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Electronic Counting of Used Swabs in the Operating Room – Trial Use of the "SC Smart Cart" Device in General Hospital Novo Mesto

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Abstract: Leftover surgical materials in the body after surgery, including the surgical swab as the most commonly forgotten item, remain a considerable problem despite advances in surgical techniques. Alongside manual counting, in recent years electronic counting has also been introduced. This brings certain advantages. In this pilot study, electronic counting was experimentally introduced in the SB Novo mesto general hospital, Slovenia in cooperation with the company Smart-OR d.o.o. from Trbovlje, Slovenia. A "SC Smart cart", a special device for electronic counting, was used in 90 major procedures in various surgical specialities while traditional counting was simultaneously performed. We recorded the surgical team's workflow, the net time needed to count swabs, and errors with and without the device. Although no errors were made with either counting method, time analysis showed faster work with the device with team members reporting reduced workloads. Counting with the device offered greater transparency in the operating room. The trial did not record any negative consequences of electronic counting. Electronic counting using the SC smart cart proved to be a safe and efficient alternative to the traditional manual counting of items with several other advantages – lower team workload, a faster workflow, greater patient safety, and more efficient organisation of the operating room.

Keywords: Swab Counting, Operating Room Safety, Machine Counting

1. Introduction

Adverse events or complications have accompanied surgery ever since the very first operation. The advancement of medicine has seen many practices and protocols being developed to reduce the frequency of complications. These are constantly updated with new findings and technological developments. [1] Apart from common complications like wound infection or bleeding, invasive procedures are accompanied by the risk of medical material being left inside the patient. Events of this kind entail a serious error that often holds serious medical consequences for the patient and legal ones for the medical team. [2] The item most commonly left inside is a surgical swab. [3] Various protocols and methods have emerged to combat this, including manual counting of swabs, multiple counting, radiopaque markers and special swab forms. [4] Yet, despite these measures, the mentioned complication continues to be recorded in modern surgery. The incidence lies between 1 in 5,500 and 1 in 18,760 and, given the legal ramifications of reporting this complication, the incidence is probably even higher. [4-6] Retained swabs occur in all surgical specialties of surgery, where risk factors are operations in body cavities, emergency operations, and longer and more complex operations. [8] The manual counting of swabs has the longest tradition and remains most institutions' primary method for preventing retained swabs. Traditional counting has undergone little change, notwithstanding advances in medical technology. It is human-dependent, prone to errors, and time-consuming under modern counting protocols. [9] These limitations have led to swab machine counting being introduced in recent years. Special electronic devices enable more reliable and faster counting. [7] The first major studies of machine counting began after the turn of the millennium, with the first prospective double-blind study conducted at Stanford University in 2006. The Stanford study used an RFID system with microchip-embedded swabs which they scanned with a hand-held device to keep an accurate count during procedures. [12] In 2008, Brigham Women's Hospital, Boston, USA, attempted to use a similar system that relied on bar codes instead of microchips. [13] The bar code System was experimentally adopted by the Mayo Clinic in Rochester, USA, with a few modifications the following year. Although while using these devices they reported improved safety, the complexity of these systems meant the counting time was longer and extra staff were needed, notably an assistant who manually scanned all of the swabs. [11] The two mentioned systems have since been successfully implemented and are still being used today with certain improvements. The chipping or individual labelling of swabs remains a problem with the cost also limiting full implementation. [7] A system of unlabelled optical detection and machine counting regarding swab collection has yet to be described in literature. It is a new technology of simple design. The system does not require the special labelling of swabs or additional staff in the operating room. This method of machine counting has been experimentally introduced in the authors institution in an effort to improve patient safety and increase the surgical team's efficiency. The purpose of the research was to study machine counting while using the SC smart cart device in the operating room. The aim of the research was to determine the device's reliability for counting swabs, compare the workflow and the time it takes to count the swabs in the traditional way and while using machine counting. Personnel were careful to note all of the advantages and disadvantages of the manual and machine counting process.

2. Method

The research used a free descriptive and comparative method of collecting data, noting the impressions of the staff as well as accurately measuring the counting times. The research took place at the Novo mesto general hospital in the operating theatres. The ward includes six operating theatres and has 3 dislocated theatres in which ENT procedures are also performed. Four different operating rooms were included in the study: the orthopaedic trauma, orthopaedic joint replacement, plastic surgery, and the dislocated operating room for ENT procedures. The studied sample included 90 surgical procedures, with 47 procedures being performed without a device with traditional counting and 43 with the electronic device. To ensure proper sampling, the procedures were performed by the same team on the same day of the week, performing a similar mix of urgent and elective procedures. The operating room team used traditional counting and machine counting in an alternating fashion every other week. Before each operation, a two-person team counted the swabs intended for use in the operation. During the operation, used swabs directly were deposited into the SC smart cart, which recorded and displayed the number of used materials on the screen. Finally, after the operation, a manual count of the swabs in the machine was performed. As per protocol traditional swab counting was performed by a two-person team prior to the procedure several times during operation and after the procedure. The time needed for counting the swabs was recorded by the operating staff who recorded the cumulative counting time during each operation with a stopwatch. Time was recorded and added when at least one member of the OR team was counting the swabs. After each operation, the whole team also recorded their subjective impressions of the workflow.

The SC smart cart meter consists of a bin and a cap made of translucent acrylic glass. The machine is connected to an electrical outlet in the operating room. The opening of the collector cap is covered by a light curtain comprising a series of infrared sensors and detectors. This detects the passing of any particle exceeding 10 mm into the bin. At each pass, an audible signal is emitted to alert the operating room technicians while the number on the display increases. For ease of use, the device has only one button located on the back that is designed to reset it. All other functions such as light and heat adaptation are performed by the device itself.

