Essay on health informatics project

Environment, Disaster

Radiologists and the complementary professionals and para-professionals face unique risks while at the work place. Exposure to ionizing radiation induces nuclear changes in cells that may cumulatively lead to cancer. In the case of the patient, the exposure to radiation is necessary in order to establish diagnosis or treatment and the benefits should outweigh the potential harm. For the staff on the other hand exposure to increased levels of exposure is hazardous and undesirable. Shielding is used to avoid accidental exposure to radiation, as well as careful obedience to the laws of physics. The effects of radiation lessen as distance is increased and delivery rate is reduced. Modern diagnostic and interventional radiology attempts to reduce the size of delivered radiation as much as possible to the point of being a tiny fraction of acceptable total radiation exposure. However, no amount of radiation is without risk of mutagenesis and it is desirable to control and limit all exposure (Chida, et al, 2013).

Various systems exist to control the radiation exposure of staff at risk of contact with ionizing radiation. A radiation dosimeter is used to measure the amount of incidental exposure to radiation. In an interesting occupational safety presentation compiled by Duke University they describe different badges in use. The type of film badge worn by the radiation worker is dependent on their role in the department: ring badges, body badges, and neutron badges are used by appropriate personnel. Dosimeters are processed to measure radiation exposure either once a quarter, or once a month, depending on the type of exposure risks. It is presumed that the staff will only wear the badges when they are working, in order to control the effects of background radiation effecting measurements. A report of the overall radiation exposure is delivered to the employee indicating greater than acceptable levels of exposure. While this method of radiation detection can detect overall exposures within the given time frame, excess radiation exposure is of immediate concern. If a large leak is not detected before the next check of the badge, many people may be overexposed to ionizing radiation and the concurrent risks. Epidemiological studies already indicate increased risks for many cancers in medical radiation workers, and rapid detection of over-exposure may prevent future cancers (Linet, et al, 2010). It important to remember that in light of modern shielding and delivery methods the annual radiation risk of cancer for medical radiation workers is less than 1/10 000 (Niklason, et al, 1993).

A literature review conducted using PubMed to search for information regarding dosimeter badges and informatics systems to speed up detection of radiation exposure yielded disappointing results. Searches for radiation badges, film badge, dosimeter system, and occupation safety and radiology, yielded a paucity of articles dealing with increasing the rate of film dosimeter analysis to limit exposure to radiation. Most articles focused on occupation specific risks of exposure using film badges placed in specific locations on the body, and analyzing and comparing the differences between radiation doses detected behind shielding and in front of shielding. Some research exists regarding radiation film chemical composition and differing abilities to immediately detect levels of radiation exposure. To date, they do not appear to be in common use across health care setting, and a review of the safety protocols in several large university hospital systems discuss the use of the badge dosimeter and the monthly or quarterly submission of the badge for analysis.

Roth, Schweizer, and Gückel note that overall, an average person in Switzerland is exposed to 4 mSv of radiation per annum (1996). This exposure comes from all sources, including natural and man-made with as much as forty percent of the exposure coming from Radon. The authors also note that while intermediate and high range doses of exposure are harmful, there is also a bioprotective adaptive response and hormesis that develops after low dose exposures. The investigators speculate about beneficial effects of radiation outweighing the potential side effects, and surmise that radiation is detrimental, inhibitory, modifying, or beneficial based on the nature of the molecular lesions that occur (Roth, Schweizer, and Gückel, 1996). Traditionally, the damage caused by radiation is classified as stochastic or deterministic. Stochastic effects are genetic and carcinogenic, whereas deterministic effects require a threshold of exposure to be reached and include things such as radiation burns. By definition, the probably of stochastic effects increase with dose, but any negative event is independent of the dose. Deterministic effects occur after a particular threshold and the negative event is related to the dose of exposure. Beginning with intermediate levels of exposure, the dose-response relationship stops being linear and becomes quadratic in nature. In sum, the authors seem to indicate that there is more leeway with regards to radiation exposure than clinicians would admit, but due to an inability to confirm the leeway by academic study, we should not rush to change the " restrictive radiation protection policy" as it currently exists (Roth, Schweizer, and Gückel, 1996).

There are several discussions to be found in the French literature regarding radiation safety and radiation-based occupational hazards of physicians. In a system proposed in 2005, Gauron & Boulay relied on the framework of the International Commission on Radiological Protection to establish relevant protocols. The goal of their project was to provide a framework for the use of ionizing radiation, to exclude deterministic effects and to restrict stochastic effects. Essentially, they view favorably the French regulatory systems of radiation protection and point out that it is based on EURATOM, European Directives, the French Institute for Radiological Protection and Nuclear Safety, and the General Department of Nuclear Safety and Radiation Protection (Gauron, Boulay, 2005). In a broad review of the occupational safety of the anesthesiologist, Mérat and Mérat devote a section to the risks posed to the practitioner by ionizing radiation. They recount the many instances of possible accidental exposure, such as during radiological interventions performed under anesthesia, and also the risk in the operating theater, particularly in orthopedic, urological, and vascular procedures (2008). The authors further reassert the necessity of limiting exposure doses of radiation to 20 mSv/year on the thorax and 500 mSv/year on the limbs. When the appropriate safeguards are followed, the anesthesiologist's exposure to radiation is generally very limited. Orthopedic surgery tends to have the highest risk of exposure to ionizing radiation with an average dose of 0. 43-0. 85 mSv reported per procedure. Wearing cervical protection to shield the thyroid from harmful rays is stressed as is effective shielding and regular review of the film dosimeter to monitor exposure (Mérat, Mérat, 2008).

