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Slovenian patients' knowledge on radiation and radiologic imaging modalities and their expectations of informed consent discussion

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Abstract

Medical imaging is considered a useful technique for diagnostic purposes. However, radiologic procedures based on the use of ionizing radiation carry possible health risks. Consequently, patients' knowledge about radiation plays a key role in their treatment process, especially in terms of reducing unnecessary exposure. The aim of this study was to assess patients' level of knowledge regarding radiation and medical imaging procedures and to correlate it with the availability of such information provided upon x-ray imaging. Online questionnaires were distributed to patients after they underwent x-ray imaging to investigate the extent to which patients understood the procedure. We also examined whether patients took the initiative to learn about the procedure, how they perceived the radiographers, how they experienced the medical procedure, and how satisfied they were with the treatment. Information that the patients acquired from the medical professionals ($p = 0.006$) or by self-educating on the topic ($p < 0.001$) is associated with their understanding of radiation. In contrast to gender and age, a statistically significant association between education and patients' knowledge was revealed ($p = 0.008$). The results also showed an association between gender and patients' comfort during imaging, revealing that females are more likely to experience emotional distress ($p < 0.001$). Satisfaction is statistically significantly higher when patients tend to educate themselves on the topic ($p = 0.038$). Most clients were informed about why they had to undergo x-ray imaging, however, they did not receive information about radiation and its risks upon examination. This resulted in inadequate patient knowledge. In order to improve patients' awareness, comprehensive educational programs should be implemented into the clinical practice.

Keywords: radiation, awareness, patient, satisfaction, perception

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1. Introduction

Due to their noninvasive properties, radiologic imaging modalities are indispensable part of the modern medicine. Medical radiation that includes ionizing radiation, such as the x-rays or alpha and beta particles, causes cancer (Brenner & Hall, 2007; Wong et al., 2012). In contrast, modalities, such as magnetic resonance imaging (MRI) or ultrasound, are based on different, nonionizing principles and are therefore considered safe.

Multiple past studies evaluated the awareness and knowledge on radiation and associated risks among patients from different backgrounds. Although doctors are legally obliged to provide informed consent, that is, to educate the patients on the risks and benefits of a medical procedure, numerous reported results demonstrate very low levels of delivered information. Hence, significant underestimation of radiation doses and its risks among patients was found (Lee et al., 2004; Luk et al., 2010; O'Sullivan et al., 2010).

Previous research also revealed strong correlation between the lack of information and the patient's discomfort during medical imaging as well as the dissatisfaction with the medical treatment (Blue Shield of California Foundation, 2012; Martinez et al., 2009). This means that the informed consent discussion plays a major role in the patient-staff relationship as inadequate patient knowledge can hinge staff's efforts of reducing unnecessary radiation exposure.

The purpose of this study was to define the concept of informed consent, and to evaluate the effects of given information on the level of patients' understanding of radiation and radiologic imaging methods, their satisfaction and emotional state during the x-ray imaging.

2. Related work

In this section an overview of related studies is presented. Previous studies from around the world show various levels of the quantity and quality of information on the radiologic procedures that the patients received. A study from a Hong Kong hospital (Sin et al., 2012) revealed that 98.2 % respondents were informed about the reason for the prescribed radiologic procedure, however, only 49.4 % were informed about the procedure itself and its possible health effects. Alhasan et al. (2015) reported comparable results suggesting that less than 50 % of all respondents received the explanation about radiation dose they had been exposed to and its health risks. A study performed in Italy (Ria et al., 2017) concluded the majority of the patients believed that the staff-patient communication was of great importance. The respondents emphasized they wanted to receive information about imaging modality they were about to undergo, whether they would be exposed to radiation and how high would the radiation dose be. Similar findings were reported by Sin et al. (2012) who found that 95.9 % of the respondents expected to be told the reason for the radiological examination and what potential effects could they anticipate. The majority (94.6 %) even thought they should have received the exact amount of radiation dose they obtained.

