Occupational radiation exposure in chemoembolizations:

Evaluation of doses in different body regions of professionals with different roles in the procedure

Machado C.[1], Monteiro, A.[2], Oliveira, F.[1], Pinto, I.[3]

[1] TSDT- Radiologia, Centro Hospitalar Universitário do Porto, Porto, Portugal
[2] TSDT – Radiologia, Centro Hospitalar Lisboa Norte
[3] Especialista em Física Médica, Centro Hospitalar Universitário do Porto, Porto, Portugal

Interventional radiology is a non-invasive technique used in various fields of medicine for diagnostic and therapeutic purposes. When the interventions are long and complex, the radiation dose to the patient can exceed the threshold of tissue reactions. In this regard, special evaluation of the exposure of the patient and the medical staff is necessary in order to ensure their protection. The main objective of the radiation monitoring is to ensure that the doses received by professionals do not exceed the values established by Portuguese Decree-Law No. 108/2018. The aim of this study is to investigate radiation exposure profiles in medical staff during an interventional radiologic procedure - hepatic chemoembolization.

Hepatocellular carcinoma is one of the most common cancers worldwide, the prognosis is poor because curative resection with partial hepatectomy or liver transplantation is applicable to only a small proportion of patients. For patients with unresectable disease, the goal of palliative treatment is to prolong survival and to control symptoms. Chemoembolization of the liver is a combination of chemotherapy delivered directly into the blood vessel feeding the tumor and a procedure called embolization in which an embolic agent is placed inside the blood vessels that supply blood to the tumor, in effect trapping the chemotherapy in the tumor. It is a non-surgical and minimally invasive procedure performed by an interventional radiologist, that takes a prolonged exposure to radiation.

Methods

This study was carried out at Centro Hospitalar Universitário do Porto, in the angiography intervention room. We evaluated radiation dose in hepatic chemoembolizations based on four criteria: total exposure time (fluoroscopy time), procedure frequency, Air Kerma and Dose Area Product (DAP), values that are the result of the selected protocol and is influenced by tube current (mA). This procedure was selected considering the potential high dose to medical staff due to prolonged exposure to radiation and the difficulty of the procedure. The disposition of the room is shown in figure 1.

This study reports to the radiation exposure values of professionals who attend hepatic chemoembolization procedures in a single institution, during a five week period and 9 procedures. The dosimetry was measured in six staff members, one primary interventionist and one assistant, a circulating nurse, a radiographer, an anesthetist and an anesthetist nurse. The thermoluminescent dosimeters (TLD) were attached according to the Figure 2 and Table 1.

