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Radiation Protection and Safety: Awareness and Implementation of the Bonn Call for Action Priorities in Canada

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Context

Medical imaging has transformed health care delivery by facilitating the early detection of disease and improving patient outcomes.[1,2] Radiology exams, however, expose patients and radiology workers to X-ray and gamma-ray radiation, which can have dose-dependent adverse effects. This kind of radiation is used in several medical imaging procedures including angiography, fluoroscopy, computed tomography (CT), and radiographic and nuclear medicine imaging.[3] In alignment with the linear, no-threshold (LNT) dose response model for post-radiation exposure cancer risk — which states that risk is directly proportional to dose — keeping radiation doses as low as reasonably achievable (i.e., the ALARA principle) reduces such risk.[4]

The relative benefit of medical imaging outweighs the risks of radiation to the overall population.[5] Nonetheless, the radiation dose to the population more than doubled in the United States between the early 1980s and 2006 and, in some instances, the population's exposure to ionizing radiation from medical procedures had increased to seven times as much during this period.[6] The increase is primarily due to the expanded use of CT and nuclear medicine procedures. Consequently, there is growing concern about potential health hazards associated with imaging procedures that use radiation.[2] As well, radiation protection practices that focus on balancing the patient care benefit against the potential for harms linked with radiation exposure are of great national and international interest.[7]

A recent Canadian study on radiation awareness investigated and compared the level of knowledge about radiation dose and the risks incurred from many imaging exams among radiology workers, including radiology residents, fellows, staff radiologists, and technologists.[5] The study found that knowledge of radiation dose and risk is poor among all radiology workers, with more significant knowledge gaps among technologists compared with residents, fellows, and staff radiologists.[5] The study also reported a significant underestimation of radiation dose and cancer risk from common examinations.[5]

Most of the emphasis on radiation protection is focused on CT exams[3] because CT accounts for the majority of total radiation received by patients from any imaging modality.[2] Hybrid imaging modalities that use CT are also significant contributors to individual patient radiation dose.[1] While recent technical innovations have contributed to lowering the radiation dose from CT,[3] not all CT units in routine use have this capability. As well, advances in technology have resulted in the expanded use of imaging equipment outside of traditional imaging departments. There is concern that workers in these settings, particularly those using fluoroscopy machines, may not have undertaken the necessary radiation protection training to ensure that patients and staff are not subjected to unnecessary radiation risk.[8]

National and international efforts have been made to identify, advocate, and implement solutions to address existing and emerging challenges related to the appropriate and safe use of radiation in medicine. The ICRP — the International Commission on Radiological Protection — and the IAEA, or International Atomic Energy Agency, have both published guidelines on radiation protection in medicine.[4,9]

In 2012, the IAEA and the World Health Organization (WHO) co-sponsored an international conference on radiation protection in medicine, in Bonn, Germany. More than 500 participants (and observers from 77 countries and 16 organizations) came together to identify opportunities to strengthen radiation protection practices for patients and health workers.

The main outcome of the conference was a proposal for 10 priorities — collectively named the Bonn Call for Action[10] — and related sub-priorities, considered to be essential for the strengthening of radiation protection in medicine. The main priorities include:

- Enhance the implementation of the principle of justification
- Enhance the implementation of the principle of optimization of protection and safety

- Strengthen manufacturers' role in contributing to the overall safety regime
- Strengthen radiation protection education and training of health professionals
- Shape and promote a strategic research agenda for radiation protection in medicine
- Increase availability of improved global information on medical exposures and occupational exposures in medicine
- Improve prevention of medical radiation incidents and accidents
- Strengthen radiation safety culture in health care
- Foster an improved radiation benefit-risk-dialogue
- Strengthen the implementation of safety requirements globally. (paragraph 2; "The objectives of the Bonn Call for Action")[7]

By encouraging the balancing of the highest benefit with the least possible risk to patients, the Bonn Call for Action may assist in more fully integrating a culture of radiation protection in the health care setting, help improve the benefit-risk dialogue with patients and the public, and enhance the safety and quality of radiological procedures in medicine.[10]

In 2017, Canada Safe Imaging[11] in collaboration with CADTH conducted a pan-Canadian survey of awareness and attitudes related to the Bonn Call for Action recommendations. The survey asked health professionals working in radiation protection to report the extent to which the 10 Bonn Call for Action principles had been implemented in their jurisdictions. As well, for each principle, survey responders were invited to provide feedback on four areas: initiatives that promote compliance, policy and practice issues that impact the application of the principles, actions to help harmonize radiation protection activities across Canada, and ideas to support the principles in the future.

Objectives

This CADTH Environmental Scan reports on the awareness and application of the principles of the Bonn Call for Action among Canadian health care professionals working in radiation projection. This report summarizes information obtained through a survey of key informants. The objectives of the Environmental Scan were to:

1. Ascertain awareness of the Bonn Call for Action in Canada.
2. Determine the extent to which the Bonn Call for Action priorities have been, or may be, implemented.
3. Identify actions not addressed by the Bonn Call for Action that could impact radiation safety and protection.

Methods

The findings presented in this Environmental Scan are informed by responses to the Bonn Call for Action survey. The survey was offered in both French and English, and responses were gathered between June 4, 2017 and October 14, 2017.

Survey responses were collected from jurisdictional informants involved in radiation protection. Participants were identified by Canada Safe Imaging or CADTH staff through professional and clinical networks and electronic mailing lists or referred by other respondents. A 12-question survey (with additional sub-questions) was developed and revised following its review by Canada Safe Imaging. The final electronic survey was uploaded to Hosted in Canada Surveys, and distributed via email to individuals in all provinces and territories across Canada. In jurisdictions with either no or minimal representation, CADTH liaison officers identified relevant contacts through professional and clinical networks. The survey questionnaire is provided in Appendix 1. Information regarding the jurisdictions and organizations represented by survey respondents is presented in Appendix 2.

The survey questionnaire consisted of 12 main questions (with additional sub-questions), that were either open-ended or nominal variables — in which items were rated on a six-point ordinal scale, according to agreement with a statement (the possible responses were "fully implemented," "partially implemented," "not implemented but intend to implement," "not implemented and unlikely to implement," "not applicable," and "no answer"). Open-ended qualitative responses were categorized by theme and summarized narratively. Responses to the nominal variable questions were summarized descriptively. Supportive literature was identified using targeted Internet searching, when necessary. All respondents gave explicit permission to use the provided information for the purpose of this report.

Findings

The information presented in this Environmental Scan on awareness and implementation of the Bonn Call for Action priorities in Canada is based on a survey of key informants from Canadian provinces gathered as of October 2017.

The total number of potential respondents who received the survey is unclear because the survey was distributed to the coordinators of electronic mailing lists relevant to the radiology protection community. The coordinators did not reveal the number of email contacts on their listservs. Responses to all or some of the questions were received from all provinces and no territories. Thirty-three participants completed or partially completed survey responses. Of the 33 participants, 20 submitted "full" responses, one submitted a partial response, 10 were blank, and two declined to complete the survey. Nine participants answered the survey anonymously. Most responders did not identify their professions and those who did most commonly identified themselves as university professors, radiation safety officers, medical radiation technologists, or nuclear medicine physicists. The survey results are presented from a pan-Canadian perspective and do not summarize information about specific jurisdictional or organizational practices.

Overall, out of the 33 responses received for this survey, nine participants declared an awareness of the Bonn Call for Action, 14 participants were not aware of the Bonn Call for Action, and 10 participants provided no answer to the question. Results of the survey are presented sequentially for each Bonn Call for Action priority and each section contains information on survey participant comments recorded in the following categories: activities conducted to promote compliance, policy and practice issues that may facilitate or prevent the application of the priorities, actions to harmonize activities across Canada, and actions to support Bonn Call for Action principles in the future.

Action 1. Enhance the implementation of the principle of justification[10]

Justification of imaging exams ensures that only medically necessary exams are carried out. Twenty-one survey responders answered the Bonn Call for Action priority related to enhancing the implementation of the principle of justification. The sub-action related to the development of criteria for the justification of health screening was reported as being "fully implemented" by five out of 21 respondents. The sub-action of introducing and applying tools to support awareness and appropriateness of medically necessary exams was reported as being "partially implemented" by 13 out of 21 respondents. The sub-action most "unlikely to be implemented," according to four out of 21 respondents, is the introduction of information technology solutions, such as decision-support tools for clinical imaging. Table 1 provides an outline of the complete responses for this action item.

