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3 **Physician's knowledge on X-ray exposure from CT scans in**
4 **a Moroccan hospital**
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7

8 **Abstract**

9 **Background:** Computed tomography (CT) is a major source of ionizing radiation exposure in medical
10 diagnostic. Patients more exposed related to radiation are supposed to be more susceptible to health risks.

11 **Purpose:** The aim of this study was to assess physician's knowledge of radiation doses and potential health risks
12 of radiation exposure from CT.

13 **Materials and methods:** A standardized questionnaire was distributed to physicians. The questionnaire covered
14 the demographic data of the prescriber, the frequency of referrals for CT scan examinations, the physicians'
15 knowledge of radiation doses, the potential health risks of radiation exposure from CT scan and training on
16 patients' radiation protection. The data were analyzed using the Statistical Package for the Microsoft Office
17 Excel 2007.

18 **Results:** A total of 72 physicians (55%) completed the questionnaire. Ninety nine percent of the practitioners'
19 prescribe CT examinations for patients during their exercises but only 10% of physicians use the guideline
20 during CT prescriptions. Thirty eight percent of prescribers took into account the ratio benefit/risk related to x-
21 rays during radiological exam prescription. While 4% of prescribers' explained the risk related to x-rays to the
22 patients during radiological exam prescription, 14% of physicians have correctly estimated the effective dose
23 received during an abdomen pelvic scan compared to the dose of a standard chest x-ray radiograph in an adult.
24 Fifty four percent of doctors underestimated the lifetime risk of fatal cancer attributable to a single computed
25 tomography scan of the abdomen pelvic and 8% of practitioners have received formal training on risks to
26 patients from radiation exposure.

27 **Conclusion:** The present study showed the limited knowledge of radiation exposure for the Physicians.
28 Recurrent training in advanced radiation protection of patients could lead to significant improvements in
29 knowledge and practice of CT prescribers.
30

31 **Key words:** CT scan examinations; Patients' radiation protection; X-ray risks.
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33 **1. Introduction**
34

35 Every day in each hospital, physicians use various X-ray technologies to screen diagnose,
36 stage and treat cancers with the aim of saving lives¹. The use of CT in medical diagnosis
37 delivers radiation doses to patients which are higher than those from other radiological
38 procedures. Biological effects resulting from the accumulation of low doses received during
39 repetitive diagnostic medicals imaging could be harmful. The cancer radiogenic is well
40 documented^{2,3}, indeed the lifetime attribute to the risk of cancer is 1 for every 82 in high-use
41 groups⁴ and 1 in every 1000 CT abdomen pelvic examination⁵. For example, in the United
42 Kingdom, it has been estimated that 100 to 250 death cases occur each year because of
43 the radiological exposures^{6,7}.

44 In any diagnostic procedure the dose of radiation delivered should be ^{8, 9} just enough to
45 answer the relevant clinical question. Moreover, it should be as low as reasonably achievable
46 to minimise the risk to the patient. It is very important that physicians who prescribe
47 radiological imaging should be well trained in deciding whether diagnostic imaging is
48 necessary and have an accurate knowledge of the associated risks.

49 The absence of studies on doctor's knowledge in Moroccan Hospitals and the lack of
50 knowledge on the medical exposure per inhabitant in Morocco ^{10,11,12,13} initiated us to
51 undertake the current study. The aim of this study is to assess knowledge of patient radiation
52 exposure from CT examinations prescribed in Hassan II Hospital.

53

54 **2. Materials and Methods**

55 **2.1. The study population**

56 Out of the 130 physician's practitioners in our hospital, 72 participated in the questionnaire
57 giving a response rate of 55%. There were 42 men (sex ratio 1.4). The study group contained
58 the General practitioners, Interns, Surgeons and Medical specialists. The percentage of each
59 specialty was respectively 10%, 19%, 36% and 37%. The average professional experience for
60 all participants was $10,29 \pm 0,83$ years with 58% of them having more than 10 years of
61 experience.

62 **2.2. The questionnaire**

63 The investigated population included the prescribers of CT scans in Hassan II hospital. In
64 total, the entire population studied comprised 130 practitioners. The participants in this study
65 have received a standardized questionnaire.