The SC smart card reader is based on optical detection technology. While using this detection method, debris accumulating on the walls of the device during the operation can cause counting errors. The manufacturer guarantees that the sensor recognises minor contamination and adapts automatically, thereby assuring proper counting. However, counting is interrupted if a large foreign object appears on the sensor wall or if the detection is otherwise impaired. An audible signal is then triggered to warn of the problem and the device waits for the staff to clean it. After that, the counting resumes automatically.

3. Results

Results showed that for all 90 procedures the SC smart cart counted the correct number of swabs. Namely, the team confirmed the device's stated 100% level of reliability. By observing and recording impressions, personnel also compared the two methods of counting swabs. Use of the device greatly contributed to the quality and efficiency of work in the operating room. Operating room technicians still traditionally counted the swabs before and immediately after the procedures and thus no swabs were unaccounted for. Using the counting device during an operation meant no additional counting was needed since the technicians only supervised the device. The device thus directly helped to reduce the staff workload and added to patient safety during the surgery. The swabs were safely and diligently collected off the sterile surfaces during the operation where they remained until the end of the operation. This helped to better separate clean from used swabs while reducing clutter. Staff had no problems counting the swabs in the collector at the end of the procedure. Use of the appliance entailed the swabs being removed immediately from the work surface, which also potentially assists in lowering infection risk. No "debris on the sensor" alarm was noted during use.

Table 1. *Swab counting times.*

OR procedures:	No.	Cumulative swab counting time (min)	Average per procedure (min)
Orthopaedic trauma	15	89.70	5.98
Joint replacement	12	64.68	5.39
Plastic surgery	10	74.50	7.45
ENT	10	36.30	3.63
Combined:	47	265.18	
Average time:			5.61

OR procedures:	No.	Cumulative swab counting time with the SC reader (min)	Average per procedure (min)
Orthopaedic trauma	12	42.72	3.56
Joint replacement	17	47.26	2.78
Plastic surgery	9	46.17	5.13
ENT	5	6.15	1.23
Combined:	43	142.3	
Average time:			3.18

As may be seen in the tables, the average counting time of swabs varies depending on the type of surgical procedure, which may of course be expected. In all procedures, the average counting time was shorter when using the device since during the procedures no intermediate counting was performed. While analysing the times needed for counting, on average the time was reduced by more than 2 minutes when using the device.

4. Discussion

During the trial use, the OR team noticed swab machine counting with the tested SC smart cart brought some advantages. In their experience, its use results in faster and safer patient treatment. Its use represents a step forward in equipment digitisation in the operating room. Personnel did not detect any weaknesses or factors that could negatively affect the workflow in operating rooms during the trial. Despite the built-in debris-detection system on the sensor, there was no need to clean the detector during the operation. Further, no errors were detected while using the optical detection system. Based on this a conclusion may be made that this is a safe technology.

In recent years and on all levels of healthcare, several computer-assisted products have been developed and deployed. In surgery, computer navigation is being introduced which measures osteotomies to the nearest degree and predicts bone resections with microscopic precision. In tumour surgery, we can now use different markers that are detected with special detectors to help determine resection levels and precise safety margins. We can now also rely on artificial intelligence to diagnose cardiac arrhythmias. AI can analyse a month of continuous ECG recording in just a few minutes [10], and the list could go on and on. Why then are we still counting swabs ‘manually’ in the operating room. It appears as if we are in denial about the concept of human error. Is machine counting a more reliable method? It seems the answer is an obvious YES. This leads one to question why digitisation and computer technology use in swab counting has been so slow? Why is the electronic counting of swabs not yet the standard method of care? First and foremost, we believe the answer is doubt, or maybe fear – who will be held responsible for a mistake? With this trial, the authors wished to dispel any doubt. The implementation of electronic counting in the OR workflow was uncomplicated. The trial also proved, albeit in a small sample, that the reliability level is very good, thus far at 100%. Rather than being science fiction, it is just a simple algorithm for detecting and recording surgical swabs. Still, the authors believe that responsibility is a concept dependent on institutional organisation and legal regulations, which probably vary in every country. In the end, nobody can blame a simple apparatus. However, such an apparatus can only improve reliability and safety, meaning that liability cannot be a concern.

In the future, in order to ensure the highest possible level of reliability it will be necessary to conduct a large follow-up, randomised, multi-centre study to further determine the reliability of digital counting because this trial study is limited by the relatively small number of surgeries performed. Yet, the numbers are large enough to detect statistically significant deviations or problems, which thus far are simply non-existent.

It is not difficult to imagine how quickly human error can creep in, even during routine surgeries. Add to that the stress of emergency surgeries or unforeseen complications during routine procedures and the possibility of a mistake skyrockets. In the past, various protocols and methods were developed to deal with retained swabs: counting swabs, multiple counting, radiopaque markers, and special forms of swabs. [4] Despite these measures, the mentioned complication continues to be recorded in modern surgery. The incidence is between 1 in 5,500 and 1 in 18,760, and given the legal ramifications of reporting this complication, the incidence is probably even higher. [4-6] In authors opinion, the use of electronic swab counting would reduce this incidence. It will certainly entail considerable research, controversy and even legal advice before digital counting is a standard practice in the operating room, but the start is here. A little late, perhaps.

5. Conclusion

This trial shows that electronic counting with the SD smart cart is a safe and effective alternative to traditional manual swab counting and brings several advantages. The OR personnel experienced lower team workload, a faster workflow, more efficient operating room organisation and, most of all, greater safety for our patients.

In the future it will be necessary to conduct a large follow-up, randomised, multi-centre study to further determine the reliability of digital counting with optical detection and to possibly detect any rare adverse events that might arise with prolonged routine use.

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