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# Fluoroscopy-use during ureterorenoscopy: are urologists concerned about radiation exposure? A nationwide survey in Belgium and The Netherlands

Michaël M. E. L. Henderickx, Joyce Baard, Harrie P. Beerlage and Guido M. Kamphuis

Department of Urology, Amsterdam UMC, University of Amsterdam, Amsterdam, The Netherlands

**ABSTRACT**

**Introduction:** To evaluate the use and awareness of radiation during URS among Belgian and Dutch urologists.

**Material and methods:** An online questionnaire was send to all members of the Belgian and Dutch Association of Urology.

**Results:** 170 urologists finished the complete questionnaire. 10% of the respondents are not familiar with the ALARA-principle. 29% starts with a KUB and 48% makes an XRPG at the beginning of the procedure. 85% uses fluoroscopy to place a wire or ureteral access sheet, 18% during stone treatment, 59% to screen for missed stones or calyces, 90% to place a JJ-stent or ureter-catheter and 23% to check for extravasation. 82% do not document radiation data. 51% does not wear a dosimeter during fluoroscopy. Almost all wear a lead apron during fluoroscopy, 47% uses additional thyroid shields and only 4% uses lead glasses. 88% intentionally reduces fluoroscopy time, 75% reduces the exposed area with a diaphragm, 72% brings the radiation source close to the patient and 44% uses pulsed fluoroscopy.

**Conclusion:** There is a wide variety in the use and awareness of radiation during URS. To further reduce radiation and its negative effect for patients and medical staff, awareness about radiation safety should increase among urologists.

**Abbreviations:** URS: Ureterorenoscopy; NVU: Dutch Association of Urology; BVU: Belgian Association of Urology

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**KEYWORDS**
Endourology; ureterorenoscopy; survey; fluoroscopy; ALARA-principle

## Introduction

According to the ALARA-principle the radiation exposure should be kept *as low as reasonably achievable* to decrease the risk of negative long-term effects of radiation for patients and medical staff [1]. These negative effects are the result of DNA and tissue damage, which can lead to an increased risk of developing cataract, malignancies, skin reactions, sterility or congenital anomalies [2–6].

Shock wave lithotripsy was the treatment of choice for renal calculi for a long time (1982–early 2000) [7]. However, over the last two decades percutaneous nephrolithotripsy and ureterorenoscopy (URS) gained in popularity [8]. The rise of these minimal invasive techniques lead to simultaneous rise in the use of fluoroscopy in urological operation rooms [8,9].

The aim of this survey was to evaluate the use and awareness of radiation during URS and the knowledge of the ALARA-principle among the members of the Dutch (Nederlandse Vereniging van Urologie, NVU) and Belgian (Belgische Vereniging voor Urologie, BVU) association of urology.

## Materials and methods

In August 2018, a hyperlink to an online questionnaire was send to all members of the NVU and BVU to assess the use and awareness of fluoroscopy during URS and the knowledge of the ALARA-principle among urologists in Belgium and the Netherlands.

The questionnaire was conducted using the web-based SurveyMonkey® system (Palo Alto, California, United States). The hyperlink to the questionnaire was forwarded through e-mail to all members of the NVU and BVU through their respective national association office, accompanied by a short description of the aim of this questionnaire. The questionnaire remained open for one month. No reminder e-mail was send.

The questionnaire consisted of 14 questions (Appendix). All questions were multiple choice.

CONTACT Michaël M. E. L. Henderickx michael.henderickx@gmail.com Department of Urology, Amsterdam UMC, University of Amsterdam, Amsterdam, The Netherlands

For six questions, respondents had the possibility to give a free text response. For three questions, multiple answers were allowed. The questions were divided into three main categories: respondents characteristics (four questions), awareness of the ALARA-principle (five questions) and the use of fluoroscopy during URS (five questions).

## Results

The online questionnaire was sent to 413 members of the NVU and 193 members of the BVU. 170 urologists (28%) responded and completed the questionnaire.

