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Insights into patient awareness and preferences in medical imaging procedures involving ionizing radiation

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Abstract

Introduction: Advancements in technology have revolutionized the landscape of medical imaging, offering a multitude of modalities. However, this progress is not always fully traceable to patients, necessitating studies in this area to bridge the gap between technological advancements and patients' insights. This study delves into patient awareness, preferences, and understanding concerning radiation risk in medical imaging procedures using ionizing radiation.

Material and methods: An anonymous survey was conducted among 152 patients in Bulgaria who underwent X-ray procedures to gauge their insights into medical imaging. Data analysis utilized SPSS version 20.0, computing frequencies and percentages for categorical variables like gender, age, and education.

Results: Significant correlations were found between gender and the need for knowledge related to radiation risks ($\chi2 = 4.622$, $p = 0.032$), as well as patient understanding of radiation dose information and decision-making preferences ($\chi2 = 10.800$; $p = 0.020$). Female participants showed higher awareness levels in these areas compared to male participants. Younger patients, notably aged 36-50 (52.6%), comprised a significant portion undergoing X-ray imaging, diverging from global trends. Age correlated with the frequency of X-ray examinations ($\chi2 = 171.256$; $p = 0.000$) and decision-making preferences ($\chi2 = 8.324$; $p = 0.016$), with older patients favoring informed decisions with physician input. Education levels significantly influenced radiation risk awareness ($\chi2 = 7.084$, $p = 0.008$) and understanding of radiation dose information ($\chi2 = 14.752$, $p = 0.001$). Patients with higher education levels demonstrated a significantly better understanding of absorbed radiation doses compared to those with secondary education. These findings highlight the influence of demographic factors such as gender, age, and education on patient awareness, knowledge acquisition, and decision-making processes regarding medical imaging and radiation risks.

Conclusions: Tailored communication strategies, informed consent practices, and ongoing specialist education are crucial to enhancing patient awareness, optimizing decision-making processes, and ensuring radiation safety in medical imaging. Implementation of electronic health records can further improve radiation exposure monitoring, aligning with evolving technological standards and patient needs.

Keywords: radiation protection; X-ray imaging; patient awareness.

Introduction

Advancements in scientific knowledge and technology have revolutionized the landscape of medical diagnosis and therapy, offering a multitude of modalities to healthcare providers. However, with these advancements come new challenges, particularly concerning the increased use of ionizing radiation in medical procedures.[1] This evolution has led to a notable rise in the number of medical procedures utilizing ionizing radiation, ranging from diagnostic imaging modalities like computed tomography (CT) and positron emission tomography (PET) scans to interventional procedures guided by X-rays.[2] Interventional techniques that employ ionizing radiation often necessitate higher doses compared to conventional methods,[3] reflecting a paradigm shift in medical practices. As medical services strive for higher quality and precision, there is a parallel emphasis on adhering to radiation protection principles. Optimizing medical exposures involving ionizing radiation is paramount, emphasizing the need for meticulous consideration and adherence to established guidelines and standards.[4,5]

Authors' contribution:
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article.

Radiation protection has always been based on the latest understanding of the biological effects caused by radiation exposure. Regarding tissue responses, the International Commission on Radiological Protection (ICRP) noted that in the absorbed dose range <100 mGy, tissues were not observed to exhibit relevant clinical functional impairment. This judgment applies both to single doses and to situations where these low doses are experienced in a sustained form such as repeated annual exposures.[6] With regard to stochastic effects, the conclusions of the ICRP are that, for the purposes of radiation protection, it is scientifically plausible to assume that the incidence of cancer or hereditary diseases will increase in direct proportion to the increase in the equivalent dose to the relevant organs and tissues, <100 mSv. Despite growing evidence that there are other health effects associated with radiation - heart disease, stroke, digestive disorders and respiratory diseases - the ICRP considers that the data are insufficient to allow their inclusion in the assessment of harm after low doses of radiation (<100 mSv).[7] Radiation damage is a concept developed by the ICRP to quantify the severity of the stochastic effects of low doses and/or low power exposures to the population. Calculating radiation damage is a complex process that requires information from a variety of sources and judgment about how to perform the calculations. In order to form a solid basis for its future recommendations, in 2016 the ICRP established working group 102 to develop a methodology for calculating damages.[8] A sensitivity analysis was performed to identify the calculation parameters and conditions that could be major sources of variation and uncertainty in the calculation of radiation damage. The results show that sex, age at exposure, dose and dose rate efficiency factor, dose assumption in lifetime risk calculation, and lethal fraction have significant effects on radiation damage values.[9] Against the background of this progress, it is imperative to assess the extent to which patients are informed about radiation risk, thereby protecting their rights as active participants in decisions concerning their health. Recognizing patients as equal partners underlines the ethical principle of autonomy in health care, which requires comprehensive and comprehensible information for informed consent and shared decision-making processes.[10]

