

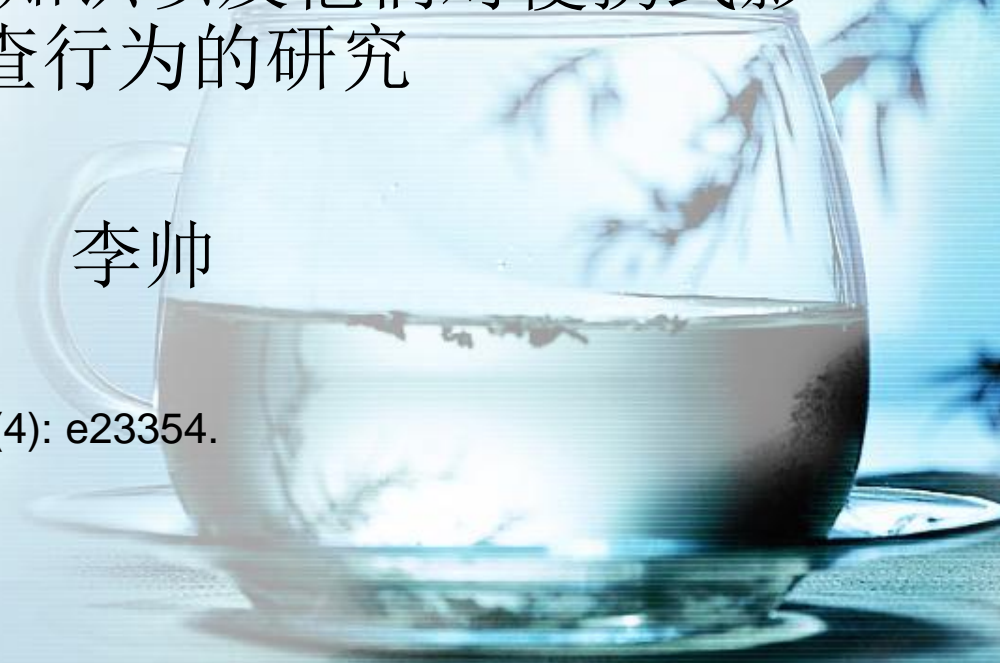
Intensive Care Nurses' Knowledge of Radiation Safety and Their Behaviors Towards Portable Radiological Examinations

对ICU护士辐射安全知识以及他们对便携式影像学检查行为的研究

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摘要1

- Background: Radiological examinations for patients who are hospitalized at intensive care units are usually performed using portable radiography devices. However they may require knowledge and safety precautions of nurses.
- Objectives: The aim of the study was to investigate ICU nurses' knowledge of radiation safety and their behaviors towards portable radiological examinations.
- 背景：对于那些在重症监护病房住院患者的影像学检查，通常是用便携式的装置。然而，他们可能需要护理人员具备安全防护的知识和措施。
- 目的：这项研究旨在探讨ICU护士辐射安全方面知识和他们对便携式放射学检查的行为。

摘要2

- **Materials and Methods:** In total, 44 intensive care nurses were recruited for this cross-sectional descriptive study using census sampling during April and May 2014. The study setting was at intensive care units of Shahid Beheshti Hospital of Kashan, Iran. An eleven-item questionnaire and a five-item checklist were used for evaluating nurses' radiation protection knowledge and behaviors, respectively. An expert panel consisting of ten nursing and radiology faculty members confirmed the content validity of the questionnaire and the checklist. Moreover, a Geiger-Müller counter was used for measuring ionizing radiation during portable radiological examinations. Study data were analyzed using the SPSS software version 13.0. Mean, standard deviation, frequency and one-sample t test were used for description of the data. The level of significance was set at below 0.05.
- **材料与方法:** 2014年四月和五月期间, 用普查抽样的方法, 共有44位ICU护士被招募为这次横断面描述性研究, 这项研究的设置是在伊朗沙希德贝赫什提医院的重症监护病房。共有11个问题的调查问卷和五个选项的量表分别用于评估护士的辐射防护知识和行为。
- 由10名护理和放射专家组成的小组证实了调查问卷和量表的效度。
- 此外, 一个Geiger-Müller计数器用来测量在便携式影像学检查期间的电离辐射。
- 使用 SPSS 13.0软件进行数据分析, 得出均值, 标准差, 频率, 单样本采用t检验, 以 $P < 0.05$ 为差异有统计学意义。