Table 1: Action 1 of the Bonn Call to Action

Action 1. Enhance the Implementation of the Principle of Justification[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Introduce and apply the 3A's (awareness, appropriateness and audit), which are seen as tools that are likely to facilitate and enhance justification in practice;[10]	2 (9.5%)	13 (61.9%)	3 (14.3%)	0 (0%)	2 (9.5%)	1 (4.8%)
Develop harmonized evidence-based criteria to strengthen the appropriateness of clinical imaging, including diagnostic nuclear medicine and non-ionizing radiation procedures, and involve all stakeholders in this development;[10]	0 (0%)	9 (48.9%)	6 (28.5%)	1 (4.8%)	4 (19%)	1 (4.8%)
Implement clinical imaging referral guidelines globally, keeping local and regional variations in mind, and ensure regular updating, sustainability and availability of these guidelines;[10]	1 (4.8%)	5 (23.8%)	7 (33.3%)	1 (4.8%)	6 (28.5%)	1 (4.8%)
Strengthen the application of clinical audit in relation to justification, ensuring that justification becomes an effective, transparent and accountable part of normal radiological practice;[10]	1 (4.8%)	7 (33.3%)	8 (38.1%)	2 (9.5%)	3 (14.3%)	0 (0%)
Introduce information technology solutions, such as decision-support tools in clinical imaging, and ensure that these are available and freely accessible at the point-of-care;[10]	0 (0%)	6 (28.5%)	6 (28.5%)	4 (19%)	4 (19%)	1 (5%)
Further develop criteria for justification of health screening programmes for asymptomatic populations (e.g., mammography screening) and for medical imaging of asymptomatic individuals who are not participating in approved health screening programmes (e.g. use of CT for individual health surveillance).[10]	5 (23.8%)	6 (28.5%)	2 (9.5%)	1 (4.8%)	6 (28.6%)	1 4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Numerous initiatives (subsequently listed) have been undertaken, or are in progress, that may help to promote compliance with enhancing the implementation of the principle of the justification. Survey responders noted that many of these initiatives are local and information about them is often not disseminated between hospitals, regions, or jurisdictions. There is concern that a lack of information-sharing may stifle a culture of collaborative engagement and continuous improvement. One responder indicated there is a need to coordinate activities between physicists in different provinces to strengthen safe practices.

It was reported that there is greater awareness of radiation protection in the hospital setting than there is in the referring physician's setting. Further to this point, one responder noted that referring physicians may not always follow the clinical guidance developed by the radiology community. Two responders reported that few actions have been taken to support compliance with radiation protection practices. Overall, it was

reported that more education and training is required to raise the awareness of the importance of ensuring that only medically necessary exams are conducted.

Some activities, reported by seven survey responders, that have already been undertaken to promote compliance with the principles of justification across Canada include:

- dose tracking for fluoroscopy exams
- quality assurance audits
- peer review of imaging exams
- development of internal guidelines
- participation in the national Canadian Computed Tomography Survey Dose Audit in 2013[12]
- compliance with accreditation programs
- collaboration with radiologists to unify common head protocols on the same scanners
- the use of ordering physician utilization report cards
- standardization of equipment and protocols across geographic regions
- development of provincial health ministry recommendations to help limit the dangers of radiation.

Activities reported to be in progress that promote compliance with the principles of justification include:

- the development of local awareness projects
- educating health care professional in order to reduce fluoroscopic examinations
- standardization of lens-of-eye dose monitoring techniques including institutional implementation action plans
- implementation of peer review processes.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Survey responders reported numerous policy and practice issues that have facilitated the implementation of the principles of justification. The promotion of best practices through publishing work nationally and internationally is a technique reported to be used by one provincial governing body. Two survey responders noted that the provincial enforcement of Health Canada's Safety Code 35[13] — a document that outlines safety procedures for the installation, use, and control of X-ray equipment in large medical radiological facilities — has facilitated the use of standards in radiation output and protection in diagnostic imaging. Other policy and practice initiatives reported by survey responders that have assisted the implementation of the principles of justification include:

- the full integration of picture archiving and communication systems (PACS) across provincial geographic regions
- the establishment of dedicated radiation protection organizations
- the application of peer review processes
- the promotion of excellence in imaging by provincial accreditation programs.

Three survey respondents reported a number of policy and practice issues that may present challenges in implementing the principles of justification. Some participants indicated that referring physicians, particularly those with less experience, may not always follow clinical guidance or other measures that they may perceive as limiting their ability to make a diagnosis. One survey participant reported that the large number of medical specialists who can prescribe radiological examinations are so diverse that raising awareness among such a broad group is difficult to achieve. It was suggested that the province-wide implementation of decision-support software is a practice that could ensure adherence to appropriateness criteria.

Actions to Harmonize Activities Across Canada

Survey responders reported several actions that can be taken to help harmonize principles of justification activities across Canada. Responders suggested improving liaisons between federal, provincial, and territorial groups and professional bodies, and assigning leadership responsibility to provincial ministries to spearhead harmonization efforts. Three survey responders reported that the creation of federal legislation may be the only effective means of harmonizing radiation protection regulations across Canada. One responder supported tying reimbursement to radiation protection practices. Several responders noted that harmonization across Canada would be difficult until Health Canada's Safety Code 35 has been adopted by every province. Another responder noted that more certified diagnostic physicists are needed to facilitate the harmonization of activities across Canada. Overall, the promotion of increased communication and collaboration between specialists and clinicians were regarded as important actions to facilitate harmonization efforts. As well, raising awareness of tools such as decision support and appropriate use systems, sharing best practices, and education and training were seen as actions that could help achieve harmonization.

Proposed Actions to Support These Principles

Ten survey responders provided comments and suggestions for future actions to support principles of justification. These proposed actions include:

- Incorporate justification requirements into accreditation programs.
- Apply harmonization regulations across all regions.
- Enforce regulations and audits.
- Threaten non-compliance with fines.
- Increase awareness and education.
- Link justification to reimbursement.
- Ensure appropriate staffing is provided to oversee these initiatives.
- Compensate physicians, technologists, and physicists for their efforts in standardizing and harmonizing radiation practices.
- Encourage collaboration between technologists, radiologists, and physicists.
- Facilitate a change in culture from practising medicine to avoid litigation to practising medicine to treat disease.

Action 2. Enhance the implementation of the principle of optimization of protection and safety[10]

The optimization of protection and safety ensures that practices and processes are in place to minimize the incorrect use of radiation while optimizing a diagnostic or therapeutic result. Twenty-one survey responders answered this question.

The sub-action related to the adoption of harmonized criteria for the release of patients after radionuclide therapy, and the development of further detailed guidance, as necessary, was reported as being "fully implemented" by seven out of 21 survey participants. Two sub-actions — ensuring the establishment, use of, and regular update of diagnostic reference levels (DRLs) for radiological procedures and strengthening the establishment of quality assurance programs for medical exposures — were reported as being "partially implemented" by 15 out of 21 survey participants. The sub-action most "unlikely to be implemented" according to two out of 21 survey participants pertains to the development and application of technological solutions to enhance the optimization of patient protection and safety. Table 2 provides an outline of the complete responses for this action item.

Table 2: Action 2 of the Bonn Call to Action

Action 2. Enhance the implementation of the principle of optimization of protection and safety[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Ensure establishment, use of, and regular update of diagnostic reference levels for radiological procedures, including interventional procedures, in particular for children;[10]	1 (4.8%)	15 (71.4%)	2 (9.5%)	0 (0%)	2 (9.5%)	1 (4.8%)
Strengthen the establishment of quality assurance programmes for medical exposures, as part of the application of comprehensive quality management systems;[10]	3 (14%)	15 (71%)	2 (10%)	0 (0%)	1 (5%)	0 (0%)
Implement harmonized criteria for release of patients after radionuclide therapy, and develop further detailed guidance as necessary;[10]	7 (33.3%)	6 (28.6%)	1 (4.8%)	0 (0%)	7 (33.3%)	0 (0%)
Develop and apply technological solutions for patient exposure records, harmonize the dose data formats provided by imaging equipment, and increase utilization of electronic health records.[10]	2 (9.5%)	7 (33.3%)	8 (38.1%)	2 (9.5%)	1 (4.8%)	1 (4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Three themes emerged in survey respondent comments regarding initiatives that have already been undertaken within jurisdictions to promote compliance with principles of optimization of protection and safety. The first is the development, review, and adherence to DRLs, ideally using dose-tracking software, and the assignment of this responsibility to medical physicists. One survey responder noted that there would be no DRL initiatives in their facility until a medical physicist was hired. The second initiative, also aimed at optimizing patient exposure to radiation, is the development of adult and pediatric CT protocols. The third is the audit of average radiation doses, either at the provincial or local level. It was noted that collaboration among medical physicists, technologists, and radiologists across hospitals helps to ensure the optimization of imaging quality and dose, and can facilitate the successful implementation of these initiatives.