Despite the critical importance of patient awareness regarding radiation risks from medical procedures, this issue remains inadequately explored and documented in scientific literature. Our research interest is fueled by the potential benefits of enhancing patients' awareness of ionizing radiation risks in medical diagnostics and therapy. Through rigorous investigation and analysis, new research in this area promises invaluable insights that can refine patient information processes, bolster informed decision-making, and ultimately, improve healthcare outcomes in radiology and related fields.

Material and methods

The study was conducted among 152 patients who had undergone or were scheduled for X-ray examinations and procedures in outpatient care facilities across eight cities in Bulgaria. The participants included individuals aged 19 and above.

To assess the possibilities of raising awareness about the risks of ionizing radiation in medical diagnosis and therapy, a direct anonymous survey was employed. The self-developed questionnaire consisted of 26 closed questions with predefined response options to ensure efficient data processing (APPENDIX A). Some questions permitted multiple answers within the provided options. The design of the questionnaire was informed by previous studies on patient awareness and opinions about medical radiation risks[11,12] and was extended with additional questions focusing on effective communication.

The questions were structured into the following groups: patient socio-demographic characteristics (gender, age, level of education); imaging methods assigned to patients; patient awareness of ionizing radiation in medical procedures; patients' understanding of radiation dose explanations; and patient preferences on information and decision-making.

Data analysis was conducted using professional statistical software SPSS version 20.0. Frequency and percentage were calculated for categorical variables like gender, age, and education. The statistical significance level was set at $p < 0.05$ to determine meaningful relationships and outcomes in the study.

A drawback of the study is that it focused only on diagnostic procedures, excluding therapeutic ones such as image-guided therapy. Additionally, the study was conducted in the northeastern region of Bulgaria, which may limit the generalizability of the findings to other regions.

The study protocol was approved by the Research Ethics Committee at the University (Protocol No. 115/31.03.22).

Results

The study focused on evaluating the opinions of 152 patients who have undergone or are scheduled to undergo medical imaging diagnosis procedures using ionizing radiation.

Patient Socio-demographic characteristics

Gender Distribution: The distribution of patients by gender in the study group was uneven, with a predominance of female participants at 81.6% (n = 124), while only 18.4% were male (n = 28).

Age Profile: The age range of the surveyed patients was between 19 and 80 years old, with an average age of 43.6 years (± 13 years). Patients aged 36 to 50 years old constituted the majority (52.6%), followed by those aged 51 to 65 years old (21.6%). The significant number of patients in the 36-50 age

group indicates a concerning trend towards a younger population undergoing medical imaging procedures using ionizing radiation in outpatient and inpatient care settings. These findings are even more alarming when compared to studies by other authors who reported about 20% of patients to be in the age range below 50 years.[13-15]

Education Level: The majority of patients had higher education levels – 121 individuals (79.6%), while around one-fifth had secondary education levels, constituting 20.4% or 31 individuals. These results suggest a high level of education among the surveyed patients, implying greater awareness of the surveyed issue.

Data of patient socio-demographic characteristics are presented in **Table 1**.

Imaging methods assigned to patients

We investigated what X-ray examinations the patients had most often undergone in the last one month. The results show that the most frequently prescribed X-ray examination of patients is conventional X-ray – 88.8%. In second place is dentography (59.9%), and in third place is mammography (40.8%), which can be explained by the predominant percentage of women in the study. One-third of the patients indicated that they had a computed tomography scan (30.3%), and only 2.6% of the surveyed patients underwent the highly specialized PET examination. Of interest is the group of five individuals, which is a relatively small proportion of the examined patients (3.3%), who indicated that they did not know what procedure they had undergone (**Figure 1**). A weak correlation was found between the age of the patients and the type of imaging studies that were administered to them ($\chi 2 = 171.256$; $p = 0.000$). With increasing age, the proportion of patients who underwent conventional X-ray, dentography (sectional or panoramic), mammography, computed tomography, and osteometry increased.