### *Respondents characteristics*

Of the 170 respondents, 74% ($n = 126$) is Dutch and 26% ($n = 44$) is Belgian. 81% ($n = 138$) works in a non-academic hospital and 19% ($n = 32$) in an academic hospital. 20% of the respondents ($n = 34$) are residents, 23% ($n = 39$) has 0–5 years of experience, 17% ($n = 29$) 6–10 years of experience, 23% ($n = 39$) 11–20 years of experience and 17% ($n = 29$) has more than 20 years of experience (Table 1).

On a monthly basis, 26% of the respondents ($n = 45$) performs 0–5 ureterorenoscopies, 47% ($n = 80$) performs 6–10 procedures, 22% ($n = 37$) performs 11–20 procedures and 5% ($n = 8$) performs over 20 procedures.

**Table 1.** Characteristics of respondents.

| | |
|---|---|
| Nationality | |
| Belgian | 26% |
| Dutch | 74% |
| Hospital | |
| Academic | 19% |
| Non-academic | 81% |
| Experience | |
| Resident | 20% |
| 0–5 years | 23% |
| 6–10 years | 17% |
| 11–20 years | 23% |
| >20 years | 17% |
| Number of URS per month | |
| 0–5 procedures | 26% |
| 6–10 procedures | 47% |
| 11–20 procedures | 22% |
| >20 procedures | 5% |

### *The ALARA-principle*

10% ($n = 17$) of the respondents are not familiar with the ALARA-principle and 6% ($n = 11$) did not take any additional radiation protection course. Of the 170 respondents, half (51%, $n = 87$) do not wear a dosimeter during fluoroscopy and only 26% ($n = 43$) always wears a dosimeter (Figure 1).

To lower the exposure to radiation, 88% ($n = 149$) intentionally tries to reduce the fluoroscopy time, whereas 75% ($n = 127$) actively collimate with a diaphragm to reduce the exposed area and 72% ($n = 122$) lowers the distance between the radiation source and the patient. Finally, 44% ($n = 74$) uses pulsed fluoroscopy during URS (Figure 2).

The vast majority of respondents (99%, $n = 169$) wears a lead apron to protect themselves during fluoroscopy, 47% ($n = 80$) uses an additional thyroid shield as protection and only 4% ($n = 7$) wears additional lead glasses. 2% of the respondents ($n = 3$) uses a lead screen. None of the respondents uses lead gloves during fluoroscopy-use (Figure 2).

### *Fluoroscopy-use during URS*

29% ($n = 50$) of the respondents starts by making a kidney, ureter and bladder X-ray before starting the actual procedure and 48% ($n = 82$) makes a retrograde ureteropyelogram at the beginning of the procedure as a standard step of the procedure. 85% ($n = 145$) uses fluoroscopy to place a guide wire, safety wire or ureteral access sheet. 18% ($n = 30$) uses fluoroscopy during stone treatment and 59% ($n = 101$) uses fluoroscopy to screen the collecting system for missed stones or calyces.

