National survey of healthcare providers' views on the risk of inadvertent exposure of pregnant patients to ionizing radiation in Canadian radiotherapy departments

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Abstract

Background Women of child-bearing age are at risk of developing a malignancy that may require treatment with radiation therapy (RT). Radiation exposure to pregnant patients is associated with a risk of fetal malformation and death.

Methods An online survey was created and distributed to all radiation oncologists (RO), radiation oncology residents (ROR), radiation therapists (RTT), and medical physicists who were members of their respective national professional organizations ($n=2,146$).

Results Of the respondents, 317 (15%) completed the questionnaire. Only 58% of ROs/RORs remembered to discuss

the risk of RT in pregnancy most of the time. The majority (70%) of respondents did not believe or know if RTTs discussed the risks of radiation in pregnancy. In addition, 65% either thought no warning signs existed in their department or were unsure of their existence. Furthermore, only 8% of respondents believed their center had handouts for patients. Of the respondents, 9% encountered a situation where a pregnant patient was inadvertently treated with RT, while 13% encountered a situation where a pregnant patient was almost inadvertently treated with RT. There was no significant difference by province in the proportion of respondents who reported inadvertent or almost inadvertent RT in pregnancy (range, 6–24%; $p=0.20$).

Conclusion Nationally, respondents believe there are inadequate mechanisms to prevent inadvertent ionizing radiation exposure to pregnant patients and one fifth of respondents encountered situations in which a pregnant patient was, or was almost inadvertently irradiated. This suggests that national guidelines and detailed institutional policies and procedures are needed.

Keywords Cancer · Pregnancy · Radiation therapy · Radiation safety · Risk reduction

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Introduction

Women of child-bearing age are at risk of developing a malignancy that requires treatment with radiation therapy (RT), in particular breast cancer, cervical cancer, leukemia, lymphoma, and melanoma [1–5]. Radiation exposure to a developing fetus can result in growth retardation, malformations, future malignancy, and even spontaneous abortion depending on the dose received and stage of pregnancy [1,

Table 1 Survey questions

What is your occupation?	
Which Canadian province do you work in?	
How many years have you worked in this field?	
Are you male or female?	
How many linear accelerators are there at your center?	
As far as you know, as part of the radiation therapist's education session with potentially fertile patients, is it mandatory to discuss the risk of RT during pregnancy? ^a	
If you are a radiation oncologist or radiation oncology resident, how often do you remember to discuss the risk of RT in pregnancy during the initial consultation with a potentially fertile female patient? ^a	
If you are a radiation oncologist or radiation oncology resident, when you meet with the patient prior to RT planning, how often do you remember to discuss the risk of RT in pregnancy with a potentially fertile female patient? ^a	
Are warning signs/notices asking patients to notify staff if they think they might be pregnant in use at your cancer center? ^a	
Do you have any patient education materials or handouts at your cancer center specifically about the risks associated with RT in early pregnancy? ^a	
Is it mandatory for potentially fertile female patients to have a pregnancy test prior to RT planning or treatment at your cancer center? ^a	
Do you think it would be appropriate for potentially fertile female patients to have a pregnancy test prior to RT planning or treatment? ^a	
A young woman becomes pregnant just prior to starting adjuvant RT after lumpectomy for early stage breast cancer. Only after her RT is completed, is it discovered that she had been in the first trimester of pregnancy during her RT. She did not remember being told by her physician, or HCPs, that RT in these circumstances could be hazardous. There were no signs in the department warning her that she should notify her HCPs if she thought that she was pregnant. She was never given any relevant patient education materials. Who is responsible for this error? ^a	The patient's radiation oncologist The radiation therapist who administered the radiotherapy Both the oncologists and the radiation therapist The cancer institute where she was treated
In this same case, in your opinion which party would be most likely to be found liable in a court of law? ^a	The patient's radiation oncologist The radiation therapist who administered the radiotherapy Both the oncologists and the radiation therapist The cancer institute where she was treated
Does the radiation oncologist owe a "duty of care" to the patient's unborn child? ^a	
How many times have you encountered a situation where a pregnant patient was almost treated accidentally with RT, but the pregnancy was detected in time to prevent this from happening?	What anonymous details can you remember about the circumstances and how long ago did this/these event(s) occur?
Did this/these event(s) occur in Canada? ^a	
How many times have you encountered a situation where a pregnant patient was actually given RT accidentally?	What anonymous details can you remember about the circumstances and how long ago did this/these event(s) occur?
Did this/these event(s) occur in Canada? ^a	
How effective do you think the following methods are to help prevent accidental treatment of a pregnant cancer patient with RT?	Prominent display of warning signs/notices to catch the attention of patients in the department Discussion during therapist/patient education session Discussion with treating oncologist Handouts/patient education materials Mandatory pregnancy test for any potentially fertile patient prior to RT planning or treatment
Would it be helpful to have a checklist (listing the different steps taken to warn the patient about risks of RT and pregnancy and to ensure that the patient is not pregnant) to complete for potentially fertile female patients prior to any RT? ^a	
Do you think that it would be helpful to have a set of National Canadian Guidelines in place to help prevent accidental treatment of pregnant patients with RT? ^a	