摘要3

- Results: The mean of participants' radiation protection knowledge was 4.77 ± 1.38 . The most prevalent radiation protection behavior of nurses was leaving the intensive care unit during portable radiological examinations. Only 6.8% of nurses stayed at the nursing station during radiological examinations. The highest dose of radiation was 0.11 micro Sievert per hour ($\mu\text{Sv/h}$), which was much lower than the highest permitted level of radiation exposure i.e. $0.25 \mu\text{Sv/h}$.
- 结果：参与者的辐射防护知识的平均值为 4.77 ± 1.38 。护士最普遍的辐射防护的行为是在便携式放射学检查时离开重症监护室。只有6.8%的护士在检查期间留在护士站。最高剂量的辐射值为0.11微西弗/小时，这比辐射暴露的最高允许水平即0.25微西弗/小时要低得多。

摘要4

- Conclusions: Portable radiological examinations did not expose healthcare providers to high doses of ionizing radiation. Nurses' radiation protection knowledge was limited and hence, they require in-service education programs.
- Keywords: Radiation Protection; Knowledge; Behaviors; Nurses
- 结论：便携式影像学检查的高剂量的电离辐射并未使医务人员暴露。护理人员的辐射防护知识是有限的，因此，他们需要在职教育。
- 关键词：辐射防护；知识；行为；护士

1. Background 背景

- Ionizing radiation has been increasingly used during the past decades for diagnosing and treating different medical conditions (1). However, besides its diagnostic and therapeutic effects, ionizing radiation is also associated with different side effects. Severity of side effects varies with the dose, for which there is threshold value. Beyond certain thresholds, radiation can impair the functioning of tissues and/or organs and can produce acute effects such as skin redness, hair loss, radiation burns or acute radiation syndrome. These effects are more severe at higher doses and higher dose rates. For instance, the dose threshold for acute radiation syndrome is about 1000 millisievert per year (mSv/yr)
- 电离辐射在过去十年中在不同的医疗条件下已越来越多地用于诊断和治疗。但是，除了它的诊断和治疗作用，电离辐射也具有不同的副作用。副作用的严重程度随剂量而变化，为此，辐射是有阈值的，超过一定阈值，辐射即可损害组织或器官的功能，并且能够产生急性效果，例如皮肤发红，脱发，辐射烧伤或急性辐射综合征。在高剂量和高剂量率情况下这些症状更严重。比如说，对于急性放射病的剂量阈值约为1000毫西弗每年（毫希/年）

- If the dose is low or delivered over a long period of time (low dose rate), there is greater likelihood for damaged cells to successfully repair themselves (3). However, long-term effects may still occur if cell damage is repaired but incorporates errors, transforming an irradiated cell that still retains its capacity for cell division. This transformation may lead to cancer when years or even decades have passed. Effects of this type will not always occur, but their likelihood is proportional to the radiation dose. This risk is higher for children and adolescents, as they are significantly more sensitive to radiation exposure than adults
- 如果剂量过低或经过了一段很长的时间（低剂量率），有更大的可能受损细胞成功的进行自我修复。然而，如果辐射后的细胞修复受损，发生错误，但仍保留其细胞分裂能力的情况下，长期影响仍可能存在。当几年甚至几十年过去后，这种转变可能会导致癌症。
- 这种情况不经常发生，但其发生可能性与辐射剂量成正比。儿童和青少年中这种风险更高，因为它们比成人对辐射更敏感

- Epidemiological studies on populations exposed to radiation showed a significant increase of cancer risk at doses above 100 mSv/yr (4).
- Accordingly, healthcare professionals particularly nurses are at a great risk for being exposed to harmful effects of ionizing radiation (5).
- 在暴露于辐射的人群的流行病学研究表明，在高于100毫希/年剂量的癌症的风险显著增加。
- 因此，医疗保健专业人员，尤其是在暴露于电离辐射的护士存在很大的有害风险