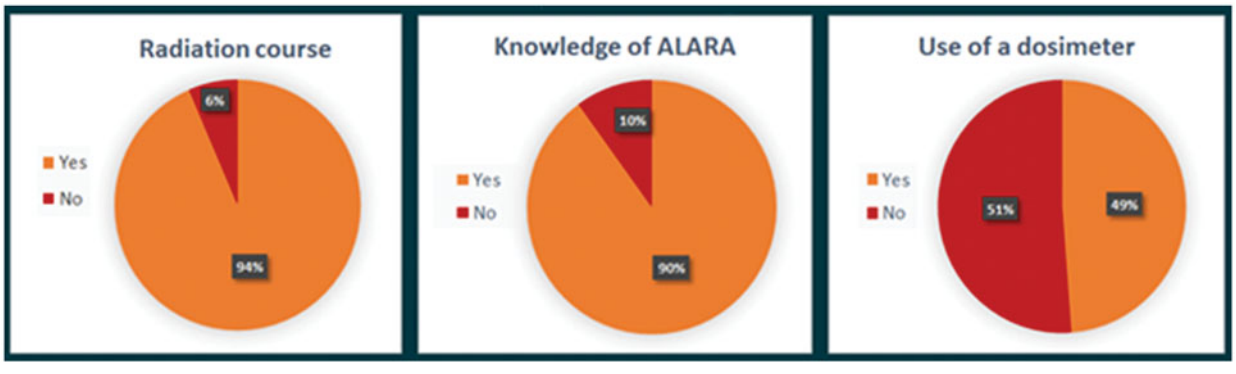


**Figure 1.** The ALARA-principle in daily practice (additional radiation protection course, knowledge of the ALARA-principle, use of a dosimeter during fluoroscopy).

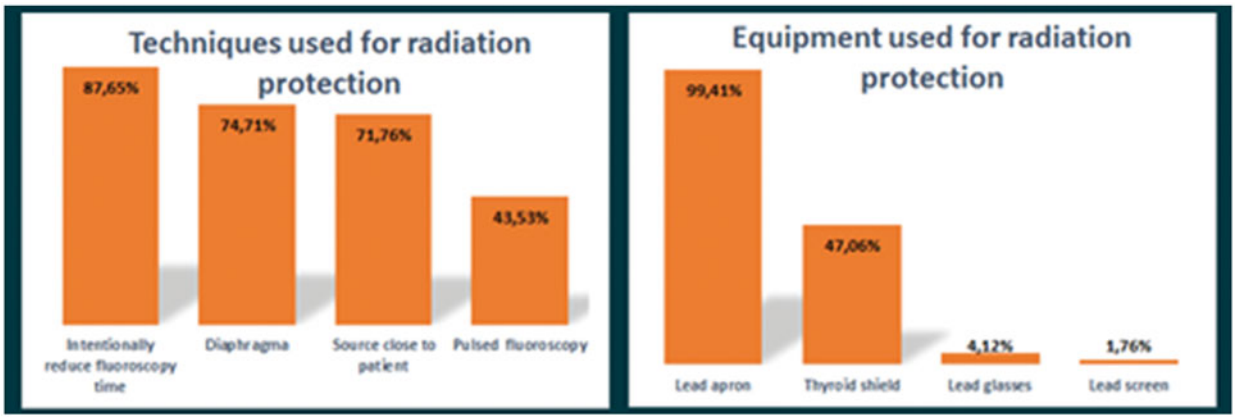


**Figure 2.** The ALARA-principle in daily practice (techniques used for radiation protection, equipment used for radiation protection).