However, according to previous work, very few respondents were actually educated on radiation and its potential health risks—barely 2.9 % (Steele et al., 2016). In their work, Martinez et al. (2009) reported a statistically significant correlation between the amount of information acquired during an informed consent discussion and satisfaction. Similar results were discovered in an American study (Blue Shield of California Foundation, 2012), additionally revealing that patients who did not receive enough information prior to the examination felt less involved in their own medical treatment and felt more uncomfortable asking questions. Additionally, research carried out by Alhasan et al. (2015) demonstrated a strong association between the information obtained from the medical staff and the

awareness about radiation and its potential health risks. Less than 50 % of the patients were sufficiently informed, which was shown in their questionnaires where they answered less questions correctly.

Considerable percentage of oncology patients (29 %) was found to search for information about their illness online (Metz et al., 2001). Numerous works showed that people who acquired additional information about health and various medical procedures on the internet felt more involved in their own therapeutic process. Consequently, they asked more questions and felt more comfortable discussing details with the medical staff, which lead to higher levels of satisfaction with the treatment (McMullan, 2006). Findings of a Japanese study (Kanda et al., 2014) demonstrated a statistically significant association between the amount of self-obtained information and the radiation knowledge among respondents, as people who searched for information were revealed to be more aware about medical imaging methods and radiation.

Takakuwa et al. (2010) performed an extensive analysis of the correlation between the demographic data and the patients' radiation knowledge. They showed that gender, body mass index, and personal perception about severity of the disease did not impact the patients' radiation awareness. However, younger and more educated patients showed significantly higher knowledge on the differences in radiation doses obtained during computed tomography (CT) examinations and two-view chest x-ray. A much higher knowledge of younger patients on this topics was also revealed by an Italian study (Ria et al., 2017).

Furthermore, age was found to have a statistically significant impact on both patients' emotional perception of the imaging and their treatment satisfaction. Significant association between the age and emergence of emotional distress during an examination has been reported (Chen et al., 2020; Lyratzopoulos et al., 2011). The younger patients were found to be more prone to have a negatively experience during such procedures, and consequently they evaluated their experience at the radiology department with lower satisfaction scores.

Comparably, previous work (Findik et al., 2010; Radwin, 2003) shows a correlation between level of education and satisfaction. The patients who are more educated tend to be less satisfied with the treatment at the radiology department. In contrast to the level of education, no significant association was found between the gender and emotional perception or satisfaction (Boudreaux et al., 2000; Lyratzopoulos et al., 2011).

So far, no work covering this topic has been done in Slovenia. Our study wass the first to analyze the information acquired during the informed consent discussion and the radiation knowledge among the Slovenian population in a relationship with many other aspects, such as the amount of self-obtained information, demographic data, treatment satisfaction, emotional perception of the imaging, radiographer's personal traits and environmental factors.

Based on the objective of our study, we developed a conceptual model which helped us formulate four research questions and two hypotheses. The model is based on previous research findings presented above. Figure 1 shows the part of the model that is relevant to the content of this article and covers the four research questions that we address in this paper:

1. What kind of information about radiation and imaging modalities do health care workers (physicians, radiographers) share with their patients? What are patients' expectations regarding this type of information and how satisfied are they with the amount they receive?
2. Is there an association between the information given by the health care workers and the patients' radiation knowledge, their emotional perception of the x-ray imaging

and satisfaction with the treatment?

3. Is there an association between the information that the patients obtained on their own and the patients' radiation knowledge, their emotional perception of the x-ray imaging and satisfaction with the treatment?
4. Is there an association between patients' demographic factors and their radiation knowledge, emotional perception of the x-ray imaging and satisfaction with the treatment?