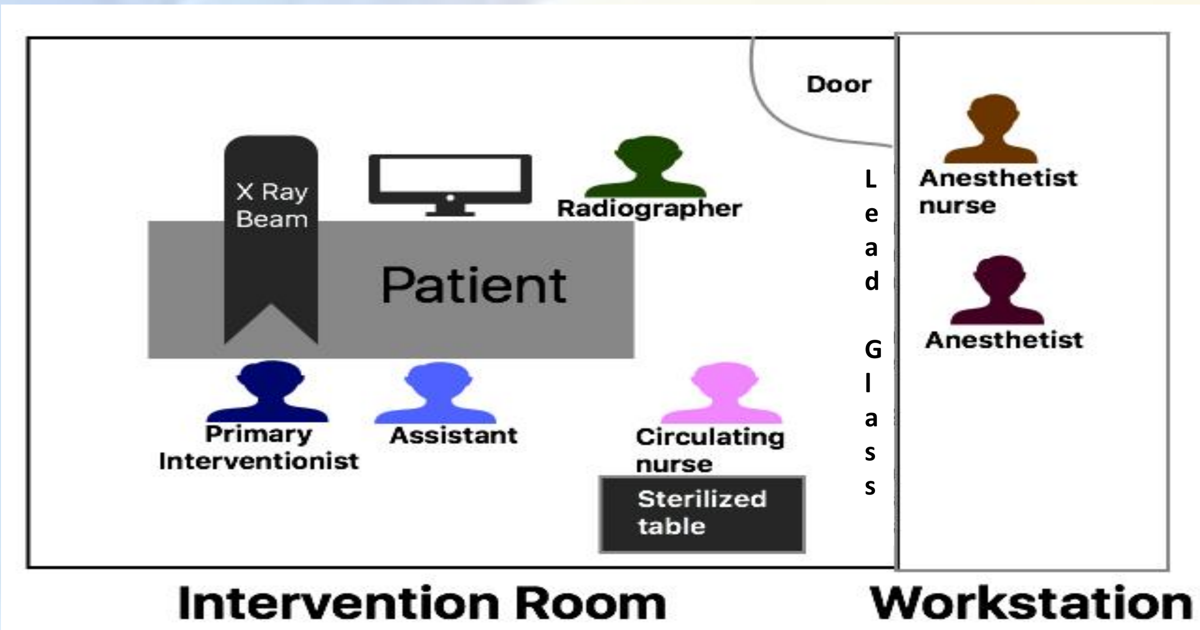

Figure 1: Layout of the Intervention room .

Figure 2: Location of dosimeters.

Professional	Dosimeter Location
Primary Interventionist and Assistant	Eye, thyroid, chest (one inside vest and one outside the vest), hand, inferior leg
Radiographer	Thyroid, chest (one inside vest and one outside the vest)
Nurse	Chest (one inside vest and one outside the vest)
Anesthetist	Chest (one inside vest and one outside the vest)
Anesthetist Nurse	Chest (one inside vest and one outside the vest)

Table 1: Location of dosimeters.

All procedures were performed in an interventional room with the equipment Philips Allura Xper FD20/10, that is in accordance with all standard radiation control tests made by the hospital external supporting physicists team. The equipment has two X-ray tubes, that allows the acquisition of images in two planes simultaneously with a single contrast injection. This equipment has a "Spectrabeam" filter that increases filtration of the soft radiation.