The creation of a clinical expertise centre in radioprotection in one jurisdiction played an important role in promoting compliance with the principle of optimization of protection and safety, according to one survey responder. Similarly, the implementation of Health Canada's Safety Code 35 was also reported by a survey participant as a means of helping to promote compliance. Overall, it was reported that more education and training is required to raise awareness of the importance of implementing principles of optimization and safety, particularly among technologists.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Three survey participants reported that the main policy and practice issue that has facilitated the implementation of the principles of optimization of protection and safety at the provincial level relates to the implementation of Health Canada's Code 35. One survey responder commented that diagnostic accreditation programs should include the regular reviews of best practices as part of their responsibilities.

Four survey participants reported that little has been done to facilitate the implementation of the principles of optimization at the provincial level. A challenge, reported by two survey responders, is the number of consultations required at various levels of the health care system and between professional organizations, which may hinder agreement on specific policies and procedures.

Actions to Harmonize Activities Across Canada

Survey responders reported several actions that can be taken to help harmonize activities across Canada. The federal regulation and regular review of DRLs as a means of optimizing protection in medical exposure was reported as a possibility by three survey responders. Another action related to DRLs that could help harmonize activities across Canada is their standardization across regions and the availability of funding to enable this analysis. Two survey respondents suggested that Canada should look to Europe for guidance and implement initiatives similar to either the EuroSafe Imaging Stars initiative[14] or the *European Guidelines on Quality Criteria for Computed Tomography,*[15] both of which promote best practices in radiation protection.

Proposed Actions to Support These Principles

Five survey responders provided comments and suggestions for future actions to support the principle of optimizing protection and safety. These actions include:

- Supply funding for a group to develop Canadian standards.
- Incorporate these principles in regulations and frame them in an Act.
- Encourage imaging departments to submit annual reports to ensure guidelines are followed.
- Establish a decision-making body that requires certain measures to reduce radiation dose to patients and ensure they are adhered to.
- Provide education and training on the principles of optimization.

Action 3. Strengthen manufacturers' role in contributing to the overall safety regime[10]

Twenty-one survey responders answered questions regarding the third Bonn Call for Action priority related to strengthening the manufacturer's role in contributing to overall safety regimes. The sub-action of reinforcing the conformance to applicable standards of equipment regarding performance, safety, and dose parameters was reported as being "fully implemented" by eight out of 21 survey participants. Two sub-actions were noted as "partially implemented" by 11 out of 21 respondents. One of the sub-actions pertains to enhancing the provision of tools and support in order to give training to users that is specific to the particular medical device. The other sub-action pertains to strengthening co-operation and communication between manufacturers and other stakeholders. The sub-action most "unlikely to be implemented" according to five of the 21 survey responders pertains to supporting platforms for interaction between manufacturers and health and radiation regulatory authorities and their representative organizations. Table 3 provides an outline of the complete responses for this action item.

Table 3: Action 3 of the Bonn Call to Action

Action 3. Strengthen Manufacturers' Role in Contributing to the Overall Safety Regime[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Ensure improved safety of medical devices by enhancing the radiation protection features in the design of both physical equipment and software and make these available as default features rather than optional extra features;[10]	3 (14.3%)	6 (28.6%)	1 (4.8%)	2 (9.5%)	9 (42.8%)	0 (0%)
Support development of technical solutions for reduction of radiation exposure of patients, while maintaining clinical outcome, as well as of health workers;[10]	2 (9.5%)	10 (47.5%)	2 (9.5%)	2 (9.5%)	5 (24%)	0 (0%)
Enhance the provision of tools and support in order to give training for users that is specific to the particular medical devices, taking into account radiation protection and safety aspects;[10]	3 (14%)	11 (52%)	2 (10%)	0 (0%)	5 (24%)	0 (0%)
Reinforce the conformance to applicable standards of equipment with regard to performance, safety and dose parameters;[10]	8 (38%)	7 (33%)	1 (5%)	0 (0%)	5 (24%)	0 (0%)
Address the special needs of health care settings with limited infrastructure, such as sustainability and performance of equipment, whether new or refurbished;[10]	5 (23.8%)	3 (14.3%)	2 (9.5%)	2 (9.5%)	9 (42.9%)	0 (0%)
Strengthen cooperation and communication between manufacturers and other stakeholders, such as health professionals and professional societies;[10]	0 (0%)	11 (52.4%)	3 (14.3%)	3 (14.3%)	4 (19%)	0 (0%)
Support usage of platforms for interaction between manufacturers and health and radiation regulatory authorities and their representative organizations.[10]	2 (9.5%)	6 (28.6%)	2 (9.5%)	5 (23.8%)	5 (23.8%)	1 (4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Four survey responders reported engaging with manufacturers through a variety of channels including during quarterly meetings, while commissioning new equipment, during joint tenders for shared purchases, and on an ad hoc basis to help achieve compliance with strengthening manufacturers' role in contributing to overall safety regimens. Another survey responder reported that there is continued communication with application support to help optimize various CT protocols for dose reduction without impacting image quality.

One survey participant noted that they standardize CT equipment to provide iterative reconstruction and are working to optimize the utilization of that technology. Another responder reported that they have a good relationship with their regulator through which stakeholder input is encouraged via a province-wide safety committee.

An activity reported by a survey participant that promotes compliance with strengthening the manufacturers' roles is the regular inspection of radiation emission by a quality control program and the use of ALARA radiation safety principles when setting up programs. Similarly, another survey responder reported using Radimetrics software to collate and analyze CT dose data.

One survey responder commented that there is a willingness from their perspective to engage with industry, but the scope is difficult to manage. Another responder commented that the manufacturer/user relationship is "politically complex" and this disables opportunities to promote compliance.

Policy and Practice Issues that May Facilitate or Prevent the Application of These Priorities

Three survey participants reported that no action has been taken to facilitate strengthening manufacturers' roles in contributing to overall safety. One of the responders added that they have no provincial policies regarding radiation safety for ionizing radiation equipment and that there are units in their province that have never had a radiation assessment. Another participant reported that there is no budget for the purchase and renewal of equipment. A survey responder suggested using a single standard set of units to report dose from fluoroscopy equipment instead of using three different Gray (Gy) units (i.e., mGy, dGy, and cGy) to report air kerma (kinetic energy released per unit mass) would help facilitate compliance with this Bonn Call for Action principle. An observation reported by another survey responder was that because manufacturers tend to be based in the US, it is sometimes difficult to translate practices and equipment into the Canadian context.

Actions to Harmonize Activities Across Canada

Five actions were suggested that could help to harmonize activities across Canada. These actions include:

- Assign authority to Health Canada to set certain requirements that manufacturers would be obliged to adhere to.
- Create better national standards on dose reporting.
- Establish a forum for the engagement of clinicians and manufacturers, so that manufacturers can gain a better understanding of Canada's unique needs.
- Supervise tenders and set expectations whereby manufacturers are required to provide advanced and efficient equipment.

Proposed Actions to Support These Principles

Five survey responders provided comments and suggestions for future actions to enhance the implementation of the principle of optimizing protection and safety. The proposed actions include:

- intervention and forced compliance by Health Canada
- standardization of government agencies
- development of a common strategy for the acquisition of state-of-the-art technological equipment in all health care environments
- encouragement of manufacturers to be more concerned about dose emissions according to protocols.

Action 4. Strengthen radiation protection education and training of health professionals[10]

Twenty-one survey responders answered questions regarding the fourth Bonn Call for Action priority related to strengthening radiation protection education and training. The sub-action that has already been "fully implemented" according to seven out of 21 survey respondents pertains to prioritizing radiation protection education and training for health professionals. The most frequently cited "partially implemented" sub-action according to 12 out of 21 survey respondents pertains to the further development of newer platforms such as specific training applications on the Internet. The two sub-actions most "unlikely to be implemented" according to one out of 21 respondents are prioritizing radiation protection education and training, and strengthening collaboration in education and training between education providers in health care settings with limited infrastructures. Table 4 provides an outline of the complete responses for this action item.