Given the frequency of performed radiographic procedures and the cumulative dose's impact on a patient's health, it was crucial to investigate the number of diagnostic imaging procedures performed on patients in the last year. The majority of patients reported undergoing one procedure in the last year (42.8%; n = 65). More than one-third of surveyed patients (37.5%; n = 57) reported "none," likely indicating pending procedures. Concerningly, nearly one-fifth of surveyed patients underwent two or more diagnostic imaging procedures in the last year (without clear cumulative dose information) (19.7%; n = 30) (**Figure 2**).

Table 1. Socio-demographic characteristics of the study population in public outpatient and inpatient health care facilities, Bulgaria, 2023

Variable	Characteristics	Frequency (n=152)	Percent
Sex	Female	124	81.58
	Male	28	18.42
Age	19 - 35	30	19.74
	36 - 50	80	52.63
	51 - 65	33	21.71
	65+	9	5.92
Education	Second degree	31	20.39
	Higher education level	121	79.61

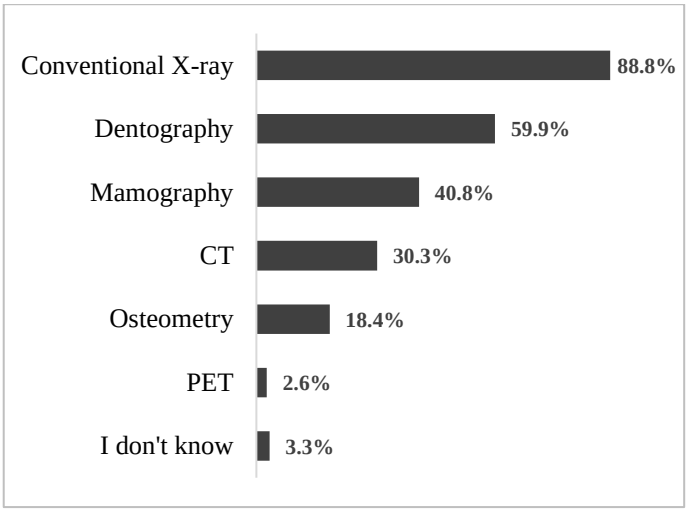

Figure 1. X-ray procedures performed among respondents in the last month

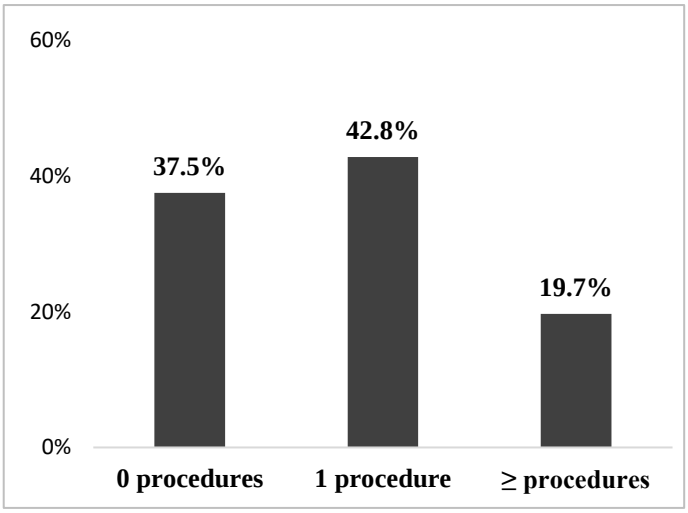

Figure 2. X-ray procedures performed among respondents in the last year

Patient awareness of ionizing radiation in medical procedures

The majority of surveyed patients (83.6%; n = 127) were informed that some diagnostic procedures they undergo involve X-rays. However, a portion of patients indicated they were not informed about the use of ionizing radiation during X-ray procedures (16.4%; n = 25). While this group is small, its existence confirms the lack of comprehensive and thorough information during the process of obtaining informed consent. This result highlights one aspect of the gaps in this bilateral process, with some patients unaware of the use of ionizing radiation in diagnostic procedures.

