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Radiation dose optimization in interventional cardiology using artificial intelligence

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In the interventional cardiology (IC) procedures{ the use of fluoroscopy in IC can cause high radiation doses to patients and operators because of the prolonged duration of x-ray exposure. Artificial Intelligence (AI) allows in the prediction of the system, classification and regression of the problems, and enhancement of clinical decisions. In the present work, the application of AI in our interventional cardiology (IC) room can be divided into 3 main branches, virtual and physical, imaging decision, and abnormalities detection. Results can be predicted outcomes for future interventional procedures. Imaging decision, clinical decision support systems with computing data are under development using ML and DL in order to improve IC procedures. Abnormalities detection. More recent advances, have given rise to superior algorithms that learn through direct navigation of data to "recognize" some human error findings. AI has been utilized in the practice to analyzing of ESAK measurements for patients undergoing diagnostic and therapeutic interventional procedures, considering variables such as the anatomy of the patient (height, weight, gender, BMI, age), the complexity of the procedure, radiological parameters as well as cardiologist´s expertise. The implementation of AI tools in IC suggested reduction variability and improve the quality, safety, and efficiency of care around radiation dose management. Beside, our findings were used to assist IC staff to be able to visualize and navigate procedures more safely and efficiently with significantly less radiation dose exposure.

INTRODUCTION

Exposure to ionizing radiation like X-rays, depending upon the absorbed dose, leads to a variety of biological manifestations which are classically referred to as acute and chronic effects [1]. The contribution on the dose received from cardiological and radiological procedures in the world is 0.43 milli sieverts (mSv) annually, which is equivalent to 22 chest radiographs per person per year. In this sense, collective dose is increasing for medical purposes worldwide.

In Mexico as well as in the world interventional radiology procedures (ICP) have been increased during the last decade, this increasing provokes an increasing of collective dose, besides, actually interventional procedures are more complex which arisen more time [2].

Since the 1990s, the data mining technique has been applied in scientific research, decision-making, data quality improvement, etc. In December 2014, Applications of Data Mining Methods were used for Medical Studies in Coronary Heart Disease using K MEANS algorithm [3, 4].

The aim of the present work consists in analysing of interventional cardiology procedures, based on the set of data collected annually from patients undergoing interventional procedures, using data mining to determine the efficiency of the procedures in medical practice. radiation dose used and detect possible abnormalities.

MATERIAL AND METHODS

Data were collected from 614 patients undergoing interventional cardiology from March 2018 to February 2019 [2]. Attributes were collected using a computerized record, collecting data such as: patient number, year, date, start time of the procedure, time of the procedure, patient name, gender, age, weight, height, file number, causes, diagnosis, procedure, adverse event, diabetes and hypertension disease, destination, name of the doctors and nurses who attended the patient during the procedure, Dose-Area Product (DAP), CD, number of images, frames per second, pulses per second, number of consecutive shots, and contrast. Radiological parameters were also collected as nominal voltage, anodic angle, total filtration.

Misclassified attributes of the Excel file were identified, which were diagnosis and procedure the Python programming language was used, and we relied on the Jupyter Lab notebook interface

Based on the results obtained in the present work, the correlation coefficient allows us to observe interventional procedures behavior for diagnostics procedures as well as interventional procedures.

In figure 1, the cumulative dose of the diagnostic interventional procedures related to body index mass (BIM) are shown, as it seems in the figure interventional procedures are closer to a linear fit, this is increasing as BIM is increased. A correlation of 12% was obtained and meanwhile for interventional therapeutic procedures was 5% some procedures leave this correlation that indicates a high dose over than 2 Gy. This figure allows us to focus on the procedures for dose optimization.

Figure 2 shows a correlation between cumulative dose as a function of DAP, it seems a linear fit. Some patients received low doses during interventional procedures, but as DAP is increasing the CD also is increasing. some patients received high doses during diagnostic procedures which relate to a radiation risk, this result suggests a collimation of the beam. Some procedures leave of linear fitting which suggest an investigation processes for that higher values mainly for doses higher than 2 Gy.

Figure 3 describes the relationship between cumulative dose (CD) and dose area product (DAP). a correlation coefficient showed of 78.2% for diagnostic procedures and 73.3% for therapeutic procedures. Linear regression shows a behavior prediction, except for at least 10 cases of a diagnostic type and only 8 of cases of a therapeutic type. Finally, these figures (1,2, and 3) show how use AI for radiation doses optimization in interventional cardiology processes, the main objetive of this work.