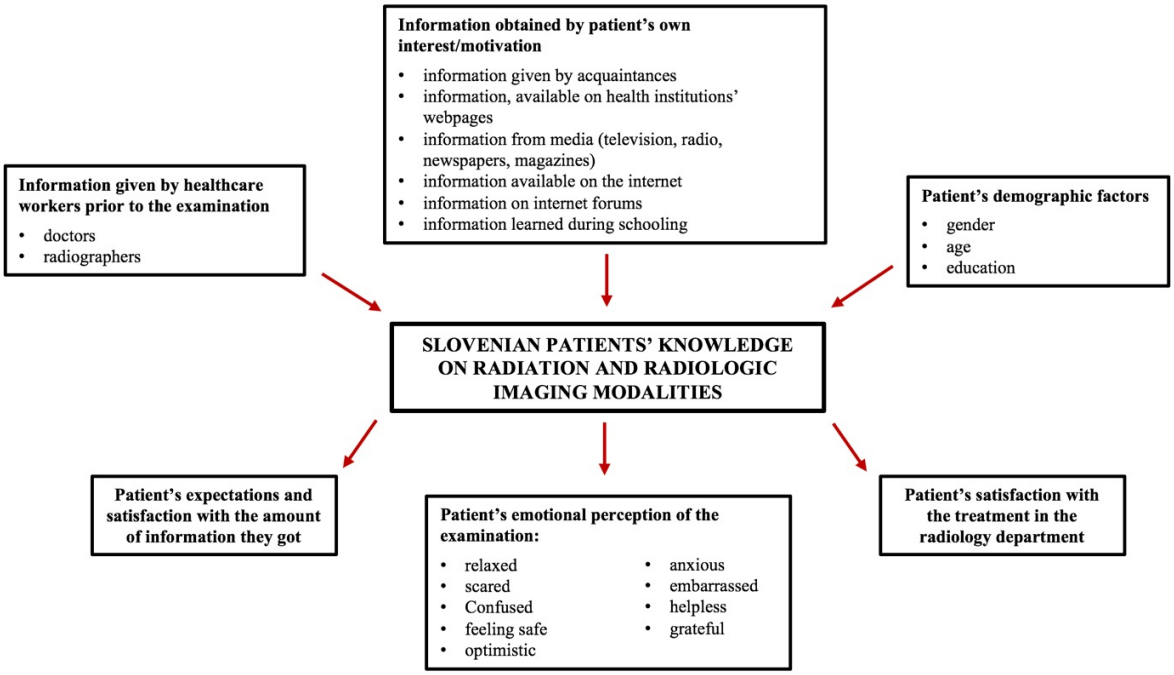

Figure 1: Conceptual model of the research displaying relation between variables

3. Methods

Our work is a cross-sectional study with online data collection mode and was conducted at one of the health centers of Ljubljana between November 2021 and January 2022. Beforehand, the study was approved by the National Medical Ethics Committee of the Republic of Slovenia (0120-390/2021/3, September 29, 2021).

The study was restricted to patients who underwent radiographic examination of the skeleton, chest, or teeth. All individuals visiting during the time of data collection were invited to participate. Because patients are scheduled strictly based on the triage process we anticipated that sampling was random and that therefore our sample consisted of statistically representative group of patients. Participation in our study was completely anonymous and voluntary. Our researchers were stationed in the waiting areas of x-ray departments, where they administered the questionnaires designed in the 1KA online platform (1KA Development Team, 2021) on laptops or tablets to the patients after they had completed their x-ray imaging.

The questionnaire was in Slovene and consisted of 38 questions in different formats, mostly using the five-point Likert scale where each number represented a certain degree of agreement with a related statement (1 = *not at all agree*, 5 = *completely agree*). It was divided

into eight sections related to demographic data, information obtained from medical staff, information that the patients acquired on their own, radiation awareness, environmental characteristics, radiographer personality traits, emotional perception of the procedure, and satisfaction with the treatment at the radiology department.

Data were manually edited in Microsoft Excel before being entered into the IBM SPSS Statistics software. Descriptive analysis was performed to obtain summary values. Results were acquired using χ^2 statistics.

4. Results

The survey was adequately completed by 206 individuals, however 19 participants refused to take part in the research. The age of the respondents ranged from 18 to 91 ($M = 54$ years). A good balance of the genders was achieved, with 98 (47.6 %) subjects being male and 108 (52.4 %) female. The study population represented a fairly educated group of people, with 93 (45.1 %) falling into a category with higher educational qualifications. There was a quite even distribution of patients undergoing either skeletal (30.6 %), chest (20.9 %) or teeth (48.5 %) x-ray examinations.

