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Heat resistant electronic modules for traceable intelligent medical sterile containers

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In industry and logistics the possibility of tracking items is a well-established standard. However, in the medical sector, especially in hospitals, this is still in its infancy. One reason is the need of a full infrastructure of reader hardware in the clinics. Furthermore, the used technology needs to withstand multiple sterilisation cycles to be used for surgical tools. Beside tracking medical equipment also additional data can help to increase efficiency and safety.
This research is about the development of an electronic sensor system for sterilisable medical containers containing a power supply, sensors for both sterilisation and transport and a low power communication module. In contrast to common tacking methods this module can be connected to a regular smartphone or act like a common IoT device. This has the advantage that no specific hardware for the tracking is needed. However, to withstand the steam sterilisation temperature of up to 135 °C a heat resistant insulation needs to be found.
First tests were made with an epoxy resin to insulate the electronics and a high temperature battery. By using the sensor of a Bluetooth module the temperature inside the insulation could be measured during multiple steam sterilisations. Following, a partly insulated thermoelectric generator shall be used to get energy by the achieved temperature difference.
The results of the tests show that the used epoxy resin limits the temperature to 81 °C. However, the resin was damaged after 21 sterilisation cycles due to its high mass and entrapped air. Therefore, the insulation needs to be minimized and the electronic components need to be able withstanding higher temperatures. Additionally, insulations with not yet considered materials will be tested. Also the possibility of insulating just heat-sensitive parts like the power elements will be investigated.

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Sterilisable energy source for intelligent medical containers

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Surgical container management plays a crucial role in hospital logistics. Moreover, it is very important to know the sterile status of the container due to infection threat during the handling, storage and transportation procedure. Nowadays most of the facilities use containers with sterile indicators and tracking system based on documentation and labelling. One of the main problems in container surveillance is the need of a power source able to withstand multiple sterilizations in high temperature (135ºC). Available solutions such as primary or secondary batteries have either short life-time, or cannot withstand temperature of steam sterilization. Our aim was to design an energy source module based on partially insulated thermoelectric generators (TEG). The whole module consists a specially aligned TEGs with insulation on one side to provide sufficient temperature gradient. As an insulation, several different materials as aerogel or silicon will be tested. First efficiency tests of energy source were performed on set of two 16x16 mm thermally parallel TEGs connected electrically in series. Devices were placed on heating plate as a heat sink, with temperatures varying from 25ºC up to 55ºC. Resulting gradient of 7,4ºC from hot to cold TEG side allowed to generate 0,83V DC voltage. The results of this test showed that relatively small TEG modules with low temperature gradient could generate the voltage which can be used for powering low-power electronics. However, during the sterilization procedure, temperatures and temperature gradients will be higher. This will generate voltage sufficient to power Bluetooth module and to use sterile container as traceable IoT device. Using bigger TEG plates should result in generating higher voltages and power. Combining such voltage source with high temperature energy storage systems, should result in long-life sterilisable power system. Due to promising results we plan to perform more specific tests in clinical setup in near future.

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Model to assess the impact on patient hypothermia of different ventilation systems in the operating room

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Patient hypothermia during surgery is known to increase postoperative complications as well as being a risk factor for surgical site infections. Currently approximately half of all surgical site infections in Germany are caused by patient hypothermia during surgery. Both the DIN standard 1946-2: 2008-12 and DIN EN ISO 7730: 2005 refer to this problem as thermal comfort. In this study a model was developed to assess the impact of three different ventilation systems (temperature controlled airflow - TAF, unidirectional low turbulence displacement flow - TAV and turbulent mixing ventilation - TML) on body temperature of patients by means of a reference "phantom". For this purpose, a cubic container was built, which is open at the top. The container measures 40 cm * 40 cm * 40 cm and is filled to 39 cm with 37.5 ° C warm water. The temperature changes and cooling kinetics were recorded using digital graduated thermometers mounted on the test body at three different levels and at three different position on an OR table in respective operating rooms. Thermal comfort was assessed according to DIN EN ISO 7730: 2005.
It could be shown that all three different ventilation systems provide sufficient thermal comfort and are well suited to the needs of staff working in these rooms. With regard to patient cooling, no significant difference could be found in the different ventilation systems. The cooling kinetics of the reference body did not show significant differences for any of the assessed ventilation systems (TAF, TAV, TML). Furthermore, the cooling kinetics of the used phantom without a ventilation in operation did also not show significant differences. Thus we conclude that the cooling effect of ventilations systems in operating rooms may be overestimated.

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4K vs HD resolution in laparoscopic surgery

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Introduction: Due to the dependency on a camera monitor system for laparoscopic surgery, advances in camera or monitor technique could have an impact on performance. Does 4K Resolution of the camera monitor System lead to better results in laparoscopic surgical tasks?
Materials and Methods: In a prospective study with 40 participants who were randomized in two groups. The Participants were medical students. Both groups were given the same video introduction whereafter they performed three different laparoscopic tasks. Two tasks were based on laparoscopic instrument handling, one on visual detail identification. One group started with an HD system and the other with an 4K system. After the other round of the tasks they switched to the other system. Besides the tests we conducted a survey among the participants.
Results: The 4K system scored a significant better rating in the subjective evaluation. There were no performance differences between the two systems regarding the two handling Tasks. In the test for visual performance the participants scored significantly better on the 4K System.
Conclusion: The Experiments show a superiority of the 4K system regarding the recognition of details. This wasn’t translated into a better performance of laparoscopic handling tasks.

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Risk management in radiotherapy – patientidentification and patientverification

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According to the Radiotherapy-Risk-Profile of the World Health Organization (WHO) the incorrect identification of the patient is a risk with a high potential impact in nearly all stages of the radiotherapy process. In Germany about 340.000 patients received a radiotherapy treatment in about 8.500.000 sessions in 2014. Statistically nearly 300 Patients received a wrong treatment due to the incorrect identification of the patient. In the annual Report of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) only 2 cases are reported, but the estimated number of unreported or undetected cases might be reasonably higher. The probability of treating the wrong patient can be reduced by using the right strategy and methods during the process of radiotherapy. In this presentation, we depict, examine and rate several strategy and techniques. Simple approaches like active questioning according to the recommendations of the "Aktionsbündnis Patientensicherheit" and comparing patient photos as well as IT-based patient bar code identifier and integrating different biometric datasets for patient identification are compared. Rating creteria are reliability, complexity, convenience and compliance with the regulations of data privacy protection.