66 The 16 sections of the questionnaire were designed to evaluate the current practice regarding
67 the prescriptions of CT examinations. The questionnaire covered five main areas:

68 The first requested demographic data of prescriber (department, gender, qualification, years of
69 experiences). The second section included questions and it aimed at investigating how
70 frequently doctors prescribe CT scans, use a guide of medical imaging examinations before
71 prescription. Also it focused on their knowledge of using x rays benefit / risk ratio and asked
72 if patients were routinely informed about possible health risks. The third section tackled
73 doctors' knowledge on radiation doses which can be evaluated via two approaches: On the
74 one hand participants were asked to compare the average effective dose received during CT
75 scan of Abdomen pelvic and Radiography Skull examinations which have been evaluated at
76 ≈ 11 mSv and $\geq 0,07$ mSv respectively⁵. On the other hand, evaluate the average effective

77 dose received during CT scan of Abdomen pelvic examination. The fourth dealt with
78 prescriber's knowledge of the risk of cancer induction after one CT scan Abdomen pelvic
79 examination. Finally, we asked doctors if they had already received training with regards to
80 radiation protection.

81 **2.3. Statistical analysis**

82
83 The data were analyzed using the Statistical Package for the Microsoft Office Excel 2007.
84

85 **3. Results**

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87 **3.1. Current Prescribers Practice Regarding CT Examinations**

88 Ninety nine percent of respondents to the survey were prescribers of CT examinations. The
89 physicians non prescribers were Medical specialists in dermatology. Only 8% of our study
90 group used a guideline for prescribing the less irradiating exam. It was constituted by 33% of
91 Interns and 20% of General practitioners. Thirty eight percent of them said that they take into
92 account the benefit /risk ratio of X-rays when prescribing a scanner, while 54% sometimes
93 use it and 8% never. The benefit/risk of X-rays is still considered by 42% of senior doctors
94 and only 17% of juniors. Only 4% of practitioners have always informed patients about the
95 probable risks due to their exposure to X-radiation, while 68% did so occasionally and 28%
96 never. Thus only 5% of Physicians seniors have always passed such information to the
97 patient, while Interns represent 0%.

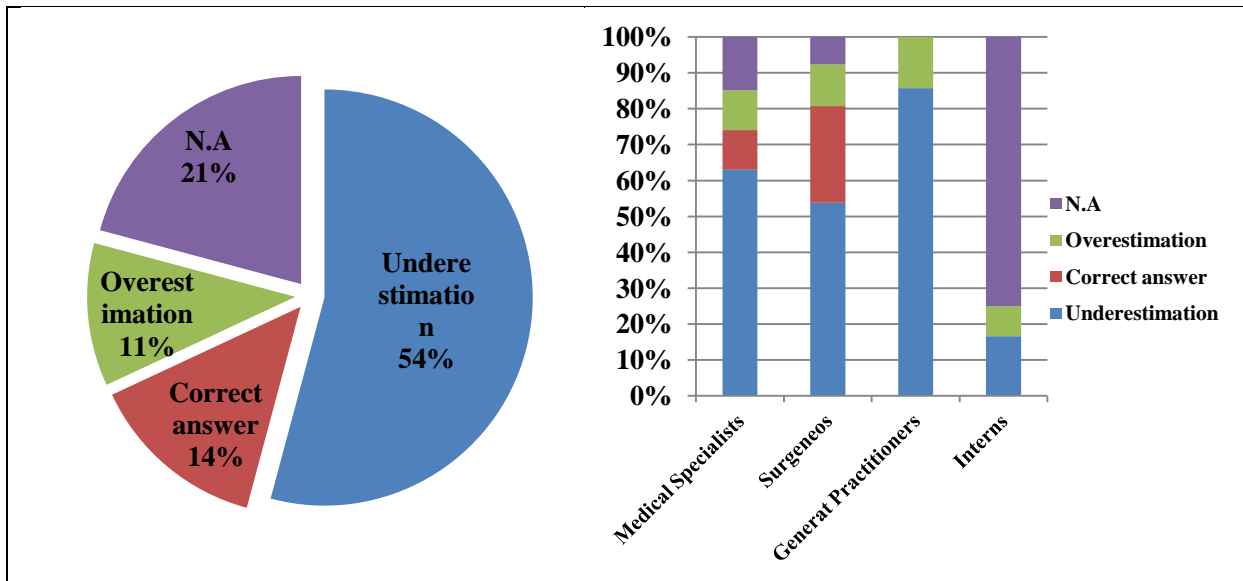
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99 **3.2. Knowledge of Doses and Health Risks Related to Radiations by Doctors**