Table 4: Action 4 of the Bonn Call to Action

Action 4. Strengthen radiation protection education and training of health professionals[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Prioritize radiation protection education and training for health professionals globally, targeting professionals using radiation in all medical and dental areas;[10]	6 (28.6%)	8 (38.1%)	4 (19%)	1 (4.8%)	2 (9.5%)	0 (0%)
Further develop the use of newer platforms such as specific training applications on the Internet for reaching larger groups for training purposes;[10]	2 (9.5%)	12 (57.1%)	4 (19.1%)	0 (0%)	2 (9.5%)	1 (4.8%)
Integrate radiation protection into the curricula of medical and dental schools, ensuring the establishment of core competency in these areas;[10]	7 (33%)	7 (33%)	1 (5%)	0 (0%)	6 (29%)	0 (0%)
Strengthen collaboration in relation to education and training among education providers in health care settings with limited infrastructure as well as among these providers and international organization and professional societies;[10]	3 (14.3%)	6 (28.5%)	5 (23.8%)	1 (4.8%)	5 (23.8%)	1 (4.8%)
Pay particular attention to the training of health professionals in situations of implementing new technology.[10]	5 (23.8%)	9 (42.8%)	5 (23.8%)	0 (0%)	1 (4.8%)	1 (4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Activities reported by survey responders that have already been undertaken to promote compliance with Action 4 (i.e., to strengthen radiation protection education) are listed, as follows:

- Establish in-person and online radiation protection educational courses.
- Create entry profiles for imaging professionals clearly indicating the skills that need to be achieved.
- Enhance the provision of tools and support in order to give tailored training for users specific to the imaging equipment they use.
- Assign authority to the Canadian Nuclear Safety Commission (CNSC) to mandate education and training that promotes the implementation of the Bonn Call for Action relative to nuclear medicine and some aspects of radiation therapy.
- Incorporate radiation safety as part of staff orientation and provide refresher courses every three years.

In addition, one survey responder suggested that medical imaging technologists should receive professional development, with a requirement to complete a minimum number of hours of training in radiation safety per year. Another survey participant suggested expanding education and training beyond standard diagnostic imaging departments and making it mandatory for anyone working with radiation-emitting devices.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Three survey participants reported that they were not aware of policy or practice issues that facilitated strengthening radiation protection education and training. One survey responder reported that, at the provincial level, radiation safety for nurses is under a collective agreement that puts a limitation on what can be taught. The survey responder suggested that education should be part of continuing education, where there are fewer controls over radiation safety education. Another survey responder suggested that radiation protection education should be part of an annual training obligation under penalty of having work permits withdrawn.

A survey responder reported how evolving practice in interventional radiology may not be sufficient to ensure that patient and staff radiation dose is adequately controlled. They reported that many interventional procedures are becoming more complex and are happening outside of traditional medical imaging departments, where the emphasis on physician education and retraining in radiation safety is insufficient and consequently patients and staff may be put at unnecessary risk. They also reported that medical imaging departments are expected to provide education and training on radiation protection to interventional radiologists without compensation for the training that radiologists provide.

Another survey responder reported that the advice of medical imaging professionals on radiation protection is ignored and, as such, their impetus to provide education and training is limited. As well, it was noted that it is challenging to keep training programs up-to-date and this is particularly important for contemporary issues of dose risk for patients.

Actions to Harmonize Activities Across Canada

One survey responder indicated that pan-Canadian harmonization efforts would require leadership at a very high level to ensure activities were implemented. Conversely, another responder reported that harmonization is not desirable and that actions are best managed at the program level. Suggestions to harmonize activities included:

- Assign authority to the CNSC to require that all hospitals with nuclear medicine programs comply with their standards or face fines or suspension of their professional licence if they do not meet education and training requirements.

- Require physician credentialing for the use of interventional fluoroscopy.
- Provide clear expectations around the types of training considered appropriate for radiation safety and the resources to meet those expectations.
- Ensure that appropriate facility training is made available and sanction those who do not fulfill the requirements.

Proposed Actions to Support These Principles

Three survey responders provided comments for actions to support the strengthening of radiation protection education and training in the future. These actions include:

- Provide more education to raise awareness of radiation protection and safety.
- Ensure the inclusion of radiation protection modules in university syllabuses.
- Further develop the technological means to facilitate learning and updating knowledge.

Action 5. Shape and promote a strategic research agenda for radiation protection in medicine[10]

Twenty-one survey responders answered questions regarding the fifth Bonn Call for Action priority related to shaping and promoting a strategic research agenda for radiation protection in medicine. The most common response for all sub-actions (38% to 52% of respondents) was "not applicable," followed by (24% to 48% of respondents) "not implemented and unlikely to implement." The two sub-actions most "unlikely to be implemented" according to 10 out of 21 survey respondents pertains to exploring the possibilities of identifying biological markers specific to ionizing radiation and promoting research to improve methods for organ dose assessment.

A single respondent noted that they had "fully implemented" the sub-action related to strengthening investigation into low-dose health effects and radiological risks from external and internal exposures. This sub-action is also reported as being "partially implemented" according to two out of 21 survey respondents, along with promoting research to improve methods for organ dose assessment. The sub-action that has "not been implemented but intend to implement" according to three out of 21 survey respondents was exploring the rebalancing of radiation research budgets in recognition of the fact that an overwhelming percentage of human exposure to man-made sources of radiation is medical. Table 5 provides an outline of the complete responses for this action item.

Table 5: Action 5 of the Bonn Call to Action

Action 5. Shape and promote a strategic research agenda for radiation protection in medicine[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Explore the re-balancing of radiation research budgets in recognition of the fact than an overwhelming percentage of human exposure to man-made sources is medical;[10]	0 (0%)	1 (5%)	3 (14%)	5 (24%)	11 (52%)	1 (5%)
Strengthen investigations in low-dose health effects and radiological risks from external and internal exposures, especially in children and pregnant women, with an aim to reduce uncertainties in risk estimates at low doses;[10]	1 (5%)	2 (10%)	0 (0%)	8 (38%)	9 (42%)	1 (5%)

Action 5. Shape and promote a strategic research agenda for radiation protection in medicine[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Explore the possibilities of identifying biological markers specific to ionizing radiation; Advance research in specialized areas of radiation effects, such as characterization of deterministic health effects, cardiovascular effects, and post-accident treatment of overexposed individuals;[b,10]	0 (0%)	0 (0%)	2 (9.5%)	10 (47.6%)	8 (38.1%)	1 (4.8%)
Promote research to improve methods for organ dose assessment, including patient dosimetry when using unsealed radioactive sources, as well as external beam small-field dosimetry.[10]	0 (0%)	2 (9.5%)	1 (4.8%)	10 (47.6%)	7 (33.3%)	1 (4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Three survey responders reported that there were limited resources available to conduct research in radiation protection. One of these responders commented that there has been a shift from dual clinical/research roles to clinical, only, roles, with leadership stating that research is part of the university domain and not an initiative for hospitals. Consequently, they noted it is difficult to explore research topics in a clinical setting. As well, there is little funding available, either provincially or nationally, for these projects. A survey participant noted that financial efforts to reduce overall exposure is focused on replacing older technology with new, more effective, devices.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

All six survey responders who answered this question reported that funding was the greatest obstacle to facilitating new research in radiation protection. One responder added that there is no direct link between academia and diagnostic imaging departments, and another responder noted that responsible people are aware that research in radiation protection is required but "concrete results" have not materialized.

Actions to Harmonize Activities Across Canada

Five survey responders provided comments on actions to support shaping and promoting a strategic research agenda. These actions include:

- Assign authority to the government to enforce an allocation of funds for research.
- Develop strategies to promote research in this area.
- Ensure the availability of grants dedicated to radiation safety.
- Update the *Radiation Emitting Devices Act*[16] to meet new equipment standards to allocate finances specifically for radiation protection projects.

Proposed Actions to Support These Principles

Four responders provided comments for actions to support shaping and promoting a research agenda for the future. These actions include:

- Provide education and training.

- Promote the need for new research at conferences and workshops.
- Ensure that the Canadian Institutes of Health Research provides grants for work in this area.
- Invest in the development of innovative projects in radiation protection.

Two survey respondents also provided responses to suggest that funding would be required to that ensure a research agenda was developed.

Action 6. Increase availability of improved global information on medical exposures and occupational exposures in medicine[10]

Twenty-one survey responders answered questions regarding the sixth Bonn Call for Action priority related to increasing the availability of improved global information on medical exposures and occupational exposures in medicine. The most common response for all sub-actions (14% to 38% of respondents) was "not applicable." Two respondents out of 21 indicated that they had "fully implemented" the sub-action of making radiation exposure data available as a tool for quality management, and for trend analysis, decision-making, and resource allocation. A further eight respondents out of 21 indicated that they had "partially implemented" this sub-action. The sub-action most "unlikely to be implemented" according to 8 out of 21 respondents relates to improving the collection of dose data and trends on global medical exposure to radiation. Table 6 provides an outline of the complete responses for this action item.