- One of the most common indications of radiological examinations is for patients who are hospitalized at intensive care units (ICU). The patients in these units are usually connected to different medical devices and have many catheters and tubes in place and hence, they cannot be transferred to the radiology unit for undergoing radiological examinations (6). Accordingly, radiological examinations in ICUs are usually performed by using portable radiography devices. Portable radiological examinations dramatically increase nurses' exposure to ionizing radiation (7).
- 重症监护病房（ICU）住院患者常常需要影像学检查，但他们身上通常连接有不同的医疗设备，并有许多导管，因此，他们不能被转移到放射科接受放射检查，因此，在ICU病房的放射学检查通常用便携式放射设备。便携式放射学检查大幅提高了护士接触电离辐射

Being aware of the risks of ionizing radiation as well as the probability of radiation exposure and effective strategies for radiation protection is of paramount importance for all healthcare providers particularly those who work in ICUs. Without having such awareness, healthcare professionals may either have unnecessary fear and anxiety over radiation exposure or they may fail to adopt measures to protect themselves from the adverse effects of ionizing radiation (8). The highest permitted level of occupational radiation exposure is 0.25 micro Sievert per hour ($\mu\text{Sv/h}$) or 20 millisievert per year (mSv/y) (9). However, most hospital staff wrongly believe that all doses of ionizing radiation are harmful to humans and hence they have fear over portable radiological examinations(7). The consequent overprotection or under protection may cause considerable damage to patients and healthcare providers' health.

- 意识到电离辐射的风险和辐射暴露的可能性。对医务人员来讲，辐射防护是最重要的，尤其是那些工作在加护病房的人。没有这种认知，医疗保健专业人员要么在辐射暴露时有不必要的恐惧和焦虑，要么他们可能不能采取措施保护自己免受不良影响。允许的最高水平的职业辐射量是**0.25**微西弗每小时或**20**毫西弗/年，然而，多数医院的工作人员错误地认为，所有剂量电离辐射对人体是有害的，因此他们对便携式放射检查感到恐惧。随之而来的过度保护可能会对患者和医务人员的健康造成相当大的伤害。

- Studies have shown that nurses have limited knowledge of radiation safety, exposure and protection (8). Rassin et al. evaluated radiation knowledge and attitude of 68 physicians and 76 nurses who were working in high-exposure clinical settings. They found that more than 70% of physicians and nurses had limited knowledge regarding hazards of radiation, amount of environmental radiation of each radiological examination, and radiation protection strategies (10). Amiri et al. also investigated a group of Iranian radiology technicians' radiation protection strategies. They found that 94.7% of the technicians adopted self-protection strategies while only 26.3% of them employed strategies for protecting patients and other healthcare professionals (11), however, in our literature review no study describing Iranian nurses' knowledge was found.
- Reliable sources indicated that there is a knowledge gap in the area of ICU nurses' knowledge and behavior concerning protection against portable radiation. Moreover, there are major conflicts between Iranian nurses and hospital administrators regarding the safest place during portable radiological examinations. Accordingly, this study was conducted to fill this knowledge gap and to provide further evidence regarding nurses' radiation protection knowledge and behavior.
- 研究表明，护士在辐射安全，暴露和保护方面知识有限。Rassin等人评估了在高曝光条件下工作的68名医生和76名护士辐射方面的知识，他们发现，超过70%的医生和护士在关于辐射危害，辐射环境、各影像学检查，及辐射防护策略等方面知识有限。Amiri等人。还调查了一组伊朗放射科技术人员的辐射防护策略。他们发现94.7%的技术人员采用了自我保护的策略，而只有26.3%的人为保护病人和其他医疗保健专业人员采取了措施，然而，在我们的文献回顾中还没有关于伊朗护士相关知识的研究。
- 可靠的消息指出，关于便携式辐射防护，ICU护士的知识和行为是有缺口的。此外，在便携式影像学检查中最安全的地方在哪里，伊朗的护士和医院管理者之间是有冲突的。因此，本研究旨在填补这一知识缺口，以及提供给护士有关辐射防护知识与行为的进一步证据。

2. Objectives 目的

- The aim of the present study was to investigate ICU nurses' knowledge of radiation safety and their behaviors towards portable radiological examinations.
- 本研究的目的是调查ICU护士关于辐射安全和便携式影像学检查的知识和行为

3. Materials and Methods

材料与amp;方法

- This cross-sectional descriptive study was conducted during April and May 2014. The study setting was the medical, surgical, and the trauma ICUs of Shahid BeheshtiBeheshti Hospital, Kashan, Iran. In total, there were 22 beds in these three ICUs at the time of the study. All 45 ICU nurses who were working in the study setting were recruited in the study using the **census method**.
- 这横断面描述性研究在2014年4至5月份实施，这项研究设置在伊朗Kashan地区的Shahid Beheshti医院的内科、外科、创伤三个ICU，共22张床位。采用**普查**的方法，在那里工作的所有45个ICU护士被纳入研究。

