

A System for Preventing Inadvertent Exposition of Staff Present outside the Operating Theater: Description and Clinical Test

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Abstract : Introduction: Mobile C-arms move throughout operating rooms of the operating theater. Being designed to move between rooms, they are not equipped with relays to retrieve the exposition information and export it outside the room. Therefore, no light signaling is available outside the room to warn the X-ray emission for staff. Inadvertent exposition of staff outside the operating theater is a real problem for radiation protection. The French standard NFC 15-160 require that: (1) access to any room containing an X-ray emitting device must be controlled by a light signage so that it cannot be inadvertently crossed, and (2) setting up an emergency button to stop the X-ray emission. This study presents a system that we developed to meet these requirements and the results of its clinical test. Materials and methods: The system is composed of two communicating boxes: o The "DetectBox" is to be installed inside the operating theater. It identifies the various operation states of the C-arm by analyzing its power supply signal. The DetectBox communicates (in wireless mode) with the second box (AlertBox). o The "AlertBox" can operate in socket or battery mode and is to be installed outside the operating theater. It detects and reports the state of the C-arm by emitting a real time light signal. This latter can have three different colors: red when the C-arm is emitting X-rays, orange when it is powered on but does not emit X-rays, and green when it is powered off. The two boxes communicate on a radiofrequency link exclusively carried out in the 'Industrial, Scientific and Medical (ISM)' frequency bands and allows the coexistence of several on-site warning systems without communication conflicts (interference). Taking into account the complexity of performing electrical works in the operating theater (for reasons of hygiene and continuity of medical care), this system (having a size $<10\text{ cm}^2$) works in complete safety without any intrusion in the mobile C-arm and does not require specific electrical installation work. The system is equipped with emergency button that stops X-ray emission. The system has been clinically tested. Results: The clinical test of the system shows that: it detects X-rays having both high and low energy (50 - 150 kVp), high and low photon flow (0.5 - 200 mA: even when emitted for a very short time ($<1\text{ ms}$)), Probability of false detection $< 10^{-5}$, it operates under all acquisition modes (continuous, pulsed, fluoroscopy mode, image mode, subtraction and movie mode), it is compatible with all C-arm models and brands. We have also tested the communication between the two boxes (DetectBox and AlertBox) in several conditions: (1) Unleaded room, (2) leaded room, and (3) rooms with particular configuration (sas, great distances, concrete walls, 3 mm of lead). The result of these last tests was positive. Conclusion: This system is a reliable tool to alert the staff present outside the operating room for X-ray emission and insure their radiation protection.

Keywords : Clinical test, Inadvertent staff exposition, Light signage, Operating theater

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