Table 6: Action 6 of the Bonn Call to Action

Action 6. Increase availability of improved global information on medical exposures and occupational exposures in medicine[a10]	**Fully Implemented**	**Partially Implemented**	**Not Implemented but Intend to Implement**	**Not Implemented and Unlikely to Implement**	**Not Applicable**	**No Answer**
Improve collection of dose data and trends on medical exposures globally, and especially in low- and middle-income countries, by fostering international co-operation;[10]	0 (0%)	1 (5%)	3 (14%)	8 (38%)	8 (38%)	1 (5%)
Improve data collection on occupational exposures in medicine globally, also focussing on corresponding radiation protection measures taken in practice;[10]	1 (4.8%)	6 (28.6%)	4 (19%)	4 (19%)	5 (23.8%)	1 (4.8%)
Make the data available as a tool for quality management and for trend analysis, decision making, and resource allocation.[10]	2 (10%)	8 (38%)	4 (19%)	3 (14%)	3 (14%)	1 (5%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Initiatives that have been implemented to promote compliance with the principle of increasing the availability of improved global information on medical exposures and occupational exposures in medicine as reported by five survey participants include:

- incorporation of electronic reject analysis tools for radiography and mammography, which are used to educate technologists on proper positioning

- application of Radimetrics software to track patient population exposure to CT, to facilitate comparison to national and international trends
- monitoring of dose records on a quarterly basis and creation of an annual report on trends.

One survey responder reported that projects related to improved global information on radiation exposures are known only to research teams and this work is not sufficiently disseminated. Three survey responders reported that nothing had been done to promote compliance with increasing the availability of improved global information on medical exposures and occupational exposures in medicine.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Three survey participants identified two policy and practice issues that could facilitate the application of this priority: using the ARC American College of Radiology dose registry, and implementing planned automatic dose-tracking software.

One survey responder commented that these initiatives are research-specific and of international relevance, and do not apply in a clinical setting. Similarly, another survey responder suggested that this is a political issue related to grants and research teams. Another responder noted that all stakeholders do not share the same vision on the issue of radiation dose to the patient and this may be the biggest hurdle to improving global information on medical exposure.

Actions to Harmonize Activities Across Canada

Five responders provided comments for actions to harmonize activities across Canada to increase the availability of improved global information on medical exposures and occupational exposures. The suggested actions include:

- Assign authority to the government to lead the initiative.
- Promote the sharing of data through national conferences and workshops.
- Integrate with the ACR American College of Radiology dose registry, mandating that all jurisdictions need to install dose monitoring systems and submit anonymized data to a central database to ensure best practices.
- Establish a national radiation protection information centre and related activities.
- Share radiation dose reports between all regions in Canada.

Proposed Actions to Support These Principles

Four responders provided comments for actions to support increased availability of improved global information on medical exposures and occupational exposures to radiation. These actions include:

- Develop a realistic national program.
- Increase education.
- Encourage radiation protection officers across Canada to perform the same study and share their results so that a baseline can be created.
- Ensure all stakeholders play a role in the issue.

Action 7. Improve prevention of medical radiation incidents and accidents[10]

Twenty-one survey respondents answered questions regarding the seventh Bonn Call for Action priority related to improving the prevention of medical radiation incidents and accidents. A sub-action that has already been "fully implemented" according to eight out of 21 survey respondents pertains to the implementation and support of voluntary educational safety reporting systems for the purpose of learning from the experience of safety-related events in medical uses of radiation. A sub-action (n = 7) that has been "partially implemented" according to seven out of 21 respondents pertains to ensuring the prioritization of independent verification of safety at critical steps, as an essential component of safety measures in medical uses of radiation; this is also the sub-action reported by five out of 21 respondents that is "unlikely to be implemented." Table 7 provides an outline of the complete responses for this action item.

Table 7: Action 7 of the Bonn Call to Action

Action 7. Improving prevention of medical radiation incidents and accidents[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Implement and support voluntary educational safety reporting systems for the purpose of learning from the return of experience of safety related events in medical uses of radiation;[10]	8 (38%)	6 (29%)	4 (19%)	0 (0%)	3 (14%)	0 (0%)
Harmonize taxonomy in relation to medical radiation incidents and accidents, as well as related communication tools such as severity scales, and consider harmonization with safety taxonomy in other medical areas;[10]	5 (23.8%)	4 (19.1%)	2 (9.5%)	2 (9.5%)	7 (33.3%)	1 (4.8%)
Work towards inclusion of all modalities of medical usage of ionizing radiation in voluntary safety reporting, with an emphasis on brachytherapy, interventional radiology, and therapeutic nuclear medicine in addition to external beam radiotherapy;[10]	5 (23.8%)	4 (19%)	3 (14.3%)	2 (9.5%)	6 (28.6%)	1 (4.8%)
Implement prospective risk analysis methods to enhance safety in clinical practice;[10]	3 (14.29%)	6 (28.57%)	5 (23.81%)	4 (19.05%)	2 (9.52%)	1 (4.76%)
Ensure prioritization of independent verification of safety at critical steps, as an essential component of safety measures in medical uses of radiation.[10]	2 (9.5%)	7 (33.3%)	1 (4.8%)	5 (23.8%)	5 (23.8%)	1 (4.8%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Initiatives that have been implemented to promote compliance with improving the prevention of medical radiation incidents and accidents, according to seven survey participants, include:

- Oblige radiation workers to report incidents and accidents at the provincial level.

- For all modalities, fully implement a patient safety and learning system — a mechanism whereby hospitals must share, with other hospitals, what they have learned from their investigations of critical incidents and their recommendations to prevent future incidents.
- Ensure the provision of third-party acceptance testing of all new and moved equipment prior to clinical use to confirm that all specifications are met.
- Introduce voluntary monitoring of all interventional radiology and CT exposures to patients.
- Report all over-exposures or mis-exposures to management, with the inclusion of a plan on how to reduce the risk of these in the future.
- Ensure that, for interventional procedures where the patient has received a dose of more than four Gys, the patient family physician is notified regarding possible skin effects the patient may experience.
- Use a centralized reporting system to manage incidents and concerns.
- Conduct arms-length verification of radiation safety that is carried out annually.
- Disclose to patients unintended or inappropriate radiation exposures that result in a much larger radiation dose than was planned, and ensure an occurrence report is filed and an Unintended Radiation Exposure Report — a mechanism for reporting all unintended radiation exposure incidents — is attached to the patient's file.

Four survey responders reported that nothing had been done to promote compliance with improving the prevention of medical radiation incidents and accidents. One of these responders noted that they were very concerned about the implementation of measures aimed at reporting incidents and accidents in radiation protection.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Four survey responders reported that they were not aware of any issues that might facilitate or prevent medical radiation incidents and accidents. No additional responders provided input on this inquiry.

Actions to Harmonize Activities Across Canada

Six survey responders provided suggestions for actions to harmonize activities across Canada to improve the prevention of medical radiation incidents and accidents. These actions include:

- Assign authority to the government to lead the initiative.
- Promote radiation safety.
- Provide more education on how interventional radiology can impact a patient's skin.
- Share incidences and identify steps to prevent reoccurrence.
- Share processes between and within jurisdictions.

Proposed Actions to Support These Principles

Four responders provided comments for actions to improve the prevention of medical radiation incidents and accidents that include:

- Educate stakeholders.
- Promote radiation safety.
- Develop strategies to manage the overall issue of radiation incidents and accidents.
- Ensure adherence to ALARA principles to minimize patient and staff exposure.

Action 8. Strengthen radiation safety culture in health care[10]

Twenty-one survey respondents answered questions regarding the eighth Bonn Call for Action priority related to strengthening radiation safety culture in health care. A sub-action that has already been "fully implemented" according to seven out of 21 respondents pertains to fostering closer co-operation between radiation regulatory authorities, health authorities, and professional societies. A sub-action that has been "partially implemented" according to 11 out of 21 respondents and pertains to the establishing of patient safety as a strategic priority in medical uses of ionizing radiation, recognizing leadership as a critical element of strengthening radiation safety culture. A sub-action "unlikely to implement" according to six out of 21 respondents pertains to learning about best practices for instilling a safety culture from other areas such as the nuclear power and aviation industries. Table 8 provides an outline of the complete responses for this action item.