- We used a demographic questionnaire, a radiation protection knowledge questionnaire (RPKQ), and a checklist, all of which were researcher-made. The demographic questionnaire consisted of five questions related to nurses' age, gender, marital status, education level, and ICU work experience. The RPKQ contained eleven multiple-choice questions on nurses' knowledge of X-ray radiation safety. Right and wrong answers were specified by one and zero, respectively. Accordingly, the total score of the RPKQ was 0-11. Scores less than 5 were considered as low knowledge.
- We also used a checklist for identifying nurses' protective measures against radiation exposure. The five items of the checklist were: going out of the unit, going to the break room, staying at the nursing station, standing behind a lead apron, and using protective equipment.
- 我们使用了一个人员信息调查问卷, 一个辐射防护知识问卷 (rpkq), 和一个量表, 所有这些都是研究者自己设计的, 人员信息调查问卷包括护士年龄, 性别, 婚姻状况, 教育程度, 和ICU工作经验的五个问题。辐射防护知识问卷包含11个选择式问题, 是关于护理人员对X射线辐射安全知识的。正确和错误的答案被分别指定为1和0。因此, 对总评分为0-11分, 评分低于5被认为是知识缺乏。
- 我们还使用了一个量表, 确定护士对辐射暴露的防护措施。量表的五个选项: 离开护理单元, 去休息室, 呆在护士站, 站在铅屏后面, 使用防护设备。

Additionally, we used a Geiger-Müller counter (Summertown Co., USA) for measuring real-time ionizing radiation. This device detects and measures ionizing radiation and shows the dose of radiation on a built-in display. The unit of measurement is $\mu\text{Sv/h}$. Furthermore, mobile imaging machines were similar in all three sectors and quality control was performed by each department of the hospital at the start of each year.

An expert panel consisting of ten nursing and radiology faculty members was invited to assess the **content validity** of the RPKQ and the checklist. We asked them to rate the relevance, simplicity and clarity of the items. The means of total relevance, simplicity, and clarity scores were 0.99, 0.98, and 0.97, respectively. The content validity index of the instrument was 0.98. Moreover, the face validity of the instrument was assessed by asking ten practicing nurses to judge the readability, clarity, and comprehensibility of the items. The reliability of the instrument was evaluated by employing the test-retest method. Accordingly, ten practicing nurses were asked to complete the RPKQ twice with a two-week interval in between. The test-retest correlation coefficient was equal to 0.85.

- 此外，我们使用一个**Geiger-Müller**计数器（**Summertown**公司，美国）测量实时电离辐射，该设备检测并测量出电离辐射并在内置显示器的上显示剂量。计量单位为 **μSV** /小时。此外，在所有三个部门里移动成像机是相似的，并且每年年初医院会对其质量进行检测。
- 由十个护理学和影像学专家组成的小组被邀请参加了辐射防护知识问卷和量表内容效度的评估。我们要求他们为该项目的相关性、简洁性、清晰度打分，分别得到**0.99**，**0.98**，和**0.97**分。得到内容效度指数是**0.98**。此外，该量表的表面效度是通过询问十名实习护士该量表可读性、可理解性和清晰度来确定的，仪器的可靠性采用重复测量的方法来评价。因此，**10**实习护士在两周时间间隔下被要求完成**RPKQ**两次。得到重测相关系数为**0.85**。

- In case of any portable radiological examinations during the present study, the second author (a trained nurse) referred to the study setting and used a Geiger-Müller counter to measure ionizing radiation at predetermined locations within the ICU. This device is annually calibrating at the Secondary Standard Dosimetry Lab (SSDL) located in Karaj city of Iran. **The measurement locations were nurses' break room, nursing station, and behind a lead apron.** Each location was studied three times. The mean of the three measurements was calculated and used for final data analysis. Moreover, the same researcher observed and documented nurses' radiation protection behavior during the concurrent measurement of radiation. At the end of the study, we invited the study participants to respond to the RPKQ. Nurses responded to the items at the end of their shift in the presence of the second author.