Our analysis revealed a statistically significant association between gender and emotional perception of the x-ray imaging ($p < 0.001$), however, no evidence of a relationship between gender and radiation awareness or satisfaction was found ($p = 0.190$ and $p = 0.232$, respectively). There was no association between age and radiation knowledge, emotional perception, or satisfaction found ($p = 0.459$, $p = 0.454$, and $p = 0.860$, respectively), whereas we demonstrated a statistically significant connection between education and radiation knowledge ($p = 0.008$) and a statistically non-significant relationship between education and emotional perception ($p = 0.179$). On the other hand education was found to have no effect on patient satisfaction ($p = 0.815$).

First, we explored how well the patients were informed by the physicians during the informed consent discussion, and by the radiographers prior to the x-ray imaging. The results, shown in Table 1, show that physicians generally explained why patients had to undergo radiologic imaging (81.6 %). Similarly, radiographers usually told the patients which body part was about to be x-rayed (76.2 %). However, very few health care workers informed their clients about radiation, unless they were specifically asked about it. The quality of information patients received from the health care workers was evaluated as fairly good (2.6/5). The amount of information given by both physicians and radiographers was considered satisfactory (3.8/5 and 4.1/5, respectively), however, 20.4 % of respondents wished to receive more information.

Information provided by health care professionals during the informed consent discussion was statistically significant ($p = 0.006$) with patients' radiation awareness, but no statistic significance on their emotional perception during imaging or on their treatment satisfaction was found.

Secondly, we analyzed patients' motivation to obtain radiation information by themselves. The results, shown in Table 2, suggest that many people would be interested in reading information sheets, brochures, or posters if they were available in the waiting area. 38.6 % of respondents acquired information online, particularly by reading forum topics about their health problems, imaging procedures, or radiation. 20.4 % of respondents visited the health facilities' websites prior to the examination to learn about the upcoming procedure.

Slovenian population was not particularly fond of obtaining information via the Internet;

Table 1: Information given by the health care workers prior to the examination

No.	Statement	True	False	IDK
1	The physician/dentist told me why I have to undergo x-ray imaging.	81.6	15.5	2.9
2	The doctor/dentist told me some additional information about the examination (whether it uses radiation, about its potential risks, other possible imaging methods, etc.).	6.8	85.0	8.2
3	The radiographer told me which body part/tooth will be x-rayed.	76.2	23.3	0.5
4	The radiographer told me some additional information about the examination (the examination instructions, where do I get the results and images, etc.).	60.7	38.3	1.0
5	In the future I would like to receive more information.	20.4	68.9	10.7
6	I would like to be informed about a radiation dose in an understandable way (e.g., number of cigarettes smoked).	41.7	58.3	0.0

Notes: IDK = "I don't know". Values presented as percentages ($N = 206$).

Table 2: Information obtained by patient's own interest

No.	Statement	True	False	IDK
1	I would be interested in educational documents if they were available on medical institution's website.	31.5	59.2	9.3
2	I would be interested in informative leaflets, brochures or posters if they were available in the waiting area.	66.6	27.6	5.8
3	I've read about radiation or imaging methods in the newspapers or magazines.	24.8	75.2	0.0
4	I've seen a TV documentary about radiation or imaging methods.	24.3	75.7	0.0
5	I've read about radiation, imaging methods or my health problems on internet forums.	38.3	61.7	0.0
6	I've been looking up radiation, imaging methods or my health problems on the internet.	26.7	73.3	0.0
7	While I'm waiting for my medical treatment, I often read leaflets or posters available in the waiting area.	32.5	67.5	0.0
8	Before I undergo a medical treatment, I often search the institution's website to find information about the procedure I'm about to attend.	20.4	79.6	0.0

Notes: IDK = "I don't know". Values presented as percentages ($N = 206$).

59.2 % admitted that they would probably not read any of the educational documents if they were accessible on the websites of medical institutions.