Patients' education level was statistically linked to their knowledge of X-ray use in some diagnostic imaging procedures ($\chi 2 = 7.084$, $p = 0.008$). The majority of patients with higher education (87.6%; n = 106) were aware of the use of ionizing radiation in certain diagnostic procedures they undergo, while the informed rate among patients with secondary education was lower at 67.7%.

We also explored the basic knowledge among the 152 survey participants regarding diagnostic procedures using ionizing radiation. When asked, "According to you, which of the listed diagnostic imaging procedures use X-rays?" with multiple possible answers, the majority of respondents (84.2%; n = 128) correctly identified conventional X-ray as using ionizing radiation. A significant portion of patients also associated mammography and computer tomography with X-ray use (respectively: 60.5%; n = 91 and 59.9%; n = 92). However, only 32 individuals (20.1%) correctly identified osteometry as using ionizing radiation, showcasing disparities in recognizing specific bone diagnostic procedures with significant radiation exposure. Meanwhile, 43 patients (28.3%) correctly identified positron emission tomography as a diagnostic procedure involving ionizing radiation. Relatively fewer patients incorrectly associated magnetic resonance imaging and echography with ionizing radiation (respectively: 24.3%; n = 37 and 6.6%; n = 10). Only 13 patients (8.6%) correctly identified all listed procedures as involving ionizing radiation, while 6 patients (3.9%) stated they were not familiar.

We asked patients whether they had discussed the risk of a particular type of X-ray examination with a medical professional. It turns out that 47 individuals out of a total of 152 patients (30.9%) discussed the risk with an X-ray technician. The majority of patients – 105 (69.1%) did not have an expert discussion related to risk assessment before the upcoming procedure.

Data on patient awareness of ionizing radiation in medical procedures are presented in **Table 2**.

Table 2. Patient awareness of ionizing radiation in medical procedures

Patient awareness	Yes	No
Undergone procedures involving X-rays	83.6%	16.4%
Diagnostic procedures using ionizing radiation		
conventional X-ray	84.2%	11.9%
mammography	60.5%	35.6%
computer tomography	59.9%	36.2%
PET	28.3%	67.8%
osteometry	20.1%	76.0%
magnetic resonance imaging	24.3%	71.8%
echography	6.6%	89.5%
correctly identified all procedures		***8.6%***

Patients' understanding of radiation dose explanations

Further analysis was conducted regarding patients' understanding of statements related to radiation dose explanations before medical imaging procedures. Three statements were assessed:

a) "The dose from a chest X-ray is comparable to the dose from natural background radiation during a one-way flight from Varna to Sofia."
b) "The radiation dose from a chest X-ray is comparable to the dose from natural background radiation received over 1.5 days."
c) "The probability of developing cancer due to an abdominal CT scan is 0.05%."

The majority of patients found the statement about the dose from a chest X-ray comparable to a one-way flight understandable (63.1%). However, one-fourth of patients expressed uncertainty, and 10% found it difficult to understand. Gender significantly influenced the understanding of this comparison ($\chi 2 = 11.631$, $p = 0.003$), with more women (67.7%) finding it easy to understand compared to men (42.9%). Also, a statistical relationship was observed between the education of the patients and the degree of understanding of the explanation of the absorbed radiation dose ($\chi 2 = 14.752$, $p = 0.001$). They can easily understand the statement 70.2% with higher education, against only 35.5% with secondary education.

Regarding the statement about the radiation dose from a chest X-ray being comparable to natural background radiation over 1.5 days, about half of the patients found it easy to understand (49.3%). Surprisingly, over one-third of patients were unsure about its clarity. The ratio of those who rated the explanation as easy to understand was 52.9% to 35.5% (higher to secondary education). Therefore, education and degree of understanding are also statistically dependent here ($\chi 2 = 7.035$, $p = 0.030$). The explanation that the radiation dose at lung radiography is comparable to the dose from the natural background radiation received in a day and a half was rated as easy to understand by 53.2% of female and 32.1% of male patients. Here, too, gender

and degree of understanding are related values ($\chi 2 = 6.547$, $p = 0.038$).