- 为了防止研究过程中任何便携式X线检查设备带来的影响，第二作者（一个受过训练的护士）将Geiger-Müller计数器安置在预定的ICU内的位置。该装置每年在位于二级标准剂量学实验室（SSDL）在伊朗卡拉杰城市校准。测量位置在护士的休息室，护士站，铅屏后面。每个位置进行了三次测量，得出数据的平均值用于最终的数据分析。同时，观察和记录护士的辐射防护行为，在研究结束时，我们邀请参与者回答rpkq的问题。护士为他们做出改变的行为在第二作者面前做出回应。

3.1. Ethical Considerations

The University Review Board and Research Ethics Committee of Kashan University of Medical Sciences approved this study (approval letter no. 9380). The objectives of the study and existence of an observer were explained to all participants. They were all assured of the privacy of their personal information and signed a written informed consent form before participating in this study.

3.2. Data Analysis

Study data were analyzed using the SPSS software version 13.0. The mean, standard deviation, and percentage of nurses' radiation protection knowledge, the frequency of their radiation protection behaviors, and the mean of radiation dose were calculated for the final analysis. Onesample t test was used for comparing the mean radiation dose with the highest permitted level of occupational radiation exposure. The level of significance was set at below 0.05.

3.1 伦理问题

Kashan University of Medical Sciences 的大学审查委员会和研究伦理委员会认可这项研究（批准函编号 9380）。向所有参与者说明了研究的目的和一个观察员的存在。在研究前他们都签署了书面知情同意书来确保他们的个人隐私。

3.2 数据分析

数据采用SPSS 13.0软件进行分析，得到护理人员的辐射防护知识的均值，标准偏差，和百分比的计量资料，最后分析计算出辐射剂量，采用t检验对平均辐射计量与允许的最高水平的职业剂量进行比较显著性水平为0.05以下。

4. Results结果

In total, 45 nurses were recruited in the study, yet, 44 nurses replied to the study questionnaire completely. The response rate was 97.77%. Most of the study participants were females (90.90%). The age of study participants ranged between 25 and 45 years with a mean of 32 ± 5.81 years. The range and the mean of participants' work experience were 7.39 ± 3.89 and 1-15 years, respectively.

- 总的来说，这项研究参与的45位护士中44名护士完全回答了调查问卷的问题。应答率为97.77%。大多数的研究参与者（90.90%）年龄在25岁和45岁之间，平均年龄 32 ± 5.81 岁，受试者工作年限为1-15年，平均 7.39 ± 3.89 年。

The mean of participants' radiation protection knowledge was 4.77 ± 1.38 . The highest and the lowest scores were 2 and 8, respectively. The highest and the lowest scored questions of the RPKQ were question numbers 4 and 8, respectively (Table 1). Table 2 shows nurses' radiation protection behaviors. We found that 37 nurses (84%) left the ICU and missed to monitor their patients during portable radiological examinations. Table 3 shows the findings of the radiation dosimetry at different locations within the three ICUs. The highest dose of radiation was related to the nursing station of the surgical ICU. The results of the one-sample t test revealed that the mean dose of radiation was significantly lower than the highest permitted level of occupational radiation exposure (P value < 0.001 ; Table 4).

受试者的辐射防护知识的平均为 4.77 ± 1.38 ，最高分8分，最低分2分。在RPKQ量表中得分最高的是问题4，得分最低的是问题8（见表1）

表2显示了护士的辐射保护行为。我们发现，37名护士（84%）离开了ICU，在便携式放射学检查过程中错过了监测他们的病人。表3指出三个加护病房中在不同位置的辐射剂量的结果，最高剂量的辐射是在外科ICU的护士站。对单样本进行t检验，结果显示，平均剂量辐射明显低于允许的最高职业辐射暴露水平（ P 值 < 0.001 ；表4）。