There was a strong association ($p < 0.001$) between self-procured information and the radiation awareness questions score, which showed that patients who had a higher motivation to learn about the topic answered more questions about the radiation correctly. Our study also displayed important association between self-acquired information and treatment satisfaction ($p = 0.038$), while no association was found with emotional perception

of radiologic examination ($p = 0.055$).

To analyze patients' awareness of radiation, we asked them to evaluate statements about radiation as "True" or "False". Table 3 shows that the topic with which the patients were most familiar with was the fact that x-rays are harmful to human beings and that clothing does not protect against radiation (statements answered correctly in 70.4 % and 57.3 %, respectively). 40.8 % of the respondents incorrectly assumed that MRI examinations are among the modalities of ionizing radiation. Only the minority was aware that people are exposed to radiation on flights, when smoking, and eating food. However, based on the discussion of respondents with the interviewer we advise that it should be taken into consideration that we probably received many false-positive (i.e., false-correct) responses because many people kept mentioning the dangerous effects of nicotine in cigarettes and fertilizers in food, and might choose the answer "True" because of that and not because they are, in fact, aware of radiation contribution due to smoking and certain types of food.

Table 3: Radiation awareness

No.	Statement	True	False	IDK
1	Radiation can be either harmful or harmless.	45.1	7.8	47.1
2	X-ray uses harmful radiation.	70.4	3.9	25.7
3	Magnetic resonance imaging uses harmful radiation.	40.8	10.2	49.0
4	Ultrasound uses harmful radiation.	19.9	29.4	42.7
5	Clothes completely protect the human body from harmful radiation.	17.0	57.3	25.7
6	Teeth x-ray and lumbar spine x-ray are equal in radiation dose.	17.0	26.7	56.3
7	Some organs are more prone to radiation risks than others.	38.8	7.8	53.4
8	Plane flight also exposes us to harmful radiation due to cosmic radiation from the space.	21.9	16.9	61.2
9	At home, in our house, we are safe from harmful radiation.	31.6	20.8	47.6
10	We are exposed to radiation in caves and some basements due to radon's radioactive decay.	27.2	15.1	57.8
11	Smoking also exposes us to certain radiation dose.	17.4	24.3	58.3
12	Radiation can also be found in some types of food.	17.5	28.6	53.9

Notes: IDK = "I don't know". Values presented as percentages ($N = 206$).

5. Discussion

5.1. Information obtained during an informed consent discussion

The quality of information patients received from the health care workers was evaluated as fairly good, although it should be noted that information mainly consisted of explaining the reason for performing the x-ray (by physicians) and the part of the body to be examined (by radiographers). No information about radiation or imaging modalities was introduced during informed consent discussion by physicians. The amount of information given by both physicians and radiographers was considered satisfactory, however, one fifth of respondents wished to receive more information in the future. Interestingly, the majority of patients did not want to be informed about the radiation dose they obtained during

radiologic procedures (neither given as a number nor as a comparison with some everyday event, e.g., flight duration due to cosmic radiation, number of cigarettes smoked due to harmful tobacco constituents). Similar findings were found in a publication by Blue Shield of California Foundation (2012) and in an article written by Martinez et al. (2009). Almost half of respondents believed that physicians were responsible for educating their patients about radiation and radiologic examinations.

Information provided by health care professionals during the informed consent discussion was statistically significant with patients' radiation awareness, but no statistic significance on their emotional perception during imaging or on their treatment satisfaction was found. Our findings differ from most foreign conclusions on this topic (Ria et al., 2017; Takakuwa et al., 2010), which may be due to cultural differences or due to the limited size of our study sample.

5.2. Information obtained by patients' own interest

The findings of our study suggest that the Slovenian population was not particularly fond of obtaining information via the Internet—more than half of the patients admitted that they would probably not read any of the educational documents if they were accessible on the websites of medical institutions. They prefer to obtain information from printed information materials such as flyers, posters, brochures, or pamphlets. The reason for this is probably the age structure of our sample (more than three fifths of the respondents were older than 50) and the fact that the older generations in Slovenia generally have very poor internet literacy (Eurostat, 2022). However, it has to be taken into consideration that there are very few online Slovenian sources that adequately educate individuals on radiation sources, radiation protection and anything concerning radiologic procedures.