The statement about the probability of developing cancer due to an abdominal CT scan being 0.05% was found easy to understand by 60.5%. However, a significant portion of patients (27.0%) struggled to assess its understandability, with 12.5% finding it difficult to comprehend.

Data on patients' understanding of radiation dose explanations are presented in **Table 3**.

Patient preferences on information and decision-making

Regarding patients' attitudes related to the content of information about the study, we explored their expectations for information about the reason for the study appointment, about the dose and about the potential risks. In addition, we explored their preferences for independent or shared decision-making about conducting the study given this information.

The majority of patients wish to be informed about the reason for the appointment of an X-ray examination (86.2%; n = 131), while a considerable number of them do not feel this need (13.8%; n = 21). The majority of patients (74.3%; n = 113) were behind the benefit of being informed about the need to be informed about the dose of X-rays (ionizing radiation) taken during a radiological procedure. At the same time, 32 patients (21.1%) could not assess the need for preliminary information about the exposure dose before appointing a specific study. However an insignificant part of the patients (4.6%; n = 7) considered that such information would not be useful. Across all respondents, the majority believed that they should be informed about radiation risks during certain diagnostic and therapy procedures – 76.3%. The need for knowledge related to radiation risks significantly depended on patients' gender ($\chi 2 = 4.622$, $p = 0.032$). Approximately 79.8% of women indicated the need to be informed about these risks, compared to 60.7% of men.

A total of 80.3% of patients preferred being informed about dose exposure and radiation risks, and deciding together with their physician on the appropriate course of action, while 16.4% preferred being informed but letting the physician make the final decision. A smaller percentage (3.3%) opted not to be informed and left the decision entirely to their physician.

The data revealed statistically significant factors influencing patient preferences regarding their role in decision-making. Age was a significant factor ($\chi 2 = 8.324$; $p = 0.016$), with older patients showing a higher tendency to prefer being informed but allowing the physician to make the final decision or opting not to be informed at all. Gender also played a role ($\chi 2 = 10.800$; $p = 0.020$), with a higher percentage of women (84.7%) preferring to be informed and jointly decide with their physician compared to men (60.7%). Conversely, more men (28.6%) than women (15.3%) preferred to be informed but let the physician make the final decision.

Data on patient preferences for information and decision-making are presented in **Table 4**.

These findings underscore the importance of tailored communication strategies in healthcare settings, considering patients' gender, age, and education to ensure effective information delivery and decision-making processes (**Table 5**). Addressing these aspects can enhance patient engagement, improve informed consent practices, and ultimately contribute to better healthcare outcomes in radiology settings.

Table 3. Patients' understanding of radiation dose explanations

Patient understanding of radiation dose information	Easy to understand	I can not decide	Hard to understand
a) The dose from a chest X-ray is comparable to the dose from natural background radiation during a one-way flight from Varna to Sofia.	63.1%	25.7%	11.2%
b) The radiation dose from a chest X-ray is comparable to the dose from natural background radiation received over 1.5 days.	49.3%	38.2%	12.5%
c) The probability of developing cancer due to an abdominal CT scan is 0.05%.	60.5%	27.0%	12.5%

Table 4. Patient preferences on information and decision-making

Patient preferences about information content	Yes	No	I don't know
The reason for the appointment of a radiological procedure	86.2%	13.8%	
The exposure dose of a radiological procedure	74.3%	4.6%	21.1%
Radiation risks of certain radiological procedure	76.3%	23.7%	
Patient preferences on decision-making	**To be informed and make shared decisions with physician**	**To be informed but physician to make the decision**	**Not to be informed and physician to make the decision**
Preferred being informed about dose exposure and radiation risks	80.3 %	16.4%	3.3 %

Table 5. Summarized correlations between variables of patient characteristics and key study areas