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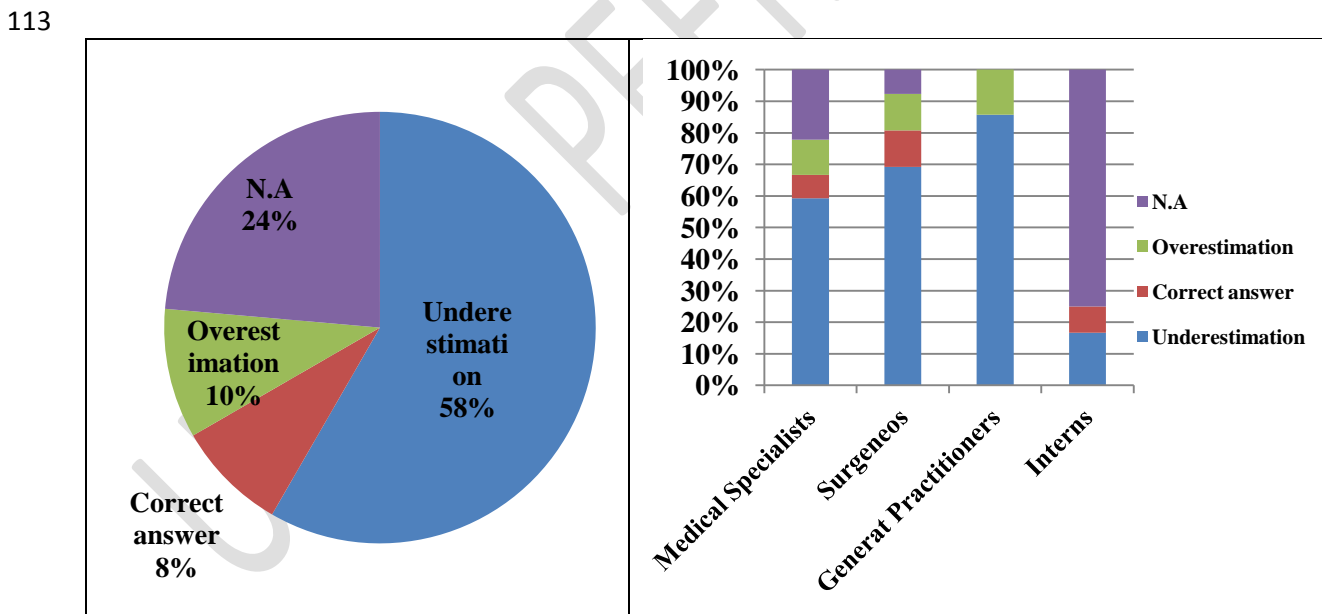
101 On the assessment of the effective dose received during an abdomen-pelvic CT compared to
102 chest X-ray front, 14% of our practitioners had correctly assessed that dose. 11% had
103 overestimated it while 54% of practitioners had underestimated it and 21% have no answers,
104 regardless of the different specialties (Figure 1).

105



106 **Figure 1:** Assessment of knowledge of the effective dose received during an abdomen-pelvic CT comparatively
 107 to an adult chest radiography by physicians per speciality.

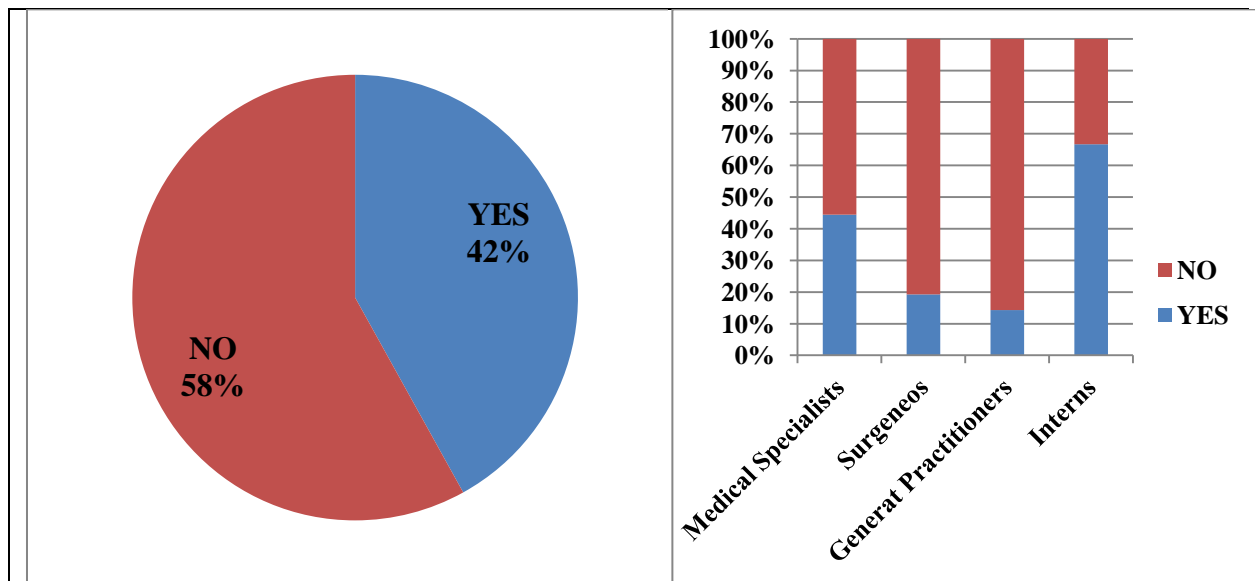
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 109 During the absolute evaluation of the dose delivered during a standard abdomen-pelvic CT,
 110 with reference to natural radiation in Morocco estimated to average 2.5 mSv per year, 8% of
 111 practitioners had correctly assessed the dose. 10% of prescribers had overestimated it, 58%
 112 underestimated it while 21% had expressed no opinion (Figure 2).