Results

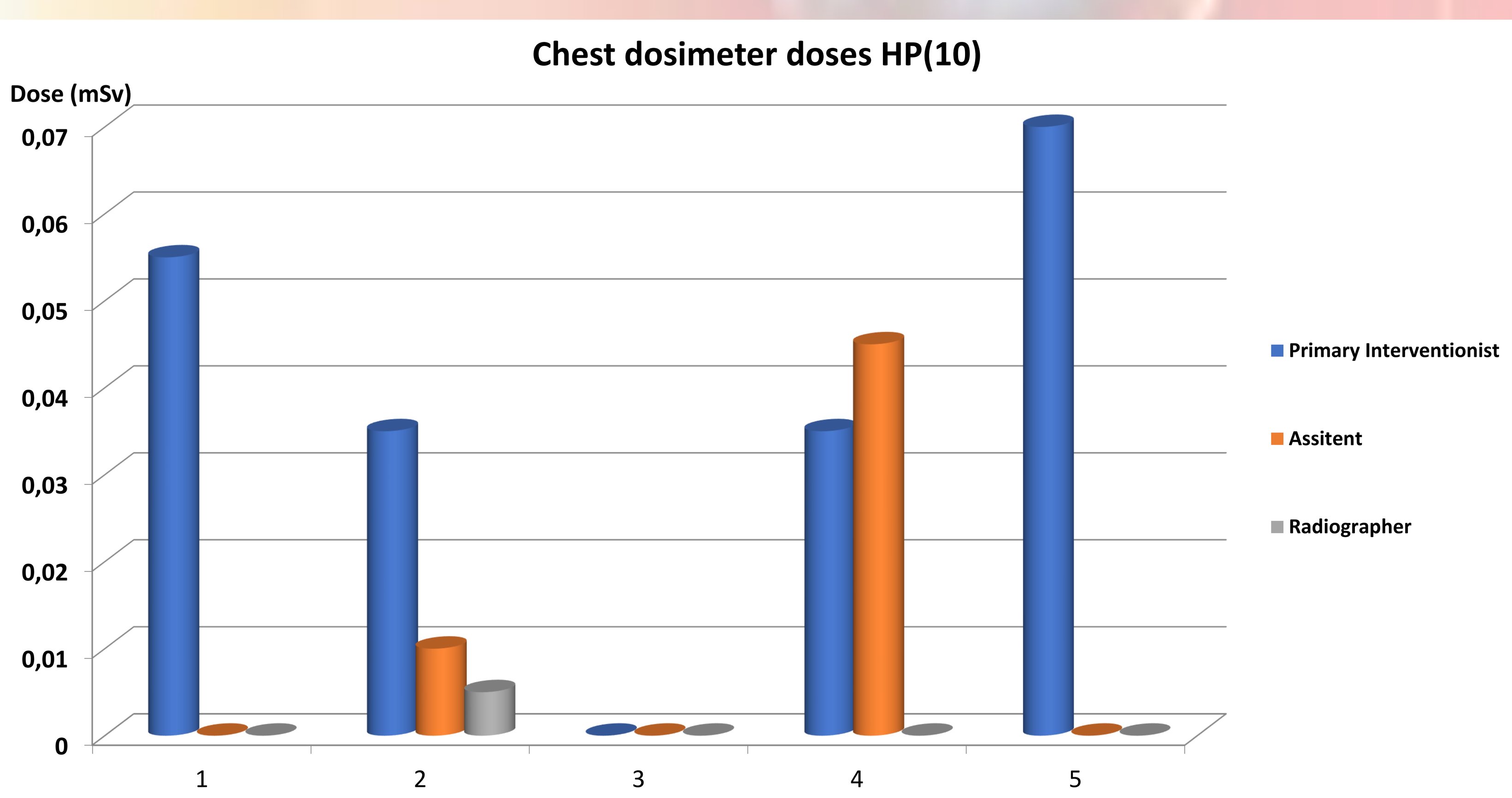

Chart 1: Chest Dosimeter, inside the vest, doses HP(10) during the 5 week monitorization of the primary interventionist, assistant and radiographer. The other members of the team had a neglective dose.

