FACULTY OF MEDICINE AND HEALTH SCIENCES

Optimizing the quality control of personal radiation protective equipment: a study on integrity, policy, and use

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A1 Publications

Pieter-Jan Kellens, Gilles Soenens, Isabelle Van Herzeele, Richard McWilliams, Tze Yuan Chan, Robert Fisher, Klaus Bacher, Peter Vlerick. Multicentric study on the relation between perceived department radiation shielding policies and staff radiation shielding conscientiousness. **Health Physics, 2023**

Pieter-Jan Kellens, An De Hauwere, Tim Gossye, Sven Peire, Ingrid Tournicourt, Luc Strubbe, Jan De Pooter, Klaus Bacher. Integrity of personal radiation protective equipment (PRPE): a 4-year longitudinal follow-up study. **Insights into Imaging, 2022**

Pieter-Jan Kellens, An De Hauwere, Sandrine Bayart, Klaus Bacher, Tom Loeys. Prediction model for lead and lead-free aprons. **Health Physics, 2024**

Under review

Pieter-Jan Kellens, Sandrine Bayart, Jan De Pooter, Klaus Bacher. Towards faster quality control of personal radiation protective equipment (PRPE) using CT scout or a dedicated biplanar radiography device. **Radiation Protection Dosimetry, 2024**

Co-authorships

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Background

Medical personnel performing X-ray procedures are susceptible of being exposed to scattered X-rays originating from the patient. This can cause health issues and therefore, all operators should adhere to the radiation safety procedures at hand. Some operators are more aware and conscious about the potential health issues from radiation exposure. This personality trait of being more aware and conscious about occupational hazard is called safety conscientiousness. Safety conscientious people tend to be more aware of safety issues in the workplace and generally, behave in a safer way. An example of safety conscientiousness regarding radiation shielding is when operators stand behind a radioprotective lead screen when the procedure is performed warranting their safety without disrupting the patient's procedure.

However, certain procedures such as X-ray fluoroscopy guided procedures (FGP) require close proximity to the patient preventing the operators to stand behind a lead screen. This necessitates the use of radiation shielding in the form of personal radiation protective equipment (PRPE) and in-room radiation protective devices (IRPD) such as the previously mentioned lead screen.

PRPE consist of pieces such as lead-equivalent aprons, skirts, vests, thyroid shields and goggles. The term lead equivalent corresponds to a thickness of pure lead that would offer the same amount of protection. As an example, if the label of a piece of PRPE mentions '0.50mm lead equivalent', then the piece should offer the same amount of radiation protection as a 0.50mm thick layer of pure lead. Unfortunately, PRPE are subject to wear and tear of the radiation protective layer. This results in defect formation lowering the shielding performance of the equipment. Moreover, this crucial layer is hidden by the outer fabrics of the garment. X-ray based quality control (QC) is thus required to localize the possible defects in the piece of PRPE.

Generally, QC of PRPE is performed using X-ray fluoroscopy where the inspector scans through the garment, localizing and quantifying each encountered defect. Unfortunately, QC using X-ray fluoroscopy is time-consuming and laborious limiting PRPE QC to a yearly occurrence.

Key Findings

Firstly, this thesis demonstrated that the general positive association between safety conscientiousness and the perception of the safety policy seems to be extendable to a positive association between the perception of the radiation shielding policy and the conscientiousness of the employees. It suggests that policy makers should not only improve the radiation shielding in general but also improve the employees' perception of the radiation shielding policy. This increased perception can trigger the safety conscientiousness in the employees enabling more radiation safe behavior.

Secondly, PRPE were shown to be prone to defects in their protective layer. Approximately 50% of all PRPE investigated showed tears at least once during a 4-year study period. Furthermore, new and repaired pieces of PRPE are not warranted to remain free of defects in the first year of use. Frequent QC is thus necessary to safeguard the integrity of all PRPE.

Thirdly, two optimization approaches for PRPE QC were proposed. The feasibility of a prediction model was investigated. The goal of the model was to predict the QC result based on readily available information, eliminating the need for X-ray imaging. The models achieved at least 80% accuracy and 95% precision indicating the possibility of a model-guided PRPE QC approach. In the other optimization proposal, the PRPE QC properties of the CT scout and a biplanar radiography device were assessed. Both devices were compared with standard X-ray fluoroscopy in terms of speed and defect detection performance. Both CT scout and the biplanar radiography device allowed much faster QC of PRPE (<10 seconds vs >60 seconds for fluoroscopy) with equivalent defect detection performance. Both optimizations of PRPE QC allow more frequent controls of PRPE and inevitably lead to a better follow-up of the integrity of all PRPE.

In combination with the optimized PRPE QC presented in this thesis, policy makers could simultaneously improve the radiation shielding behavior and awareness of their employees and increase the frequency of PRPE QC enabling a better follow-up of the integrity of PRPE. This could benefit the overall radiation safety at their respective departments and lower the radiation exposure of its employees.

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