Table 8: Action 8 of the Bonn Call to Action

Action 8. Strengthen radiation safety culture in health care[a10]	**Fully Implemented**	**Partially Implemented**	**Not Implemented but Intend to Implement**	**Not Implemented and Unlikely to Implement**	**Not Applicable**	**No Answer**
Establish patient safety as a strategic priority in medical uses of ionizing radiation, and recognize leadership as a critical element of strengthening radiation safety culture;[10]	6 (29%)	11 (52%)	1 (5%)	1 (5%)	2 (9%)	0 (0%)
Foster closer co-operation between radiation regulatory authorities, health authorities and professional societies;[10]	7 (33%)	5 (24%)	4 (19%)	1 (5%)	3 (14%)	1 (5%)
Foster closer co-operation on radiation protection between different disciplines of medical radiation applications as well as between different areas of radiation protection overall, including professional societies and patient associations;[10]	4 (19%)	6 (28.6%)	5 (23.8%)	2 (9.5%)	3 (14.3%)	1 (4.8%)
Learn about best practices for instilling a safety culture from other areas, such as the nuclear power industry and the aviation industry;[10]	0 (0%)	2 (9.53%)	6 (28.57%)	6 (28.57%)	6 (28.57%)	1 (4.76%)
Support integration of radiation protection aspects in health technology assessment;[10]	5 (23.8%)	6 (28.5%)	1 (4.8%)	5 (23.8%)	3 (14.3%)	1 (4.8%)
Work towards recognition of medical physics as an independent profession in health care, with radiation protection responsibilities;[10]	4 (19%)	9 (42.9%)	2 (9.5%)	4 (19%)	1 (4.8%)	1 (4.8%)
Enhance information exchange among peers on radiation protection and safety-related issues, utilizing advances in information technology.[10]	3 (14%)	9 (43%)	7 (33%)	1 (5%)	0 (0%)	1 (5%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Initiatives that have been implemented to promote compliance with strengthening a radiation safety culture were reported by six survey responders, as follows:

- Collaborate with other disciplines involved in radiation exposure.
- Invest in education and training to promote a culture of radiation safety.
- Create a Medical Physics Division at academic institutions.
- Ensure all new equipment records dose metrics.
- Include a medical physicist in the equipment evaluation process to ensure that safety and quality issues are addressed.
- Select imaging equipment that emphasizes low-dose imaging.

One survey participant reported that there are no activities in their jurisdiction that promote compliance with strengthening a radiation safety culture.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

A strategy that may facilitate strengthening a radiation safety culture as reported by one survey responder is ensuring that the Canadian College of Physicists in Medicine is recognized as a professional college in all jurisdictions. Another survey responder reported that because radiation safety is a multi-stakeholder concern, it is difficult to issue clear guidelines and share a common vision. Three survey responders reported that they were not aware of any issues that might facilitate or prevent the priority of strengthening a radiation safety culture.

Actions to Harmonize Activities Across Canada

Six survey responders provided suggestions for actions to harmonize activities across Canada to strengthen a radiation safety culture. These actions include:

- Provide education and training.
- Collaborate with stakeholders.
- Promote recognition and safe practice.
- Encourage provincial collaboration in purchasing and assessing technologies, and involve a medical physicist in the process.
- Impose the Canadian College of Physicists in Medicine principles in provinces where there is no provincial college for medical physicists.

Proposed Actions to Support These Principles

One responder commented that supporting activities toward the issue of strengthening radiation safety culture in health care is required to support future actions.

Action 9. Foster an improved radiation benefit-risk-dialogue[10]

Twenty-one survey respondents answered questions regarding the ninth Bonn Call for Action priority related to fostering an improved radiation benefit-risk dialogue. Each of the three sub-actions scored equally according to two out of 21 respondents for being "fully implemented." A sub-action that has been "partially implemented" according to 14 out of 21 respondents pertains to increasing awareness about radiation benefits and risks among health professionals, patients, and the public. Table 9 provides an outline of the complete responses for this action item.

Table 9: Action 9 of the Bonn Call to Action

Action 9. Foster an improved radiation benefit-risk-dialogue[a10]	Fully Implemented	Partially Implemented	Not Implemented but Intend to Implement	Not Implemented and Unlikely to Implement	Not Applicable	No Answer
Increase awareness about radiation benefits and risks among health professionals, patients and the public;[10]	2 (10%)	14 (66%)	2 (10%)	3 (14%)	0 (0%)	0 (0%)
Support improvement of risk communication skills of health care providers and radiation protection professionals – involve both technical and communication experts, in collaboration with patient associations, in a concerted action to develop clear messages tailored to specific target groups;[10]	2 (10%)	11 (52%)	3 (14%)	3 (14%)	1 (5%)	1 (5%)
Work towards an active informed decision making process for patients.[10]	2 (10%)	3 (14%)	8 (38%)	3 (14%)	4 (19%)	1 (5%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Initiatives that have been implemented to promote compliance with fostering an improved radiation benefit-risk dialogue were reported by three survey responders, as follows:

- collaboration with other disciplines
- investment in education and training
- continuation of work on patient advocacy and the patient experience.

One survey responder reported that awareness is already a part of their program and, in large centres, those who need to know about the benefit-risk dialogue receive the necessary orientation. Another survey responder commented that there is only a very small team of experts (less than five people) in their organization of more than 30,000 people and, as such, widespread collaboration is challenging. Another survey participant reported that little is being done because it is difficult to establish a common vision among the large number of stakeholders.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

Fostering an improved radiation benefit-risk dialogue, according to one survey responder, may be facilitated by the utilization of the educational materials promoted by the CNSC. Another survey responder commented that they had never seen a Choosing Wisely sign in any hospital they had worked in, and that patients need to be informed but family physicians do not have the time to inform them.

Actions to Harmonize Activities Across Canada

Four survey responders provided suggestions and comments for actions to harmonize activities across Canada to foster an improved radiation benefit-risk dialogue. These actions include:

- compliance with CNSC policies
- education and information dissemination
- facilitation of agreement among stakeholders on how to inform patients about the risks and benefits associated with dosing.

Proposed Actions to Support These Principles in the Future

Five survey responders provided comments for actions to foster an improved radiation benefit-risk dialogue in the future. These actions relate to educating stakeholders and enhancing the radiation safety culture while balancing the benefits of radiation with the risks. One survey responder commented that harmonization would be challenging because an improved radiation benefit-risk dialogue is only one aspect of the patient experience and there is a need to focus on all aspects collectively.

Action 10. Strengthen the implementation of safety requirements globally[10]

Twenty-one survey respondents answered questions regarding the 10th Bonn Call for Action priority related to strengthening the implementation of safety requirements globally. A sub-action that has already been "fully implemented" according to seven out of 21 respondents pertains to furthering the establishment of legislative and administrative frameworks for the protection of patients, workers, and the public. A sub-action that has been "partially implemented" according to five out of 21 respondents pertains to the development of practical guidance to provide for the implementation of the International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources in health care globally. Table 10 provides an outline of the complete responses for this action item.

Table 10: Action 10 of the Bonn Call to Action

Action 10. Strengthen the implementation of safety requirements globally[10]	**Fully Implemented**	**Partially Implemented**	**Not Implemented but Intend to Implement**	**Not Implemented and Unlikely to Implement**	**Not Applicable**	**No Answer**
Develop practical guidance to provide for the implementation of the International Basic Safety Standards in health care globally;[10]	3 (14.3%)	5 (23.8%)	2 (9.5%)	5 (23.8%)	5 (23.8%)	1 (4.8%)
Further the establishment of sufficient legislative and administrative framework for the protection of patients, workers, and the public at national level, including enforcing requirements for radiation protection education and training of health professionals, and performing onsite inspections to identify deficits in the application of the requirements of this framework.[10]	7 (33%)	1 (5%)	3 (14%)	4 (19%)	5 (24%)	1 (5%)

[a] 21 survey respondents answered this question.

Activities Conducted to Promote Compliance

Initiatives that have been implemented in Canada to promote strengthening the implementation of safety requirements globally were reported by five survey responders as follows:

- the application of relevant safety standards where needed
- the inspection of sites by a Radiation Safety Officer at a minimum of every four years
- participation in provincial accreditation program standards, which included references to national safety codes
- investment in education and training
- policy development.

Policy and Practice Issues That May Facilitate or Prevent the Application of These Priorities

A practice issue that may facilitate strengthening the implementation of safety requirements globally according to one survey responder is the implementation of the policies and auditing conducted by the CNSC. Another survey responder commented that there is a consultation challenge.

A practice issue that has prevented strengthening the implementation of safety requirements globally according to a survey responder is that, for X-rays in their province, there are no regulations on radiation dose limits for patients or workers.

Actions to Harmonize Activities Across Canada

Six survey responders provided suggestions and comments for actions to strengthen the implementation of safety requirements globally. These actions include:

- Gain agreement to regulate activities federally.
- Invest in education and information dissemination.
- Invite medical physicists to the CAR — Canadian Association of Radiologists annual meeting to discuss radiation safety and usage with clinical peers.
- Apply measures locally before applying them across Canada.

One survey responder commented that strengthening the implementation of safety requirements globally is “laudable but very ambitious.”

Proposed Actions to Support These Principles

Five survey responders provided comments for actions to strengthen the implementation of safety requirements globally in the future. These actions include:

- Educate stakeholders.
- Ensure appropriate funding for quality assurance initiatives.
- Foster a relationship between CAR and radiation safety officers in the hope of building stronger working groups to facilitate the development of national standards.
- Follow up with changes and inform staff of updated new requirements.
- Develop clear provincial requirements and impose them on stakeholders.