114 **Figure 2:** Assessment of the knowledge of effective dose received during an abdomen-pelvic CT comparatively
 115 to annual background exposure in Morocco by physicians per speciality.

117 Estimations of doses delivered were misjudged, and the risk of radiation-induced cancer were greatly
 118 underestimated since a large majority of practitioners (58%) had replied that there was no risk of
 119 radiation-induced cancer due to the realization of one abdomen-pelvic CT (Figure 3).

120 .



121 **Figure 3:** Assessment of knowledge on radiation-induced cancer after one abdomen-pelvic CT by physicians per
 122 speciality.
 123

124 3.3. Further Education and Training:

125 Only 8% of clinicians had already benefited from training in radiation protection of patients. The more
 126 detailed analysis showed that neither Intern, General Doctor nor Surgeon had received training of this
 127 type while only 20% of Medical Specialists have received such training.

128 4. Discussion

129 Our study group showed that Physician's knowledge of radiation exposure from medical
 130 imaging is insufficient, and that is due to the fact that they don't inform their patients of the
 131 risks of radiation exposure, and they underestimate radiation exposure of frequently used
 132 diagnostic imaging and the associated risks.

133 Only 8% of physicians of this study used a guideline during prescriptions of CT exam. Yet the
 134 European directive on the radiation protection for medical purposes requires justification of
 135 the radiological procedure which is one of the necessary steps to obtain the radiation
 136 protection of patients as part of a quality assurance process ¹⁴. The lack of use of referral
 137 guidelines could be explained by the Moroccan radiologists by the absence of national
 138 protocols ¹⁵. Thirty eight percent of prescribers in our study group took into account the ratio
 139 benefit/ risk. This result is much lower than 70% reported by Gervaise et al. in a similar study
 140 for a population of French hospital doctors ⁵. As well, It is twice more than 15.6% reported
 141 by Faragai et al. in a similar study for a population of Nigerian doctors ¹⁶. Only 4 % of our
 142 physicians group have explained the x ray risk to the patients during prescription. This result
 143 is much lower than 22% reported by Lee et al. in a similar study for a population of

144 emergency physicians in USA ¹⁷ and than 25% reported by Gervaise et al. in a similar study
145 for a population of French hospital doctors ⁵. The knowledge on radiation doses in our study
146 group is limited. In detail, we asked to compare the average effective dose received during an
147 abdomen pelvic CT scan in adults to a standard chest radiograph. Only 14 % of the study
148 participants answered correctly. This result is lower than 30% reported by Lee et al. in a
149 similar study for a population of emergency physicians in USA ¹⁷. And it is also less than 32,5
150 % obtained by Merzenich et al. in a similar study in Germany ¹. It is more than 13 % reported
151 by Gervaise et al. in a similar study for a population of French hospital doctors ⁵. The
152 physician's knowledge on the lifetime risk for the development of cancer after one abdomen
153 pelvic CT examination was answered correctly by only 42% (approx.1 cancer death per 1,000
154 deaths) of responds in our study group^{18,19}. This result is higher than 12,5 % reported by Jacob
155 et al. for a population of hospital doctors ²⁰. It is approximately the same as the 31% obtained
156 by Rice et al. for a population of paediatrics surgeons ²¹. It is higher than 39% reported by
157 Gervaise et al. in a similar study for a population of French hospital doctors ⁵. The poor
158 knowledge results achieved in this study could be explained by many factors: About 92% of
159 the questioned doctors reported that they have never undergone formal training on patients'
160 radioprotection. This reflects a poor knowledge of the principles of radiation protection by our
161 clinicians. This result is higher than 75 % reported by Gerben et al. for a physician population
162 of the Australian emergency departments ²², and higher than 34% reported by Gervaise et al.
163 in a similar study for a population of French hospital doctors ⁵.

164 **5. Conclusion**

165 The objective of this study was to explore physician's knowledge of patients' radiological
166 protection when prescribing their CT exams. The results obtained showed limited knowledge
167 of radiation exposure for the physicians. Recurrent training in advanced radioprotection of
168 patients could lead to significant improvements in the knowledge and practice of CT
169 prescribers.

170 **Competing Interests**

171
172 Authors have declared that no competing interests exist.

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