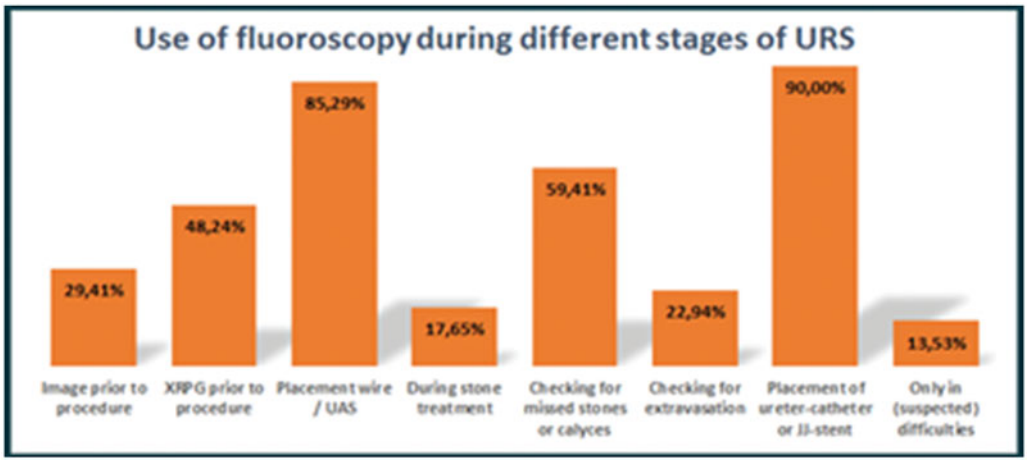


**Figure 3.** The use of fluoroscopy during different stages of URS.

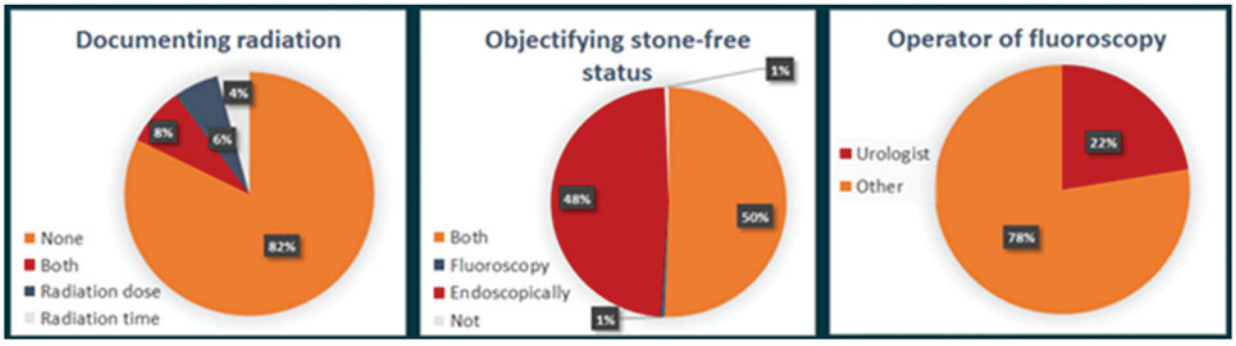


**Figure 4.** Fluoroscopy-use during URS (documenting radiation, objectifying stone-free status, operator of fluoroscopy).

23% ($n = 39$) checks for extravasation after the procedure. 90% of respondents ($n = 153$) uses fluoroscopy to place a JJ-stent or ureter-catheter. Finally, 14% ($n = 23$) only uses fluoroscopy when they expect or have difficulties (Figure 3).

22% ($n = 38$) of the respondents operates the fluoroscopy themselves, whereas 78% ($n = 132$) have a radiology technician or OR-nurse who operates the fluoroscopy (Figure 4).

48% ($n = 82$) objectify stone-free status endoscopically, where 50% ($n = 86$) uses endoscopy and fluoroscopy combined to check stone-free status. 82% ($n = 140$) do not document the radiation time or dose after a procedure, whereas 8% ($n = 13$) documents both. 6% ($n = 10$) only documents radiation dose and 4% ($n = 7$) only documents radiation time (Figure 4).

## Discussion

The rise of minimally invasive techniques to treat stones has led to a rise in the use of fluoroscopy in modern urological practice [5,9]. Consequently, radiation safety has gained in importance. Patients

and medical staff who receive high cumulative radiation exposure have an increased risk of developing malignancies, skin reactions, cataract, sterility and aplastic anemia [2,4–6].

The risk of developing malignancies increases with an increased exposure to radiation. However, no lower limit is known under which there are no harmful effects. Urologists play a key role in minimizing the radiation exposure for patients and medical staff.[5] Different studies show that medical doctors are unaware of the radiation levels they are exposed to and even underestimate the actual exposure [10–12].

This reflects in our results, where only 26% always wears a dosimeter, although 94% has followed an additional radiation protection course and 90% is familiar with the ALARA-principle. 20% of our respondents are residents, which explains why this number is not 100%. As it is mandatory for all medical personal in Belgium and the Netherlands, who operate or are actively involved in fluoroscopy, to have additional schooling in radiation protection [13,14].

Our results show that 99% of respondents wear a lead apron to protect themselves during fluoroscopy and 47% uses an additional thyroid shield. Only a minority uses lead glasses (4%), a lead screen (2%) or lead gloves (0%). These results are in line with the data from Friedman et al. [5] They describe an under usage of lead glasses (17–23%), lead gloves (10–33%) and dosimeters (26–34%) and a satisfactory usage of lead aprons (99%) and thyroid shields (24%).