In order to limit radiation doses to medical personnel it is necessary to create a networked infrastructure that manages both the radiation dose received by the practitioner, and the practitioner's access to patients. It is necessary to quickly digitize the information from a film badge dosimeter so that it can be read by computer systems currently in use in the hospital setting. If the system concludes that the practitioner has received a greater than allowable dose of radiation, putting them at risk, limitations must be put in place that will prevent them from being further exposed to harmful radiation.

Using the present system of dosimeter badges, it is possible for them to be scanned by a standard out-of-the box scanner. The flat bed scanner is a viable solution to digitize the data available from the film badge. A Microtek ScanMaker 9800XL scanner, as well as several other scanning platforms, has been used to read and store the information that dosimeter film badges contain (Sim, Wong, Ng, 2013). This data, once digitized, is storable and can be retrieved at will. According to the literature, flat bed scanners are fit for this task and have good reliability regarding detection of radiation exposure on film (Lynch, et al, 2006). Once digitized, radiation dose estimation software will be used to review the dataset that is collected. Dose estimation uses mathematical and statistical modeling to determine the level of radiation exposure (Ainsbury, Llloyd, 2010). Variables that the software can account for are the acceptable levels of radiation that the practitioner is allowed to receive, as well as the placement of the badge on the body of the practitioner and the radiation exposure to that region – the dose permissible on the arm is considerably higher than the dose permissible to the thorax.

Once the data from the film is digitized it may be matched to the practitioners login information for the hospital network system. The practitioner would be able to see the results of the scan and the dose of radiation that they received at their most current reading. Furthermore, the practitioner would be able to track their exposure to radiation over the course of a specified period of time. Considering the ease of storage of the digital data, it would be possible to track the lifetime exposure to radiation that has been received.

With the traceability of the exposure levels received, it would be possible to limit the practitioners access to patients. Threshold doses of radiation would be evaluated for either daily, weekly, or monthly dose and limitations set in place for the physician. Simple solutions could comprise of several measures. Firstly, access to patient electronic health records could be limited for practitioners that have exceeded their allowable doses, thus making patient care and further exposure impossible. Another possible solution would be to cross reference the film data with key-card access. Once the radiation threshold is reached, access to environments with potential for radiation exposure could be limited by not allowing access to the room. The risk of bypassing this system is real, as other personnel may give a practitioner that is well known access to a room. In order to prevent this possibility it is conceivable to use radio-frequency identification systems in the hospital to act as a safeguard too. Data from the dosimetry measurement can be cross-linked to an RFID inserted either in the hospitalists ID badge card, or in their white coats. When the practitioner enters a room where access should be limited, either an alert can be issued or access to systems in that area can be locked all together until the responsible parties reset them.

There are several manufacturers of dosimetry devices. The need for measuring radiation exposure is not limited to medical personnel but also includes miners, nuclear engineers, and anybody potentially exposed to ionizing radiation in their line of work. Towards that end, Canberra manufactures several dosimeter devices in common use. The Accuscan line of devices is a fully scalable, network-integrated system. The whole body scanners are able to detect gamma rays and perform spectroscopy to provide fast and accurate identification of the contaminants. Local and Wide area networks provide for a convenient means of analyzing the data and are able to stand alone should the need arise due to network failure. Furthermore, there are custom configurations that allow the fully body scanner to be stand up or bed type scanning and provide various levels of shielding as required by the consumer (http://www. canberra. com).

Other dosimeter solutions are provided by Veriteq, based in Florida. Veriteq produces a unique litany of devices including implantable devices that are placed in vascular components, breast implants, artificial hips, and knees are available. The dosimeter products that they make are also varied and they produce both wearable and implantable devices that can store and collect wide amounts of relevant data. As a manufacturer of informatics and data analytics systems they are particularly well-suited to creating devices that would be able to provide constant real-time assessment of radiation hazards (www. veriteqcorp. com).

Laurus Systems produces the Instadose system. Instadose is a USB accessible dosimetry device that can be read by the person concerned any time they have access to a computer and a USB drive. It’s use is only approved in Nigeria and Australia, however it purports to be cheap, effective, and accurate. Other solutions include electronic dosimeters with LCDs that instantly display dose levels and is usable for 2500 hours on a single AAA battery (laurussystems. com). The dose range of these devices is relatively limited compared to the traditional film badge system, and its effective dose is 0. 01-5 mSv. These devices represent a significant advance in radiation dosimetry, however, they have not been widely tested in the peer-reviewed academic literature and are not approved for use in either the United States or Europe. If the accuracy and speed of detection is as good as the manufacturers website indicates, these devices may very well be a great leap forward in occupational safety.

Any one of these systems could be integrated into an informatics system that would effectively cut off the potential for exposure to the practitioner. With appropriate use of film, scanning technology, software platforms, and network integration, it is possible to limit the potential of hazardous doses of extraneous radiation. A simplified schematic of such a system is presented below:

At present, there are few real time radiation exposure dosimeters available on the market. The informatics systems that do exist are cumbersome and expensive and would require substantial retraining of relevant monitoring personnel. The film badge system that is currently in place across many hospitals has been largely successful at monitoring exposure to radiation over the long term (one to three months between badge changes), however, this does permit for dangerous episodes of non-therapeutic radiation exposure to occur. Stochastic radiation effects compound over many years and a few incidents of higher than considered safe radiation exposure can potentially cause cancers and other diseases later in life. It is possible to use Geiger counters and Alarm systems that will alert to the existence of levels of radiation in the ambient atmosphere beyond the acceptable limits in facilities, however, given that the radiation dose is proportional to distance from the source of radiation the alarms may not accurately reflect the dangers that the practitioner is placed in. Systems that combine the cheap and utilitarian film badge system with informatics systems that can quickly and accurately analyze the film would be a welcomed advance towards keeping health care staff healthy.

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