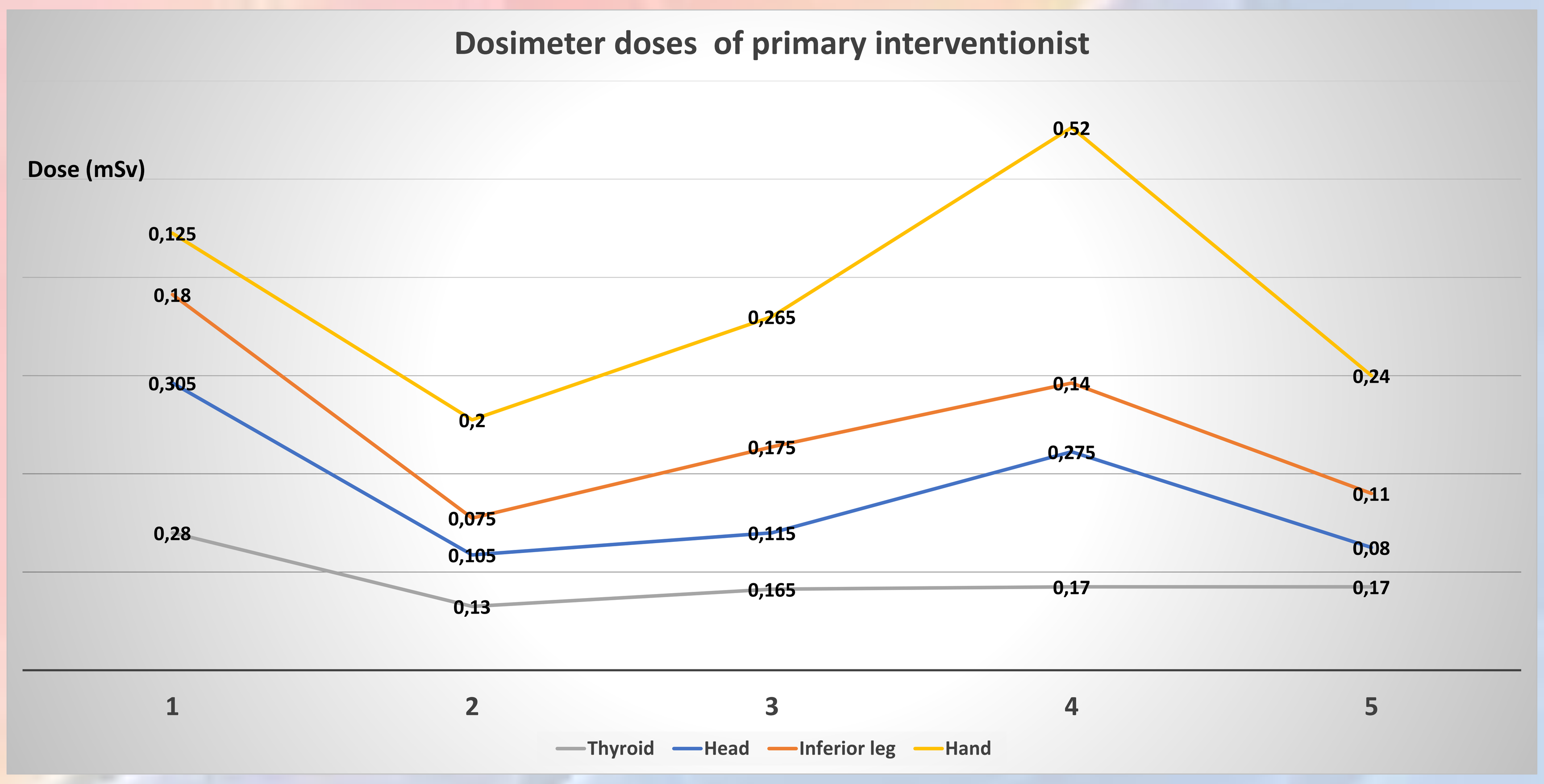

Chart 2: Dosimeter doses during the 5 week monitorization of the primary interventionist: head, thyroid, hand, inferior leg.