Table 1. ICU Nurses' Radiation Protection Knowledge ^a

Items	Right Answers	Wrong Answers
How much is the highest permitted level of occupation radiation exposure?	14 (31.8)	30 (68.2)
What is the best place for installing barriers to protect nurses' against radiation?	13 (29.5)	31 (70.5)
What is the best material for manufacturing protective clothes?	30 (68.2)	14 (31.8)
How can we enhance our radiation safety?	34 (77.3)	10 (22.7)
Who is absolutely forbidden to radiation exposure?	20 (45.9)	24 (54.5)
How much are the dose and the quality of portable radiography compared with other imaging procedures?	23 (52.3)	21 (47.7)
What is the best protective equipment for nurses during portable radiography?	11 (25)	33 (75)
What is the safe distance from the source of radiation when performing portable radiography?	6 (13.6)	38 (86.4)
What is the best place for attaching the film badge when a nurse has worn a lead apron?	14 (31.8)	30 (68.2)
What are the best protective equipment in case of any environmental radiation exposure?	19 (43.2)	25 (56.8)
Which factor reduces conscious patients' exposure to radiation during portable radiography?	28 (63.6)	16 (36.4)

^a all of the values are presented as No. (%).

- 表1

- 1允许的最高水平的职业辐射暴露量是多少？
- 2保护护士不被辐射最好的安置屏障的地方在哪里？
- 3制造防护服的最佳材料是什么？
- 4怎样才能提高我们面对的辐射安全？
- 5辐射照射的绝对禁忌人群是谁？
- 6与其他影像检查相比，便携式X光的质量和花费怎么样？
- 7便携式X光照射时护士最好的防护设备是什么？
- 8便携式X光机工作时，从放射源算起，安全距离是多少？
- 9当护士穿着铅衣时，最好的连接地方在哪里？
- 10为了避免辐射暴露，最好的防护设备是什么？
- 11什么因素降低了清醒患者暴露于便携式X光的情形？

Table 2. Emergency Care Unit Nurses' Radiation Protection Behaviors^a

Behaviors	Values
Staying at the nursing station and monitoring patients through the central monitoring system	3 (6.8)
Going out of the unit	30 (68.18)
Going to the break room	7 (15.9)
Standing behind a lead apron	4 (9.09)
Using protective equipment	0 (0)

Table 3. The Doses of Radiation at Different Locations Within the Study Setting ($\mu\text{Sv/h}$)

Location	Unit		
	ICU 1	ICU 2	ICU 3
Nurses' break room	0.00	0.00	0.00
Nursing station	0.11	0.10	0.00
Behind a lead apron	0.00	0.01	0.00

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Table 4. Comparing the Mean Dose of Radiation With the Highest Permitted Level of Occupational Radiation Exposure

Variable	Number of Place	Mean \pm SD	Min	Max	Normal	P Value
Real-time ionizing radiation ^a	9	0.02 \pm 0.04	0	0.11	0.25	< 0.001

^a Micro sievert/hours.

5. Discussion讨论

This study examined ICU nurses' radiation protection knowledge and practice. The study findings revealed that our participating nurses had **limited** knowledge of radiation protection. Rassin et al. also reported that while more than 70% of physicians and nurses personally believed that they had great radiation protection knowledge, their knowledge was poor to moderate (10). The nurses' limited radiation protection knowledge can be attributed to limited college-based and in-service educations about radiation safety and protection. Aps (12), Salti and Whaites (13) and Ilguy et al. (14) also conducted three studies in different countries and found that dental practitioners had limited radiation safety and protection knowledge. However, Slechta, Reagan and Shah found that radiology technicians' knowledge of X-ray radiation protection was 75-82% (13-16). The discrepancies among the findings of different studies can be attributed to differences in the settings, samples, and data collection instruments of the studies.

- 本研究探讨ICU护士的辐射防护知识与行为。研究结果显示我们参与的护士关于辐射防护的知识是有限的。rassin等人也报道，虽然超过70%的医生和护士个人认为他们有丰富的关于辐射防护的知识，但实际上他们知识是缺乏的。护士辐射防护知识的缺乏是因为关于辐射安全与防护的大学教育和在职教育是有限的，Aps (12), Salti and Whaites (13) and Ilguy et al.在三个不同国家也进行了研究，发现牙科从业人员关于辐射安全与防护知识也是有限的，然而，Slechta, Reagan and Shah 发现放射技师x射线防护的知识为75-82%。不同的研究导致不同的结果，这是因为在样本设置，数据收集工具的不同

We also found that most of the participating nurses left the ICU during portable radiological examinations. In this study leaving the ICU was the most common radiation protection strategy. This finding can be related to their limited knowledge of safe distance from the source of radiation during portable radiological examinations. However, Flor and Gelbcke found that nurses who worked in catheterization laboratories did not even use the basic safety equipment because they considered such equipment as heavy and uncomfortable (17). The conflict between our findings and the findings of Flor and Gelbcke can be attributed to the fact that catheterization nurses are constantly exposed to radiation and hence, they underestimate the risks of ionizing radiation and ignore the importance of using safety equipment. Moreover, they may have limited radiation protection knowledge.