Initiatives Not Addressed by the Bonn Call for Action

Six survey responders provided responses to this question. Three survey responders indicated that the Bonn Call for Action is comprehensive and no additional actions are required. One of these responders added that they "wished it was mandated by law that every department must begin an action plan on these steps;" two reported that they were not sure if the Bonn Call for Action addressed all needs. They did not specify potential deficiencies that may have been missing from the Bonn Call for Action. One survey responder reported a more general concern, not relating specifically to the Bonn Call for Action, but rather to radiation protection practice in Canada pertaining to the fact that not all provinces have regulations regarding radiation dose limits for the medical and dental use of X-rays for workers in the public health care system.

Limitations

The survey findings present the current context and trends in Canada (with the exception of the Territories) based on the perspectives of a limited number of people working in the field of radiation, and is not a comprehensive review of the topic. This report does not depict the full context of radiation protection practices; rather, the views presented may reflect the unique perspectives of the respondents. The results are presented from a pan-Canadian perspective and do not summarize information about specific jurisdictional practices. As well, the survey did not ask what work has been done directly in response to the Bonn Call for Action.

Conclusion

Overall, almost half of the survey respondents were not aware of the Bonn Call for Action. This is not to suggest that there are no initiatives in Canada aimed at radiation protection and safety. On the contrary, survey responses suggested that there are numerous initiatives at the federal, provincial, and local levels. However, there was general agreement among all survey responders that more could be done to support radiation protection and safety for patients and workers in Canada. Tools already being used to support radiation safety in some Canadian settings include dose-tracking devices, use of diagnostic reference levels, quality assurance audits, use of CT protocols for adult and pediatric populations, peer review of imaging exams, adoption of ALARA principles, and the use of Health Canada's Safety Code 35.[13] Clinical decision-support tools are also being used, although not to the extent many survey responders would like.

While initiatives have been developed to support radiation protection in Canada, according to many survey responders, not all initiatives are implemented, and adherence may vary from province to province, facility to facility, and in some instances from department to department. This, in part, may be because information is poorly and inconsistently disseminated. It has been suggested that the task of disseminating information requires a dedicated owner, either at the federal or provincial level, or at the professional body level, and that the owner should have responsibility for ensuring that information is organized and disseminated to appropriate groups and updated on a regular basis.

One of the underlying reasons for the lack of coordinated and harmonized efforts, as reported by survey responders, is a lack of education and training on radiation protection and safety. Indeed, the most common theme applied to every Bonn Call for Action priority, and often from numerous survey participants, relates to the need for more education and training on radiation awareness. A challenge associated with this pertains to keeping training programs up to date. As well, some medical imaging professionals are concerned that their advice on radiation protection may not always be adhered to by other specialists, and often their time for providing education and training is not reimbursed and thus the motivation to provide this service is limited.

There is concern from respondents that a culture of engagement and continuous improvement may not have reached its potential because clinicians from different specialties may be reluctant to collaborate. This may be because there are so many different clinical specialties involved in radiation that it is difficult to engage with them all effectively and find common ground between them. It may also be because different medical specialties face challenges when required to take direction from one another. It was noted that meaningful change can only occur in radiation protection when all stakeholders are engaged.

Numerous survey respondents were supportive of federal intervention in radiation protection, especially with regard to provincial adherence to Health Canada's Safety Code 35.[13] Some survey participants suggested that non-compliance with the Health Canada Safety Code 35[13] could be penalized with the suspension of professional licences or the imposition of fines.

Many survey respondents reported initiatives in Canada intended to address radiation protection that align with the Bonn Call for Action priorities. For example, for Action 3 ("Strengthen manufacturers' role in contributing to the overall safety regime"),[7] eight survey respondents reported fully implementing activities around the sub-action pertaining to reinforcing conformance to applicable standards of equipment regarding performance, safety, and dose parameters. Similarly, for Action 7 ("Improve prevention of medical radiation incidents and accidents"),[7] eight respondents reported that they had fully implemented activities related to the sub-action of implementing and supporting voluntary educational safety reporting systems for the purpose of learning from the return of experience of safety-related events in medical uses of radiation.

Six survey responders reported on whether the Bonn Call for Action was missing important priorities. Three survey responders indicated that the Bonn Call for Action is comprehensive and no additional actions are required, two reported that they were not sure if the Bonn Call for Action addressed all radiation safety and protection needs, and one remained very concerned that not all provinces have regulations regarding radiation dose limits for medical and dental use of X-rays, and suggested that this should be recognized as a priority in Canada. Overall, among the six survey responders who answered this question, there was no consensus on whether the Bonn Call for Action addresses all important priorities.

Radiation protection remains a challenge in Canada. To ensure that the risks of radiation are minimized, there is a need to identify opportunities for potential solutions that can be fully integrated across Canada. Solutions may require a collaborative approach involving all stakeholders in radiation protection. Based on the findings of this survey, these solutions will likely include, but not be limited to, education and training, and the development and regular review of regulations and guidelines.

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Appendix 1: Survey

Bonn Call for Action

Radiation Protection in Medicine in Canada

The International Atomic Energy Agency (IAEA) held the "International Conference on Radiation Protection in Medicine: Setting the Scene for the Next Decade" in Bonn, Germany, in December 2012, with the specific purpose of identifying and addressing issues arising in radiation protection in medicine. The conference was co-sponsored by the World Health Organization (WHO), hosted by the Government of Germany through the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and attended by 536 participants and observers from 77 countries and 16 organizations. An important outcome of the conference was the identification of responsibilities and a proposal for priorities for stakeholders regarding radiation protection in medicine for the next decade. This specific outcome is the Bonn Call-for-Action which may be found here. You have been identified as a key stakeholder in radiation protection in medicine in your institution/jurisdiction. Your input into this important survey will help to shape a contextualized Canadian approach to radiation protection of patients and health workers, and will promote the safe and appropriate use of ionizing radiation in medicine.

While responding to the survey, it is possible to save and return to where you left off. At any time, simply click on "Resume later" at the top-right of the screen; you will be prompted to fill in your name, a password of your choosing, and an email address. You will then be sent a link via email that when clicked, will take you back to the survey.

Please include some information about yourself and your role to help us. Our information will not be shared or used for any other purpose by CADTH than to support analysis of the survey data.

Please note that none of the survey questions are mandatory.

Name:

Title:

Institution/Region:

Province:

As a reminder, the **10 Bonn Call For Action** recommendations are:

Action 1: Enhance the implementation of the principle of justification
Action 2: Enhance the implementation of the principle of optimization of protection and safety
Action 3: Strengthen manufacturers' role in contributing to the overall safety regime
Action 4: Strengthen radiation protection education and training of health professionals
Action 5: Shape and promote a strategic research agenda for radiation protection in medicine
Action 6: Increase availability of improved global information on medical exposures and occupational exposures in medicine
Action 7: Improve prevention of medical radiation incidents and accidents
Action 8: Strengthen radiation safety culture in health care
Action 9: Foster an improved radiation benefit-risk-dialogue
Action 10: Strengthen the implementation of safety requirements globally

Respondent Information

It is not mandatory to fill in the following information fields to continue with the survey.

Question 1

Are you aware of the Bonn Call For Action recommendations?

☐ Yes, and I would like to complete the survey

☐ No; however, I would like to complete the survey and share my knowledge of radiation protection

☐ No; and, I would not like to complete the survey

As a reminder, the 10 Bonn Call For Action recommendations are:

Action 1: Enhance the implementation of the principle of justification
Action 2: Enhance the implementation of the principle of optimization of protection and safety
Action 3: Strengthen manufacturers' role in contributing to the overall safety regime
Action 4: Strengthen radiation protection education and training of health professionals
Action 5: Shape and promote a strategic research agenda for radiation protection in medicine
Action 6: Increase availability of improved global information on medical exposures and occupational exposures in medicine
Action 7: Improve prevention of medical radiation incidents and accidents
Action 8: Strengthen radiation safety culture in health care
Action 9: Foster an improved radiation benefit-risk-dialogue
Action 10: Strengthen the implementation of safety requirements globally

Principle Justification

Question 2

Please tick the activities below that you have implemented to support Action 1: Enhance the implementation of the principle of justification.

Introduce and apply the 3A's (awareness, appropriateness and audit), which are seen as tools that are likely to facilitate and enhance justification in practice;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Develop harmonized evidence-based criteria to strengthen the appropriateness of clinical imaging, including diagnostic nuclear medicine and non-ionizing radiation procedures, and involve all stakeholders in this development;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Implement clinical imaging referral guidelines globally, keeping local and regional variations in mind, and ensure regular updating, sustainability and availability of these guidelines;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Strengthen the application of clinical audit in relation to justification, ensuring that justification becomes an effective, transparent and accountable part of normal radiological practice;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Introduce information technology solutions, such as decision support tools in clinical imaging, and ensure that these are available and freely accessible at the point-of-care;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Further develop criteria for justification of health screening programmes for asymptomatic populations (e.g. mammography screening) and for medical imaging of asymptomatic individuals who are not participating in approved health screening programmes (e.g. use of CT for individual health surveillance).