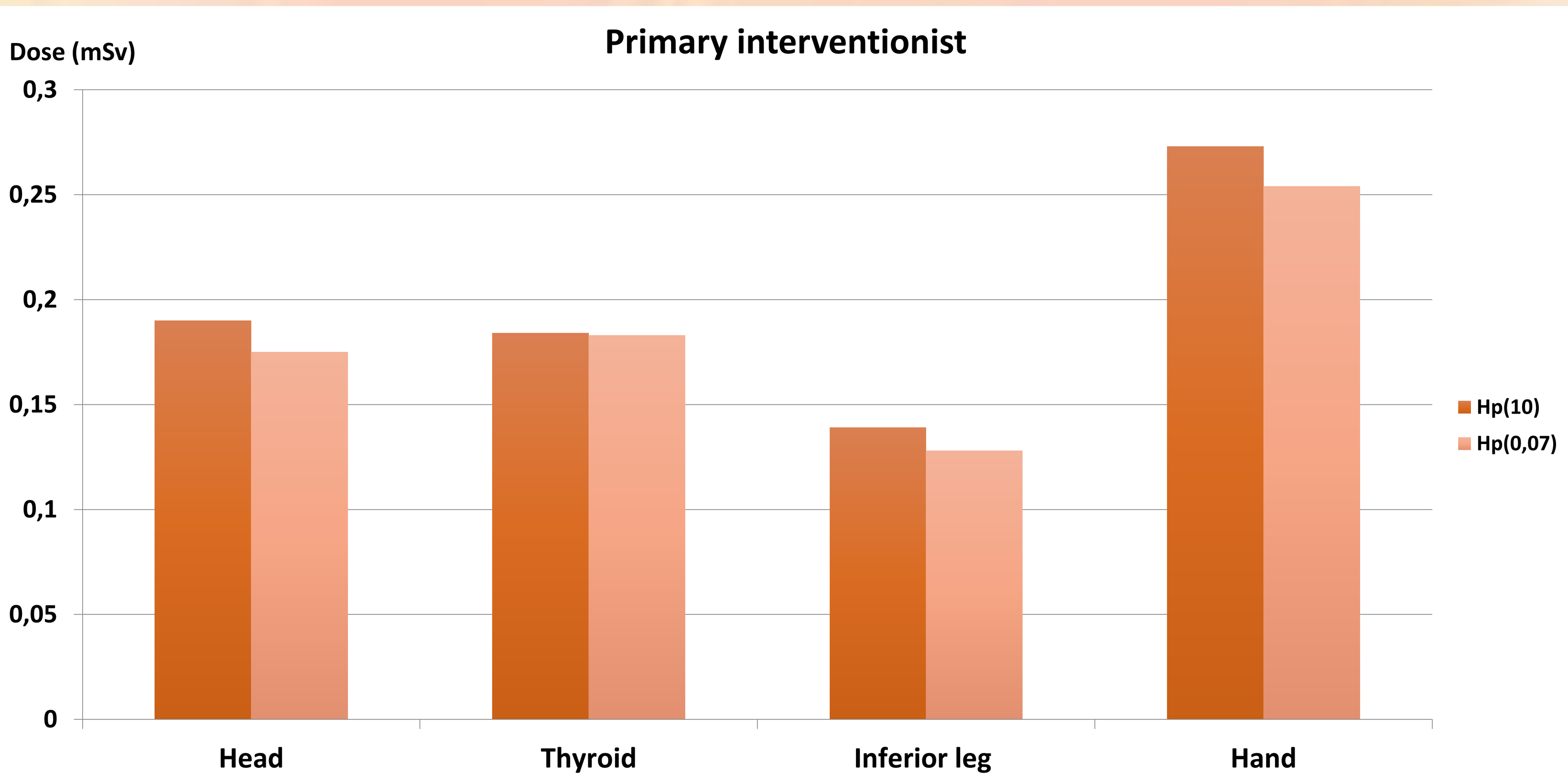

Chart 3: Mean dosimeter doses of the primary interventionist: head, thyroid, hand, inferior leg.