^a Comments were elicited

2, 6–11]. If patients and healthcare providers (HCPs) are aware of a potential pregnancy, techniques can often be used to limit the RT dose to the fetus, or avoid RT altogether [6, 12]. It is therefore imperative that patients are aware of the risk, and mechanisms are in place to prevent inadvertent RT to pregnant patients.

A survey of RT HCPs in British Columbia (BC), suggested that inadequate mechanisms were in place to prevent inadvertent irradiation of pregnant patients [13]. The primary objective of this study was to assess whether other departments across Canada had similar concerns. Secondly, this study sought to assess HCPs opinions on which potential

Table 2 Radiation oncologist respondents' discussion at consult or radiotherapy planning

How often oncologist discusses risk of radiation during pregnancy at:		
	Consult (%)	Radiotherapy planning (%)
Never	4	9
Almost never	12	21
Occasionally	26	25
Almost always	42	32
Always	16	13

mechanisms to prevent inadvertent RT to pregnant patients would be most effective.

Methods

This study was approved by the University of British Columbia Research Ethics Board. An online survey that was created and distributed using Survey Monkey®, an online anonymous survey tool (LCC Copyright 2010), to 2,146 HCPs working in radiotherapy departments nationally. The questions asked are presented in Table 1. HCPs were invited by email to participate. This request was made to all radiation therapists, medical physicists, radiation oncologists, and radiation oncology residents who were members of their respective national organizations. Participation was voluntary, anonymous, and not compensated. The survey contained 19 multiple-choice questions with optional open-ended comment sections and is described elsewhere in the provincial pilot study [13].

Statistical analyses

Respondents' opinions were presented with descriptive statistics. Chi-square tests were used to assess differences in views on effectiveness of each potential intervention by occupation of respondent and differences in proportions of respondents who have experience with inadvertent RT by province of residence. All tests were two-sided and significance was defined by $p < 0.05$. All analyses were conducted

Table 4 Proportion of respondents who encountered a situation where a pregnant patient was or was almost inadvertently given radiotherapy

Frequency	Inadvertent radiotherapy given (%)	Inadvertent radiotherapy almost given (%)
Never	91	87
Once	7	8
Twice	1	4
Three or more times	1	1

using Statistical Package for Social Sciences, version 17.0 (SPSS, Chicago, IL, USA).

Results

Of the respondents, 317 (15%) completed the questionnaire presented in Table 1 with the highest response rate from radiation oncologists (ROs; 34%). The majority of respondents were radiation therapists (55%), followed by ROs (31%), medical physicists (10%), and RORs (4%). The mean years in practice was 11 (range, 0–37). All Canadian provinces, with the exception of Nova Scotia, were represented.

Table 2 displays how often radiation oncologists perceive they discuss the risk of RT in pregnancy. Table 3 displays respondents' views on other potential interventions that were employed at their institution at the time of the survey. Table 4 presents the proportion of respondents who have encountered a situation where a pregnant patient was inadvertently or almost treated with RT. Of the respondents, 19% reported at least one incidence where a pregnant patient was or almost was inadvertently treated with RT. There was no significant difference by province in proportion of respondents who encountered a situation where a pregnant patient received or almost received inadvertent RT (range, 6–24%; $p = 0.20$).