Variable	Performed X-ray examinations	Patient knowledge of X-ray use in imaging procedures	Patient need for knowledge related to radiation risks	Patient understanding of radiation dose information	Patient preferences in decision-making
Gender			$\chi2 = 4.622$, $p = 0.032$	$\chi2 = 11.631$, $p = 0.003$* $\chi2 = 6.547$, $p = 0.038$**	$\chi2 = 10.800$; $p = 0.020$
Age	$\chi2 = 171.256$; $p = 0.000$				$\chi2 = 8.324$; $p = 0.016$
Education		$\chi2 = 7.084$, $p = 0.008$		$\chi2 = 14.752$, $p = 0.001$* $\chi2 = 7.035$, $p = 0.030$**	

**First statement, ** Second statement*

Discussion

The findings of this study shed light on several important aspects regarding patient awareness, preferences, and understanding related to medical imaging procedures involving ionizing radiation. These insights are crucial for developing effective communication strategies, optimizing informed consent processes, and improving patient outcomes in radiology settings. The gender distribution among surveyed patients revealed a significant predominance of female participants, aligning with broader trends in healthcare-seeking behavior where women tend to actively engage in preventive healthcare measures and diagnostic procedures.[16,17] This observation resonates with other studies that have consistently reported similar gender patterns in healthcare utilization across various medical specialties and settings.

However, what stands out significantly in our study is the age distribution of patients undergoing X-ray imaging, showing a notable contrast with global trends. While studies on a global scale indicate that approximately 20% of patients undergoing such imaging are under the age of 50, our study in Bulgaria demonstrated a much higher percentage, with 52.6% of patients falling within the 36 - 50 age range. This substantial difference underscores the importance of considering regional or national variations in healthcare-seeking behaviors, diagnostic practices, and population characteristics when interpreting study findings. Further research is warranted to delve into the factors contributing to this demographic variation, which may include cultural, economic, and social influences shaping patient behaviors and healthcare utilization patterns. Moreover, future studies should prioritize understanding and implementing the basic principles of radiation protection defined by the ICRP. These principles encompass justification, optimization, and dose limitation, which are fundamental for ensuring patient safety and minimizing radiation risks in diagnostic imaging procedures.[18]

The study also revealed a strong correlation between education levels and patient awareness regarding the use of ionizing radiation in diagnostic procedures. Consistent with findings by Takakuwa et al. (2010) and Alrasheed & Alammar (2024), patients with higher education demonstrated a better understanding of radiation risks.[19,20] This underscores the critical role of healthcare providers in ensuring that all patients, regardless of their educational background, comprehend the information provided. Implementing effective communication strategies and employing clear, accessible language can bridge potential comprehension gaps among patients with lower education levels. This proactive approach aligns with ethical imperatives, ensuring that patients can make informed decisions about their healthcare journey.

For a decision to qualify as informed, it is crucial to provide both complete and comprehensible information for the person making the decision. In the context of obtaining informed consent for diagnosis or therapy using ionizing radiation, presenting the information in an understandable manner to the patient is paramount, given the specificity of medical terminology. Previous studies on informing patients about the risks and benefits of research involving ionizing radiation have also emphasized the importance of using understandable language and appropriate formats for informed consent documents. Issues related to the length, format, and misunderstanding of the language used in written informed consent documents are common and reported in the literature.[21,22] Picano (2004) also stresses the importance of avoiding confusing terminology that patients cannot understand.[23] He suggests explaining radiation risk through comparisons with everyday life activities, such as smoking, and using graphs to illustrate the radiation risk of various procedures by comparing it to the number of chest X-rays. Our findings contribute to these discussions by revealing the level of patient understanding of different comparisons while reporting a statistically significant relationship between the understanding of certain statements with gender and patient education level.

Recent trends in medical decision making have focused on shared decision-making between patients and physicians.[24-26] Our survey also supports this trend as a significant number of respondents expressed a preference for shared decision-making with their physicians regarding radiation risks and procedures. However, it is also important to consider the results that show that decision-making is statistically significantly dependent on both gender and age. No such dependence was observed for the level of education, but this can be explained by the already discussed dependencies between education and general knowledge of patients related to ionizing radiations and understanding of radiation risk. The complexity of medical information related to radiation risks and procedures can also influence patient preferences. Patients with higher health

literacy levels or prior knowledge of radiological concepts may feel more empowered to engage in shared decision-making. On the other hand, individuals with limited health literacy or unfamiliarity with radiation terminology may prefer a more guided approach from their healthcare providers.