- 我们还发现，大部分护士在便携式放射学检查时离开ICU，在这项研究中离开ICU的是最常见的辐射保护策略，这个现象的发生可能是他们有限的知识，不知道在放射学检查中安全距离是多少。然而 **Flor and Gelbcke** 的研究发现在导管室工作的护士甚至没有使用最基本防护设备，因为他们认为这样的设备安全设备笨重和不舒服。我们的调查结果和 **Flor and Gelbcke** 的调查结果的不同可以归因于一个事实，即导管室的护士经常暴露于辐射，因此他们低估电离辐射和风险，忽略了使用安全设备的重要性，而且，他们可能辐射防护的知识是有限的。

- The study findings also revealed that only three nurses out of the 44 participating nurses stayed at the nursing station and continued monitoring patients during radiological examinations. Nurses who leave the ICU during portable radiological examinations may fail to diagnose patients' accidental disconnection from mechanical ventilation devices. Such accidental disconnection can cause potential complications such as hypoxia, increased length of hospital stay, and increased mortality rate (18).
- We also found that the dose of radiation in the study setting was significantly lower than the highest permitted level of radiation exposure. Cupitt et al. also reported the same findings (5). Similar findings of different studies in this area demonstrate that the dose of radiation during portable radiological examinations in different locations of clinical settings is probably lower than the highest permitted level. Accordingly, healthcare providers' fear and anxiety over radiation exposure is unnecessary.
- 研究结果还显示，**44**名护士中只有**3**名护士在放射检查期间选择在护士站连续监测病人。检查期间离开**ICU**的护士可能无法确认患者是否从医用设备上意外断开，这样的意外断开可以造成潜在的并发症，如缺氧，加重住院时间和死亡率上升。
- 我们还发现，在研究中辐射剂量明显低于允许的最高辐射暴露水平，**Cupitt et al.** 也报道了同样的研究结果。这个领域不同的研究得出相似的结论证明了在不同地点的便携式影像学检查辐射剂量临床设置可能低于允许的最高水平，因此，医务人员在辐射暴露下的恐惧和焦虑是不必要的。

- The findings of this study may guide nurses about the correct behaviors during portable radiological examinations. Eventually these actions may lead to saving time for patient care at the ICU.
- Some limitations may be noted when reading the results of the present study. This study was performed only in one medical center and the study sample size was small. Furthermore we used an analog dosimeter, which may not be as accurate as the digital version. Future studies with larger sample sizes and use of digital dosimeters may overcome these limitations.

- 本研究的结果可以指导护士在便携式影像学检查中正确的行为，最终，这些行为可能节省在ICU病人的护理时间。
- 这份研究结果有他的局限性。只在一个医疗中心进行这项研究，而且研究样本太小。此外，我们用一个模拟辐射剂量计，其数据可能不准确，未来的研究如果在更大的样本中进行和使用数字剂量计可以克服这些局限。

- The study findings indicate that portable radiological examinations do not expose healthcare providers to high doses of ionizing radiation. Accordingly, clinical settings, which have been designed and organized according to proper safety standards, can be considered safe and free from ionizing radiation during portable radiological examinations.

- 研究结果表明，便携式放射性检查没有使医务人员暴露在高电离辐射中。因此，根据已设计和组织出的适当的安全标准，在面对便携式放射学检查电离辐射时，临床环境应该是安全和自由的。

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Authors' Contributions 作者的贡献

- Mansoor Dianati, Azita Zaheri and Hamid Reza Talari were all responsible for the study conception and design. Azita Zheri performed the sampling and data collection. Fateme Deris performed the data analysis and prepared the draft of the manuscript. Mansoor Dianati critically revised the paper for important intellectual content and supervised the study.
- Mansoor Dianati, Azita Zaheri and Hamid Reza Talari 负责这项研究的构想和设计，Azita Zheri 进行采样和数据收集，Fateme Deris 执行的数据分析和完成初稿，Mansoor Dianati 严格审阅文章的重要知识内容以及监管这项研究

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