There was a strong association between self-procured information and the radiation awareness questions score, which showed that patients who had a higher motivation to learn about the topic answered more questions about the radiation correctly. Similar findings were discovered in a study conducted in California, USA (Blue Shield of California Foundation, 2012), however, the biggest difference was that Californians were very enthusiastic about the online information platform used to educate patients and even showed greater awareness compared to those who were educated through leaflets and posters. Our study also displayed important association between self-acquired information and treatment satisfaction, while no association was found with emotional perception of radiologic examination. The latter is quite contradictory to the observations of other studies (McMullan, 2006), and since the statistical p value is very borderline, we believe that further Slovenian studies on this topic could show different results.

5.3. The demographic data

Previous work (Boudreaux et al., 2000; Lyratzopoulos et al., 2011; Takakuwa et al., 2010) found that gender has no effect on radiation awareness, emotional perception, or treatment satisfaction. Interestingly, our analysis revealed a statistically significant association between gender and emotional perception of the x-ray imaging, implying that women were more likely to experience emotional distress during such procedures. However, no evidence of a relationship between gender and radiation awareness or satisfaction was found.

In previous studies (Chen et al., 2020; Lyratzopoulos et al., 2011; Ria et al., 2017; Takakuwa et al., 2010), age was correlated with all observational variables—older respondents were discovered to have significantly less knowledge about radiation and imaging modalities, experienced less fear or anxiety, and were more satisfied with treatment at the radiology

department. In contrast, our study showed no association between age and radiation knowledge, emotional perception, or satisfaction.

Similar to previous work (Findik et al., 2010; Radwin, 2003; Takakuwa et al., 2010), we demonstrated a statistically significant connection between education and radiation knowledge and a statistically non-significant relationship between education and emotional perception. However, the results of our study suggest that education had no effect on patient satisfaction. The discrepancy between studies regarding demographic factors was likely due to differences in culture and the organization of the health care system.

5.4. Significance of the study

Our work is the first research in Slovenia that focused on the patients' radiation knowledge and on the content of the informed consent discussion. Its biggest contribution is an extensive examination of the topic in relation to numerous factors (e.g., satisfaction, emotional perception, the demographics, etc.).

Translating our findings into clinical practice could significantly improve the relationship between medical personnel and their patients, including their emotional well-being during such procedures, as well as the quality of radiological examinations. Consequently, better patient cooperation would lead to a reduction in unnecessary radiation exposures and clients would feel more involved in their own medical treatment.

6. Conclusion

This paper examined the quality of an informed consent discussion, the level of patient's knowledge on radiation, their satisfaction, and emotional perception of the x-ray imaging via a questionnaire. Most Slovenian patients who visited the radiology department at the Community Health Centre Ljubljana were informed about the referral for x-ray imaging and which body part will be examined. However, they did not receive information about radiation or risks connected to the exposure to radiation during the examination. This indicates that most patients were not aware of the possible radiation-associated risks they may have been exposed to. The findings show that patients' understanding of radiation was highly dependent on the quality of the informed consent discussion, which is why patient education and awareness should be improved to reduce unnecessary exposure and stress among patients. In some foreign countries, institutions are already utilizing various information brochures or posters with information about radiologic modalities and radiation, which we highly recommend in Slovenian medical facilities as well.

Limitation of our study is our sample structure, since it does not include many respondents who live in rural areas and are relatively less educated. Consequently this means it may not necessarily be representative of the general Slovenian population. In addition, we strongly suggest that future work extends the study to include a larger sample from different health care facilities in both the capital and the rural areas of Slovenia and to include patients undergoing more complex radiologic examinations (e.g., MRI, CT, positron emission tomography [PET], or single photon emission computed tomography [SPECT]) in order to sufficiently assess their level of radiation understanding.

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