Of course, further studies focusing on different factors influencing decision-making are needed to interpret the results. One aspect to consider is the influence of previous healthcare experiences on patient preferences.[27] Patients who have had a positive experience with shared decision-making may be more willing to continue this collaborative approach to future medical decisions. Conversely, those who have experienced challenges or felt unheard in previous interactions may prefer a more passive role, relying on their physician's expertise. Moreover, cultural and societal factors can significantly shape patients' attitudes towards healthcare decision-making. Different cultural backgrounds may place varying levels of importance on autonomy versus deference to medical authority. Recognizing and respecting these cultural nuances is essential in tailoring communication approaches to effectively align with patients' preferences.

One effective solution to address these concerns is integrating dose information into electronic health records (EHRs) to streamline this process further.[28-30] By entering dose data into the EHR, all treating physicians and healthcare professionals involved in the patient's care can access and review this information as needed. This ensures that medical decisions regarding imaging procedures consider the patient's cumulative radiation exposure history, promoting both safety and informed decision-making in clinical practice.

Conclusion

The continuous advancement of technologies involving ionizing radiation necessitates ongoing studies to evaluate and update patient knowledge in this area. It is crucial that each new imaging technology is communicated effectively to patients to ensure their understanding of associated risks. Our study provides updated insights into patient awareness, identifying current gaps in knowledge and preferences for information. These results have practical applications in enhancing patient communication, such as identifying effective analogies and explanations to better convey the radiation risks associated with specific imaging procedures.

While advances in X-ray technology enhance medical imaging quality, staying informed about these advancements poses challenges for patients. Gaps in informed consent forms within imaging departments, including inconsistencies in information completeness, standardization, language, approach, and limitations on consent and refusal rights, can jeopardize the informed consent process. These gaps may result in patients having incomplete awareness of the risks associated with ionizing radiation in medical diagnosis and therapy, consequently impacting their decision-making regarding X-ray procedures.

The lack of a unified system for registering, reporting, and controlling X-ray examinations in the Republic of Bulgaria hinders specialists from monitoring patient doses and providing comprehensive risk information. Implementing tools like radiation passports or electronic health records to track individual radiation doses during X-ray procedures can enhance radiation exposure monitoring in medical facilities.

Regular training for specialists involved in procedures using sources of ionizing radiation is essential to stay updated on technological and scientific advancements in the field, ensuring informed consent processes align with current standards and knowledge.

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APPENDIX A

Survey questionnaire

1. Which of the following imaging methods have you undergone in the past?
   □ X-ray
   □ Tooth radiography
   □ Mammography
   □ Computed tomography/scanner?
   □ Nuclear Magnetic Resonance Imaging (MRI)
   □ Echography
   □ Osteometry
   □ Positron emission tomography /PET/CT/
   □ I don't know what method I've been subjected to.
   □ I am not subjected to any of these methods

2. How many diagnostic imaging procedures (CT (scanner), MRI, Ultrasound, X-ray, etc.) have you had in the past year?
   ○ Neither one
   ○ One
   ○ Two or more

3. Are you aware that some diagnostic imaging tests are carried out with the use of X-rays i.e. with the emission of ionizing radiation?
   ○ Yes
   ○ No

4. Which of the following diagnostic imaging procedures do you think use x-rays, i.e. include the emission of ionizing radiation?
   □ X-ray
   □ Mammography
   □ Computed tomography / scanner?
   □ Magnetic resonance
   □ Ultrasound
   □ Osteometry
   □ Positron emission tomography
   □ /PET/CT/ To be clarified
   □ None
   □ Everyone

5. Are you aware of the radiation risks (if any) associated with human health?
   ○ Yes
   ○ No

6. Do you feel the need to be informed why you have been assigned a certain x-ray examination?
   ○ Yes
   ○ No

7. Do you think it would be helpful to have information about the dose of X-rays (i.e., ionizing radiation) received during your radiology procedure?
   - ○ Yes
   - ○ I can't judge
   - ○ No

8. Do you think that the dose of X-rays (i.e. ionizing radiation) should be included in the patient's Electronic Record/ X-ray Passport?
   - ○ Yes
   - ○ I can't judge
   - ○ No