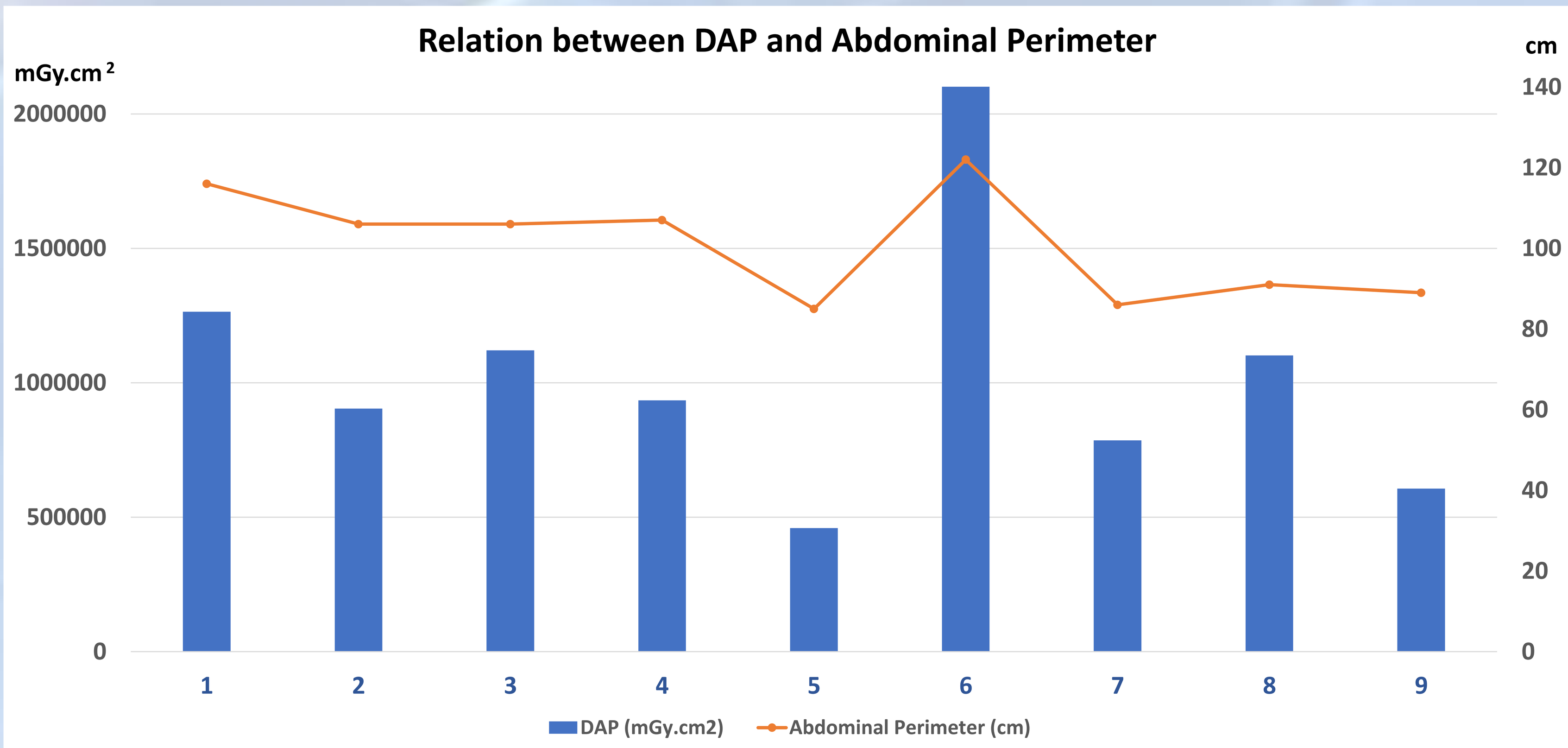

Chart 4: Relation between DAP and Abdominal Perimeter through the 9 procedures.

Each procedure had an average fluoroscopy time of twelve minutes and twenty seconds, and thirty six acquisition frames totalizing a mean DAP of 831559 mGy.cm². The dosimetric results of the primary interventionist and of the assistant are markedly superior to the rest of the team due to their proximity to the patient (chart 1). The anesthetic team and the circulating nurse do not have any dose registered in the dosimeters, since most of the time they stay out of the room and the radiographer has low values. Extensive instrument manipulation during image acquisition causes high levels of hands exposure (charts 2 and 3). The lower legs have a high dose due the positioning of the X-ray tube under the table (chart 2). The results of chart 4, Relation between DAP and abdominal perimeter, shows that the increase in DAP is related to the abdominal perimeter of the patient, since the procedure time is similar through the various procedures.

Conclusions

In our study, despite our short sample, the dose levels measured indicate that professionals who are properly shielded do not exceed the annual dose limits. The interventionists perform around 70 chemoembolizations procedures per year, and the estimated mean annual value to the crystalline in these specific procedures will be 13 mSv, not exceeding the 20 mSv established by the recent European legislation. In this study, the interventionists always put on lead glasses, that attenuate the dose received. Our analysis demonstrates that individual dosimeters, positioned on the chest, under the vest, may underestimate the doses for other body regions, especially eye lens. Therefore, a stationary shielding for the eye lens is strongly recommended, especially for high dose procedures like chemoembolizations.

1(January 2006)"Radiation Exposure of Operating Theatre Staff during Surgical Operation", Occupational Safety and Health Council;**2**Christina Heilmaier,MD,MBA,NiklausZuber,RT,CAS, Christian Berthold,MD,LeventKara,MD,EBIR,andDominik Weishaupt,MD. (2016),Establishing Local Diagnostic Reference Levels in IR Procedures with Dose Management Software", J VascIntervRadiol ;**3** Fernando Antonio Bacchim Neto a, Allan Felipe Fattori Alves a, Yvone Maria Mascarenhas b, Patrícia Nicolucci c, Diana Rodrigues de Pina(2016)"Occupational radiation exposure in vascular interventional radiology:A complete evaluation of different body regions", Physica Medica;4 Equipment manual.