RESULTS

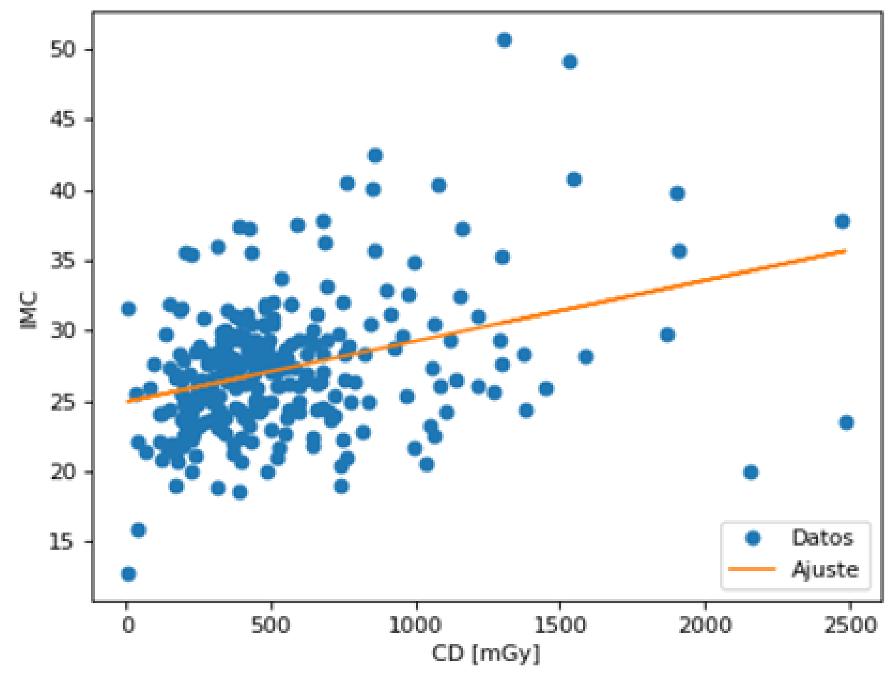

Fig. 1. Cumulative dose Vs body index mass.

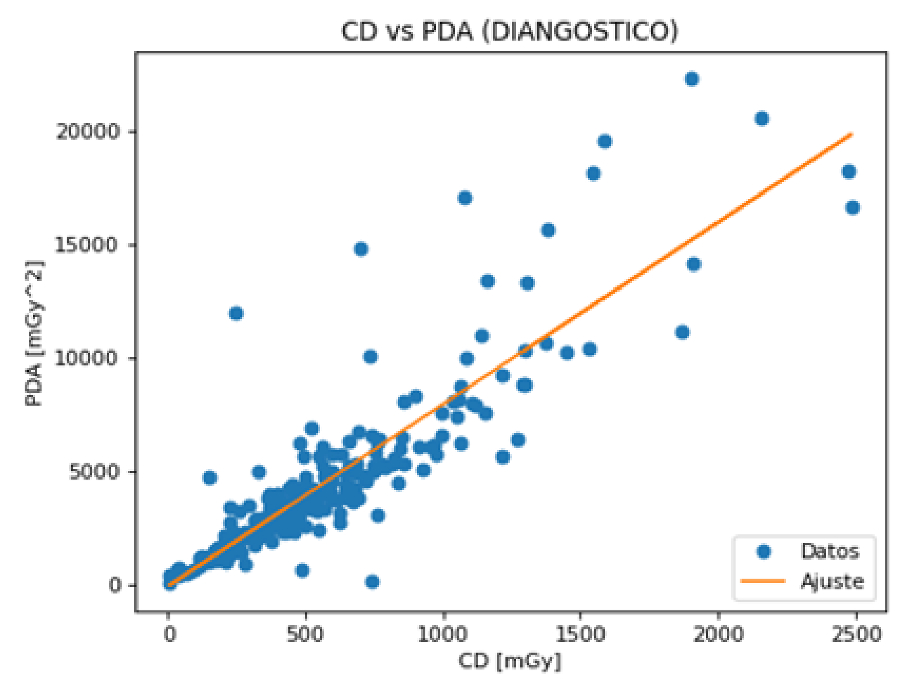

Fig. 2. CD Vs DAP

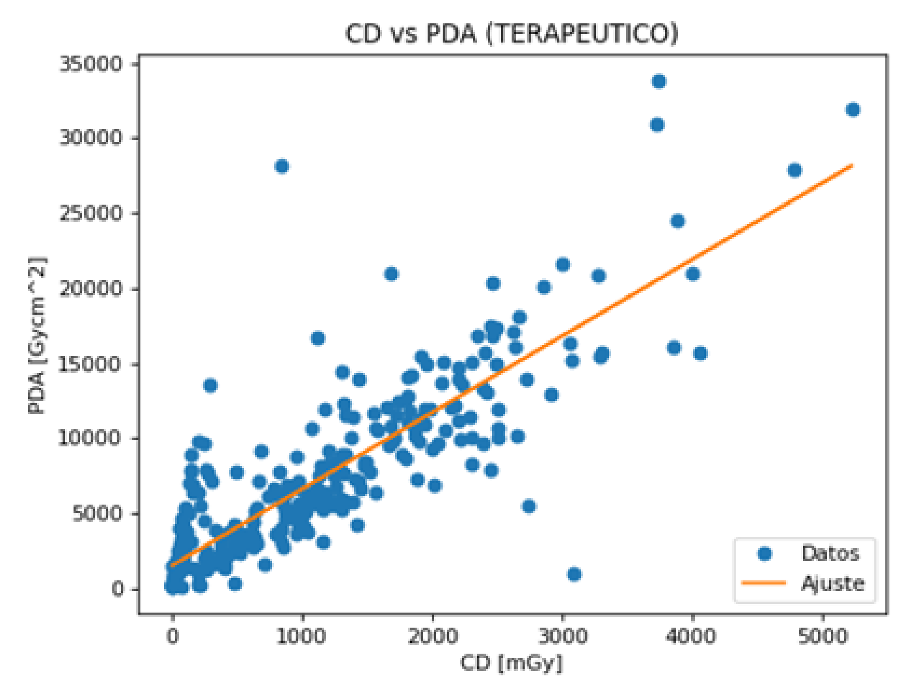

Fig. 4. TL glow curve of:$LaAlO_3$:Pr^{3+} and --- ZrO2 films (at UVR exposure)

CONCLUSIONS

AI has initiated a difficult road shift in health care, powered by the increasing availability storage of health care data and rapid changing of the technology revolution. It is expanding its footprint in clinical radiology systems, including databases, image, and interventional cardiology procedure systems, evidence-based, real-time clinical decision support, and the most important them, AI is a great tool for reducing dose during IC procedures. AI leaves at IC staff a guide for future synergistic interaction between man and machine concerning dose optimization, which ultimately will transform IC good practice in efforts to patient dose reduction

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