Kim et al. [15] state that the use of a knee-length lead apron and thyroid shield is a minimum in the protection against radiation. The additional use of lead glasses and lead gloves could lower radiation exposure to the eyes and hands respectively with 70–92% and 76.6% [15–17]. In addition, Kim et al. [15] advocate to actively reduce the fluoroscopy time and to use pulsed fluoroscopy. They state that preoperative knowledge of the anatomy can help to reduce the need of per-operative fluoroscopy. Furthermore it is important for urologists to keep distance from the radiation source and to keep their hands out of the radiation beam. Finally they advocate the use of a dosimeter to raise awareness about the received radiation dose.

Horsburgh and Higgins [18] have similar conclusions. They found that sitting during fluoroscopy use increased the dose by 78% compared to standing, as surgeons tend to be closer to the patient when sitting, and therefore advise a standing position to perform fluoroscopically guided procedures. This study also showed a reduction in radiation dose of 67–77% with pulsed fluoroscopy, 12–47% with collimation with a diaphragm and 5–25% by increasing the distance to the radiation source, however this resulted in an increase in radiation dose for the eyes and thyroid due to scattering. These three techniques also help to lower the radiation dose for the patient.

The major limitation of this survey is the low response rate of 28% with the risk of responders bias. Urology residents and urologists with an affinity for endourology will be more likely to respond, which can lead to sampling and non-response biases [19]. Then again, not all urology residents and urologists perform ureterorenoscopy in Belgium and the Netherlands. Therefore, they should be excluded from the possible responders. Consequently, it can be assumed that the relative response rate (response rate from members performing ureterorenoscopy) is higher than the absolute response rate (response rate from all members), leading to a good overview of the awareness of radiation exposure and knowledge of the ALARA-principle in Belgium and the Netherlands. Furthermore, the response rate for this survey is higher than comparable surveys concerning endourology (14.9%, 20.7%, 23%) sent to a general population of urology residents and/or urologists [20–22].

Another limitation is the lack of evidence of unvalidated survey instruments [19,23]. This makes it hard to predict the reproducibility of this study. Hence, the obtained answers only serve to give a general image and insight on the awareness of radiation exposure and knowledge of the ALARA-principle in Belgium and the Netherlands.

This study wants to emphasize the importance of awareness of radiation exposure for the urologist, the patient and the medical staff. This can be achieved by proper knowledge of the ALARA-principle and the use of a dosimeter during fluoroscopically guided procedures. Furthermore, it is important to reduce the risks of radiation exposure by using personal protection and not to underestimate the risk for the eyes and hands during these procedures. Finally, adequate use and good knowledge of the fluoroscopy will lower radiation exposure.

## Conclusion

Fluoroscopy is commonly used during URS by urologists in Belgium and the Netherlands. A majority

is reducing negative radiation effects through additional education, personal protection and the implementation of the ALARA-principle in their daily practice. However, this survey shows a wide variety in the use of radiation during URS, suggesting differences in cumulative radiation dose and thus room to reduce both radiation and the subsequent negative effect for patients and medical staff. Therefore, awareness about radiation safety should increase among urologists.

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## ORCID

Michaël M. E. L. Henderickx http://orcid.org/0000-0002-8277-0046
Joyce Baard http://orcid.org/0000-0002-5509-0213
Guido M. Kamphuis http://orcid.org/0000-0002-4583-4231

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## Appendix

**1. In welk land bent U werkzaam?**

- ◯ België
- ◯ Nederland
- ◯ overige (geef nadere toelichting)

**2. In welk type ziekenhuis bent U werkzaam?**

- ◯ perifeer ziekenhuis
- ◯ academisch ziekenhuis

**3. Hoelang bent U reeds werkzaam als uroloog?**

- ◯ arts-assistent in opleiding
- ◯ 0-5 jaar
- ◯ 6-10 jaar
- ◯ 11-20 jaar
- ◯ >20 jaar