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Implementation of the Principle of Optimization of Protection and Safety

Question 3

Please tick the activities below that you have implemented to support Action 2: Enhance the implementation of the principle of optimization of protection and safety:

Ensure establishment, use of, and regular update of diagnostic reference levels for radiological procedures, including interventional procedures, in particular for children;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Strengthen the establishment of quality assurance programmes for medical exposures, as part of the application of comprehensive quality management systems;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Implement harmonized criteria for release of patients after radionuclide therapy, and develop further detailed guidance as necessary;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Develop and apply technological solutions for patient exposure records, harmonize the dose data formats provided by imaging equipment, and increase utilization of electronic health records.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Strengthen Manufacturer's Role

Question 4

Please tick the activities below that you have implemented to support Action 3: Strengthen manufacturers' role in contributing to the overall safety regime:

Ensure improved safety of medical devices by enhancing the radiation protection features in the design of both physical equipment and software and to make these available as default features rather than optional extra features;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Support development of technical solutions for reduction of radiation exposure of patients, while maintaining clinical outcome, as well as of health workers;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Enhance the provision of tools and support in order to give training for users that is specific to the particular medical devices, taking into account radiation protection and safety aspects;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Reinforce the conformance to applicable standards of equipment with regard to performance, safety and dose parameters;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Address the special needs of health care settings with limited infrastructure, such as sustainability and performance of equipment, whether new or refurbished;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Strengthen cooperation and communication between manufacturers and other stakeholders, such as health professionals and professional societies;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Support usage of platforms for interaction between manufacturers and health and radiation regulatory authorities and their representative organizations.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Strengthen Radiation Protection Education

Question 5

Please tick the activities below that you have implemented to support Action 4: Strengthen radiation protection education and training of health professionals.

Prioritize radiation protection education and training for health professionals globally, targeting professionals using radiation in all medical and dental areas;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Further develop the use of newer platforms such as specific training applications on the Internet for reaching larger groups for training purposes;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Integrate radiation protection into the curricula of medical and dental schools, ensuring the establishment of a core competency in these areas;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Strengthen collaboration in relation to education and training among education providers in health care settings with limited infrastructure as well as among these providers and international organizations and professional societies;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Pay particular attention to the training of health professionals in situations of implementing new technology.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Shape and Promote a Strategic Research Agenda

Question 6

Please tick the activities below that you have implemented to support Action 5: Shape and promote a strategic research agenda for radiation protection in medicine:

Explore the re-balancing of radiation research budgets in recognition of the fact that an overwhelming percentage of human exposure to manmade sources is medical;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Strengthen investigations in low-dose health effects and radiological risks from external and internal exposures, especially in children and pregnant women, with an aim to reduce uncertainties in risk estimates at low doses;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Study the occurrence of and mechanisms for individual differences in radiosensitivity and hyper-sensitivity to ionizing radiation, and their potential impact on the radiation protection system and practices;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Explore the possibilities of identifying biological markers specific to ionizing radiation; Advance research in specialized areas of radiation effects, such as characterization of deterministic health effects, cardiovascular effects, and post-accident treatment of overexposed individuals;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Promote research to improve methods for organ dose assessment, including patient dosimetry when using unsealed radioactive sources, as well as external beam small-field dosimetry.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Increase Availability of Improved Global Information

Question 7

Please tick the activities below that you have implemented to support Action 6: Increase availability of improved global information on medical exposures and occupational exposures in medicine.

Improve collection of dose data and trends on medical exposures globally, and especially in low- and middle-income countries, by fostering international co-operation;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Improve data collection on occupational exposures in medicine globally, also focussing on corresponding radiation protection measures taken in practice;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Make the data available as a tool for quality management and for trend analysis, decision making and resource allocation.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Improve Prevention of Medical Radiation Incidents

Question 8

Please tick the activities below that you have implemented to support Action 7: Improve prevention of medical radiation incidents and accidents.

Implement and support voluntary educational safety reporting systems for the purpose of learning from the return of experience of safety related events in medical uses of radiation;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Harmonize taxonomy in relation to medical radiation incidents and accidents, as well as related communication tools such as severity scales, and consider harmonization with safety taxonomy in other medical areas;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Work towards inclusion of all modalities of medical usage of ionizing radiation in voluntary safety reporting, with an emphasis on brachytherapy, interventional radiology, and therapeutic nuclear medicine in addition to external beam radiotherapy;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Implement prospective risk analysis methods to enhance safety in clinical practice;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Ensure prioritization of independent verification of safety at critical steps, as an essential component of safety measures in medical uses of radiation.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Strengthen Radiation Safety Culture

Question 9

Please tick the activities below that you have implemented to support Action 8: Strengthen radiation safety culture in health care.

Establish patient safety as a strategic priority in medical uses of ionizing radiation, and recognize leadership as a critical element of strengthening radiation safety culture;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Foster closer co-operation between radiation regulatory authorities, health authorities and professional societies;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Foster closer co-operation on radiation protection between different disciplines of medical radiation applications as well as between different areas of radiation protection overall, including professional societies and patient associations;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Learn about best practices for instilling a safety culture from other areas, such as the nuclear power industry and the aviation industry;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Support integration of radiation protection aspects in health technology assessment;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Work towards recognition of medical physics as an independent profession in health care, with radiation protection responsibilities;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Enhance information exchange among peers on radiation protection and safety-related issues, utilizing advances in information technology.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Foster an Improved Radiation Benefit-Risk-Dialogue

Question 10

Please tick the activities below that you have implemented to support Action 9: Foster an improved radiation benefit-risk-dialogue.

Increase awareness about radiation benefits and risks among health professionals, patients and the public;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Support improvement of risk communication skills of health care providers and radiation protection professionals – involve both technical and communication experts, in collaboration with patient;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Associations, in a concerted action to develop clear messages tailored to specific target groups;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Work towards an active informed decision making process for patients.

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Strengthen the Implementation of Safety Requirements

Please tick the activities below that you have implemented to support Action 10: Strengthen the implementation of safety requirements globally:

Question 11

Please tick the activities below that you have implemented to support Action 10: Strengthen the implementation of safety requirements globally:

Develop practical guidance to provide for the implementation of the International Basic Safety Standards in health care globally;

☐	☐	☐	☐	☐
Fully implemented	**Partially implemented**	**Not implemented but intend to implement**	**Not implemented and unlikely to implement**	**Not applicable**

Further the establishment of sufficient legislative and administrative framework for the protection of patients, workers and the public at national level, including enforcing requirements for radiation protection education and training of health professionals, and performing on-site inspections to identify deficits in the application of the requirements of this framework.

☐	☐	☐	☐	☐
Fully implemented	Partially implemented	Not implemented but intend to implement	Not implemented and unlikely to implement	Not applicable

What has been done in your jurisdiction to promote compliance?
Comment:

Are there policy or practice issues at the national/provincial/local level that may have facilitated or prevented your application of these principles?
Comment: Please provide specific examples

What actions could be taken to harmonize activities across Canada?
Comment:

What could be done to support these principles in the future?
Comment:

Additional Actions for the Bonn Call for Action

Question 12

Are there actions that could be taken that have not been addressed in the Bonn Call for Action?

Your participation on this survey is greatly appreciated.

Thank you.

Appendix 2: Information on Survey Respondents

Province/Territory	Organization Represented by Survey Respondents
British Columbia	Vancouver Coastal Health Authority, Interior Health Authority, Island Health Authority, Northern Health Authority
Alberta	University of Alberta, Alberta Health Services
Saskatchewan	Saskatoon Health Region
Manitoba	CancerCare Manitoba
Ontario	Hamilton Health Sciences and St. Joseph's Healthcare Hamilton, Western University, Carleton University
Quebec	Ordre des technologues en imagerie médicale, en radio-oncologie et en électrophysiologie médicale du Québec, CHUS Centre hospitalier universitaire de Sherbrooke, CHU de Québec, Centre intégré universitaire de santé et de services sociaux de la Mauricie-et-du-Centre-du-Québec Centre hospitalier affilié universitaire régional (CHAUR)
New Brunswick	Centre hospitalier universitaire Dr-Georges-L.-Dumont
Prince Edward Island	Health PEI
Nova Scotia	Nova Scotia Health Authority[a]
Newfoundland and Labrador	Eastern Health
Northwest Territories	None identified
Yukon	None identified
Nunavut	None identified

[a] Either Central Zone or unspecified.