Figure 1 displays respondents' views on their perceived effectiveness of potential interventions to reduce the risk of inadvertent RT in pregnancy, divided by respondents' occupation. Of the respondents, 84% believed that a set of National Canadian Guidelines would be helpful to prevent

Table 3 Respondents' opinions on potential interventions already in place

	Percentage who have intervention in place		
	Yes (%)	No (%)	Do not know (%)
Discussion of risk by radiation therapist	30	45	25
Patient education materials or handouts	8	37	55
Warning signs asking patients notify staff if pregnant	35	47	18
Mandatory pregnancy tests for potentially fertile patients	6	57	37

Fig. 1 Proportion of respondents, divided by occupation, who indicated potential interventions to prevent inadvertent radiotherapy to pregnant patients are “somewhat effective” or “very effective”

inadvertent treatment of pregnant patients with RT. Of the respondents, 85% believed that a checklist would be useful that lists the different steps to warn potentially fertile females of the risk of radiation exposure in pregnancy.

Discussion

This national Canadian survey of radiation oncologists, radiation therapists, and medical physicists demonstrates that these HCPs perceive that there are insufficient mechanisms in place to prevent inadvertent RT of pregnant patients. In addition, 19% of respondents reported an incident where a pregnant patient was or was almost inadvertently treated with RT. Several potential mechanisms to prevent future incidents were supported by respondents, including the development of national guidelines for RT departments.

This national survey was performed because a survey of BC HCPs suggested they were largely unaware if mechanisms were in place to reduce the risk of inadvertent RT exposure in pregnancy in their province [13]. This national survey demonstrated that the concerns raised in BC are applicable nationally. In addition, it demonstrates that pregnant patients have received inadvertent RT in the past. The support of national guidelines suggests HCPs require assistance, rather than solely relying on remembering to discuss the risks with their potentially fertile patients.

The results of this survey are timely, given the recent highly publicized radiation errors in international media, with subsequent calls for improvements in safety in radiation oncology departments [14]. To the best of our knowledge, the radiation oncology literature is void of research exploring radiation safety in potentially pregnant women, though limited research has been performed in diagnostic radiology [15, 16]. Given the concerns raised by HCPs nationally, it is time that North American radiation oncology agencies develop national guidelines to empower local RT

departments. Furthermore, research is needed to explore the most effective methods of risk reduction in radiation oncology, including the inadvertent exposure of pregnant patients.

The results of this study should be considered in the context of its strengths and limitations. The results are potentially widely generalizable given it was administered nationally to the three occupations most central to the functioning of a RT department. However, the relatively low-response rate suggests the results may be prone to response bias, where respondents with certain characteristics (such as experience with inadvertent RT) may be more likely to return surveys and thereby result in higher proportion of reported experience with inadvertent RT in pregnancy than exists in the true population [17]. Furthermore, the high rates of support for future interventions may be a result of selection bias. Our survey also does not capture the actual number of cases in which pregnant patients are inadvertently irradiated. Therefore, the frequency of this event is not known, but is likely very low. However, the identification that RT departments across Canada have experience with inadvertent RT to pregnant patients is alarming no matter how low the actual rate is. Although the nature of study design does not allow for investigation of the actual effectiveness of proposed interventions, it can serve as a starting point for future research and potential national guideline development.

Conclusion

Almost one fifth of surveyed Canadian HCPs involved in the delivery of RT have experienced an event in which a pregnant patient received or almost received inadvertent RT. In addition, they perceive that there are inadequate mechanisms in place to prevent the inadvertent administration of RT to pregnant patients. Several mechanisms to prevent future inadvertent RT to pregnant women was supported by respondents,

including the development of national guidelines and completion of safety checklists. This research also raises the possibility that other countries, such as the USA, should investigate the mechanisms in place to protect women from inadvertent RT to pregnant patients.

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Conflict of interest The authors declare they have no conflict of interest

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