9. Have you ever discussed the risks of X-rays (ionizing radiation) with health professionals?
   - ○ Yes
   - ○ No

10. If your answer to the previous question is "Yes", with which of the following health professionals have you discussed information about the risks of X-rays (ionizing radiation)?
    - □ Medical Physicist
    - □ Nurse
    - □ Family doctor (GP)
    - □ X-ray laboratory technician
    - □ Radiologist
    - □ Another specialist / Please specify! /:……

11. Which of the following healthcare professionals do you think is best suited to provide information on the risks arising from X-rays (ionizing radiation)?
    - ○ Medical physicist
    - ○ Nurse
    - ○ Family Doctor (GP)
    - ○ Doctor - Diagnostic Imaging Specialist
    - ○ X-ray laboratory technician
    - ○ Another specialist / Please specify!/:……
    - ○ None

12. How do you prefer to get information about your upcoming imaging study?
    - ○ By talking to a healthcare professional
    - ○ Through an information brochure
    - ○ From an Internet source
    - ○ Other source / Please specify!/:……

13. Have you discussed with your doctor what is the radiation dose of a radiological procedure?
    - ○ Yes
    - ○ No
    - ○ I don’t know

14. If the answer to the previous question is "Yes", what information have you discussed?
    - ○ Detailed information concerning the radiation dose of an imaging method
    - ○ Information that the given imaging method has the radiation dose
    - ○ Other /Please specify!/.....

15. Have you discussed with your doctor what is the risk of a given imaging method?
    - ○ Yes
    - ○ No

16. If yes to the previous question, what information did you discuss?
    - ○ Detailed information on the risk of a given imaging method
    - ○ Information that there is a risk with the given imaging method
    - ○ Other /Please specify!/……

17. Have you discussed with your doctor what is the reason for the appointment of a radiological procedure?
    - ○ Yes
    - ○ No

18. If your answer to the previous question is "Yes", what information did you discuss?
    - ○ Detailed information on the reason for the appointment of a radiological procedure
    - ○ Information that there is a reason for the appointment of a radiological procedure
    - ○ Other /Please specify!/……

19. What do you think is the relationship between the radiation dose in X-ray and computed tomography(CT/ SCANNER)?
    - ○ The dose in radiography and CT (scanner) is equal
    - ○ The dose for radiography is greater than for CT scans
    - ○ The dose in computed tomography (scanner) is greater than in radiography
    - ○ I am not informed

20. Where did you get information about medical imaging in general?
    - □ Treating physician, (personal physician)
    - □ Specialists in imaging diagnostics (x-ray laboratory technicians, radiologists, nurse)
    - □ Friends and family
    - □ Internet
    - □ Books
    - □ Brochures and flyers
    - □ Other /Please specify!/.....

21. As a patient, do you prefer to be informed about the dose and risk so that you decide on a medical examination together with your attending physician? (Choose the right answer in your opinion.)
    - ○ I prefer to be informed and make a decision together with the doctor
    - ○ I prefer to be informed, but the doctor themselves to make a decision
    - ○ I'd rather NOT be informed and the doctor make his own decision

22. The following sentences present a way of explaining the radiation dose that a patient will receive during a medical imaging study. Please mark whether you clearly understand these explanations.
    a. The dose from a chest X-ray is comparable to the dose from natural background radiation during a one-way flight from Varna to Sofia.
        ○ Easy to understand
        ○ I can't judge
        ○ Difficult to understand
    b. The radiation dose from a chest X-ray is comparable to the dose from natural background radiation received over 1.5 days.
        ○ Easy to understand
        ○ I can't judge
        ○ Difficult to understand
    c. The probability of developing cancer due to an abdominal CT scan is 0.05%.
        ○ Easy to understand
        ○ I can't judge
        ○ Difficult to understand

23. What is your age?
    ……..years

24. What is your gender?
    ○ Male
    ○ Female

25. What is your education?
    ○ No education
    ○ Basic education
    ○ Secondary education
    ○ Higher education

26. What is your occupation?
    ○ Unemployed
    ○ Production worker
    ○ Employee
    ○ Manager
    ○ Freelance
    ○ Retired
    ○ Student
    ○ Teacher
    ○ Other (specify what)

□ *square indicates possibility of multiple answers*