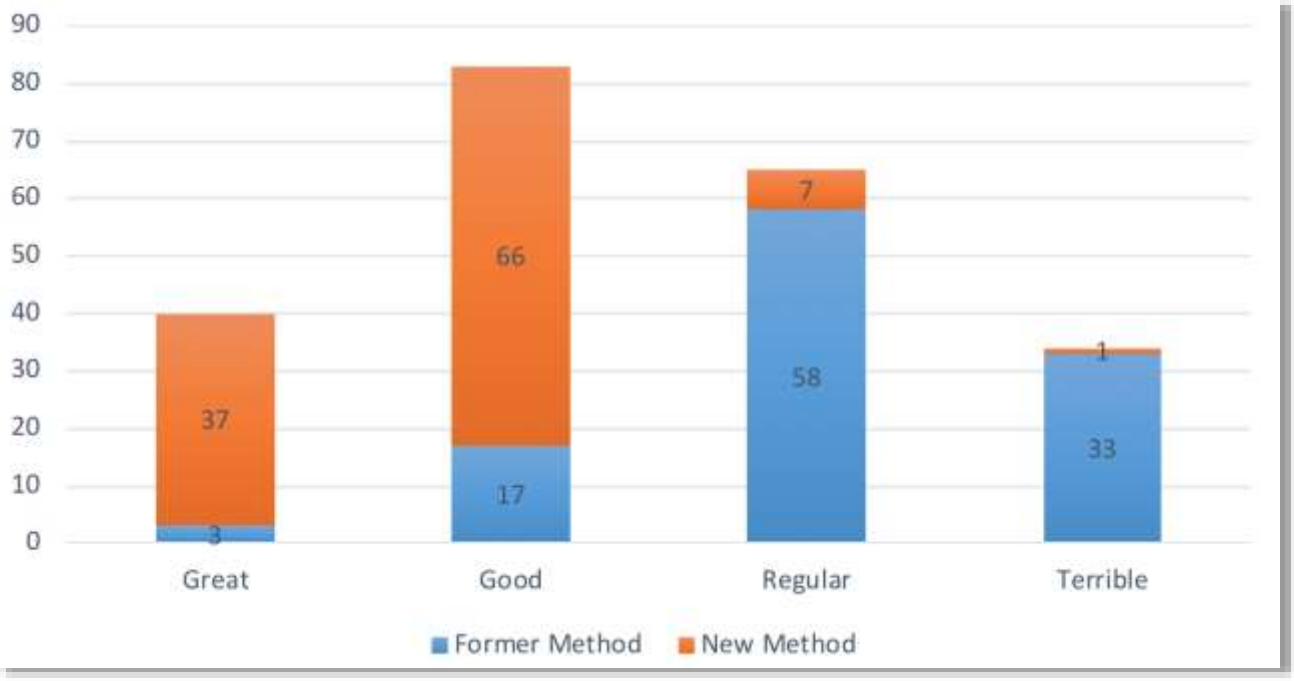
Graph 1 shows the distribution of the two systems following the quality classification provided by the students. Most of the participants considered the former method regular, and the new method good or excellent ($p < 0.001$).

4 DISCUSSION

Dentistry departments are experiencing several challenges in controlling the sterilization of materials used by students for patient care. Such difficulties include difficulty in controlling the entry and exit of materials, sterilization of the material used, and storage.

The control of the entry and exit of materials was more agile and effective following a systematized method. Another advantage of the new method is that it only allows handover and withdrawal of materials by students who already owned registered boxes, thus ensuring a more organized system, and avoiding material loss and reducing costs for material replacement. The questionnaires administered to the students indicated that they felt safer using the new

method, as fewer losses, damages, and delays were reported.



Graph 1. Frequency distribution of students' responses regarding the methods of sterilization control (Mann–Whitney, $p<0.001$).

Effective biological monitoring ensures the effectiveness of sterilization and should be conducted weekly[10]. Moreover, its result should be registered and stored in the control files. Several studies have been conducted to test the effectiveness of autoclaves[11]. However, only performing a proper material sterilization cycle does not ensure the safety of the sterile material until the moment of patient care. The proper packaging and storage of materials and the entry and exit within storage time limits should also be strictly monitored by the SD. The implementation of an electronically systematized method facilitates the control of these records by each student.

The method reported by the Univille/SC University[9] provides greater control of the materials from the exit from the SD to the moment of patient care because all materials that are withdrawn receive labels that state the sterilization and expiration date. These labels are affixed to the patient's chart. This method was the foundation for the development of the new system created by the Positivo University. The primary difference between this system and that from Univille is the shortcuts in the Positivo University software that ensures better monitoring by professors regarding whether the material was sterilized when the student was enrolled. The software also controls materials with expired sterilization.

Pimentel et al. (2012) [12] reported that students were not used to separating their instruments by

procedures or by number of patients previously programmed. They also reported that 31.6% of the students sterilized all materials in a single box, and used instruments that were not used in the first care on another patient. Knowingly, even materials not used in the patient were considered contaminated after package opening owing to the deposition of aerosols from clinical procedures. Patient safety depends on properly prepared and sterilized instruments[13]. The new methodology implemented at the Positivo University controls the separation of trays according to each specialty. In addition to aiding the student to be more organized, this reduces the likelihood that the student uses instruments in other patients after the tray has already been opened. The best guarantee of a sterile product is the careful handling of each sterilization process, along with a continuous quality control program[14].

The new method provides greater effectiveness in ensuring that all materials used by the students are sterile. In addition, most of the students have shown greater satisfaction with the newly implemented method.

5 CONCLUSION

The new method facilitated the staff and professors' control in the sterilization of materials used by students. Moreover, its use resulted in higher student satisfaction due to the lower occurrence of delays and losses and damage to the materials. The method provided greater confidence in the students regarding the sterilization of materials and reduced the time spent in material handover and receipt.

RESUMO

Implantação de um software para controle da central de esterilização do curso de Odontologia da Universidade Positivo

O objetivo deste trabalho foi descrever um método de controle de esterilização dos materiais utilizados pelos acadêmicos de Odontologia, bem como comparar a sua eficiência frente ao antigo método de controle. Um *software* foi criado pela Gestão de Tecnologia da Informação da Universidade Positivo, a partir de uma demanda interna do curso, a fim de aprimorar o controle da central de esterilização. O novo método permite que etiquetas com código de barras sejam colocadas externamente em todas as caixas dos alunos, controlando todo o fluxo de entrada e saída de materiais, gerando maior segurança e agilidade do processo de esterilização. Além disso, o sistema permite que o professor tenha acesso à lista de todo o material esterilizado pelo aluno, bem como a data, horário e número da autoclave na qual o material foi esterilizado. Para avaliar a satisfação com o método foram entregues questionários para os estudantes do último ano do curso de Odontologia, contendo perguntas subjetivas sobre o novo e sobre o antigo método de controle. De acordo com o questionário aplicado, demonstrou-se que novo método utilizado diminui os atrasos para atendimento e o número de materiais danificados e perdidos, aumenta a segurança e acelera o tempo para a colocação e retirada dos materiais ($p<0,05$). Na avalição geral, o método também se mostrou melhor quando comparado ao antigo ($p<0,001$). Assim, conclui-se que o método implantado para o controle da esterilização proporcionou maior satisfação e segurança para os alunos.

Descritores: Esterilização. Instituições Acadêmicas. Exposição a Agentes Biológicos. Validação de Programas de Computador

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