**4. Door wie wordt de stralenbron bestuurd tijdens een URS?**

- ◯ operateur zelf
- ◯ radioloog
- ◯ radiologie-medewerker
- ◯ overige (geef nadere toelichting)
- ◯ OK-verpleegkundige / OK-assistent
- ◯ arts-assistent / co-assistent

**5. Heeft U een aanvullende cursus radioprotectie / stralenbescherming gevolgd?**

- ◯ neen
- ◯ ja, 0-5 jaar geleden
- ◯ ja, 5-10 jaar geleden
- ◯ ja, >10 jaar geleden

**6. Is het ALARA-principe U bekend en houdt U er bewust rekening mee?**

- ◯ ja, het ALARA-principe is me bekend en ik probeer de stralenbelasting zelf bewust te beperken
- ◯ ja, het ALARA-principe is me bekend, maar ik laat het beperken van de stralenbelasting over aan de medewerker die de stralenbron bestuurt
- ◯ ja, het ALARA-principe is me bekend, maar ik hou er geen rekening mee
- ◯ neen, het ALARA-principe is me niet bekend

**7. Welke technieken gebruikt U of Uw medewerker die de stralenbron bestuurt om de stralenbelasting te beperken (meerdere antwoorden zijn mogelijk)?**

- [ ] de stralenbron dicht bij de patiënt brengen
- [ ] de doorlichtingsdosis met opzicht beperken
- [ ] de doorlichtingstijd met opzicht beperken
- [ ] overige (geef nadere toelichting)
- [ ] gepulseerd doorlichten
- [ ] diafragmeren

**8. Welke van de volgende beschermingsmiddelen gebruikt U tijdens het gebruik van röntgenstralen (meerdere antwoorden zijn mogelijk)?**

- [ ] loodschort
- [ ] loodbril
- [ ] loden halskraag
- [ ] overige (geef nadere toelichting)
- [ ] loden handschoenen
- [ ] loodscherm voor de stralenbron
- [ ] geen

**9. Draagt U bij het gebruik van röntgenstralen een dosimeter?**

- ◯ ja, altijd
- ◯ ja, meestal
- ◯ ja, soms
- ◯ neen, nooit

**10. Wat vindt U van het gebruik van röntgenstralen tijdens een URS?**

- ◯ altijd noodzakelijk
- ◯ meestal noodzakelijk
- ◯ soms noodzakelijk
- ◯ enkel noodzakelijk bij problemen
- ◯ overbodig

**11. Hoeveel URS'en voert U gemiddeld als eerste operateur of supervisor uit per maand?**

- ◯ 0-5
- ◯ 6-10
- ◯ 11-20
- ◯ >20

=

**12. Bij welke stappen van een URS gebruikt U (in de meeste gevallen) röntgenstralen (meerdere antwoorden zijn mogelijk):**

- ☐ blanco opname voor aanvang van de URS
- ☐ retrograde ureteropyelografie voor aanvang van de URS
- ☐ plaatsen van een safety wire, guide wire of access sheat
- ☐ tijdens de steenbehandeling
- ☐ beoordeling van het systeem om na te gaan dat er geen stenen of kelken gemist zijn
- ☐ beoordeling van het systeem om na te gaan dat er geen contrast-extravasatie is
- ☐ plaatsen van een ureter-catheter of JJ-catheter
- ☐ alleen bij (verdenking op) problemen met toegang, steenbehandeling of plaatsen ureter-catheter of JJ-catheter
- ☐ overige (geef nadere toelichting)

**13. Hoe bepaalt U de steenvrijheid op het einde van een ingreep?**

- ○ endoscopisch en met doorlichting
- ○ enkel endoscopisch
- ○ overige (geef nadere toelichting)
- ○ enkel met doorlichting
- ○ niet

**14. Documenteert U de per-operatieve stralingstijd en cumulatieve stralingsdosis na de ingreep?**

- ○ ja, beide
- ○ ja, maar enkel de stralingstijd
- ○ ja, maar enkel de cumulatieve stralingsdosis
- ○ neen