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Original Article

Radiotherapy-specific quality indicators at national level: How to make it happen

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ABSTRACT

Purpose /objective: To promote best practice and quality of care, the Belgian College of Physicians for Radiotherapy Centers established a set of radiotherapy specific quality indicators for benchmarking on a national level. This paper describes the development, the collected QIs, the observed trends and the departments' evaluation of this initiative.

Material and methods: The Donabedian approach was used, focussing on structural, process and outcome QIs. The criteria for QI selection were availability, required for low-threshold regular collection, and applicability to guidelines and good practice. The QIs were collected yearly and individualized reports were sent out to all RT departments. In 2021, a national survey was held to evaluate the ease of data collection and submission, and the perceived importance and validity of the collected QIs.

Results: 18 structural QI and 37 process and outcome parameters (n = 25 patients/pathology/department) were collected. The participation rate amounted to 95 % overall. The analysis gave a national overview of RT activity, resources, clinical practice and reported acute toxicities. The individualized reports allowed departments to benchmark their performance.

The 2021 survey indicated that the QIs were overall easy to collect, relevant and reliable. The collection of acute recorded toxicities was deemed a weak point due to inter-observer variabilities and lack of follow-up time.

Conclusion: QI collection on a national level is a valuable process in steering quality improvement initiatives. The feasibility and relevance was demonstrated with a high level of participation. The national initiative will continue to evolve as a quality monitoring and improvement tool.

There has been a growing interest in defining and collecting quality indicators (QI) that can guide healthcare programs, institutions and departments in monitoring and improving the quality of care provided to patients. A clear definition and continuous collection of QIs allows for the monitoring of performance over time. Even more, centres or countries can compare their results with others through the process of benchmarking if QIs are collected on a multicentric or multi-national basis [1–4]. Through this process, it is possible to identify gaps in practice and to put into place improvement actions that favour the delivery of best-quality care.

This increased interest for QIs is also evident in the field of oncology and even more specifically the field of radiation oncology (RO) [5–12]. RO involves a complex and multi-step process that calls for the development of a thorough quality assurance program within a quality management system that promotes continuous quality improvement through audits, risk assessment and quality indicators [13,14]. Deploying a quality assurance program locally, within a department, can be facilitated by regional or national incentives.

Abbreviations: RO, Radiation oncology; QI, Quality indicator.

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In Belgium, for instance, the College of Physicians for Radiotherapy Centers (later referred to as "the College") is a committee mandated by the Belgian Federal Government, whose mission is to improve the quality of radiotherapy delivered in Belgium. In order to carry out this mission, the College is allocated a yearly budget, based on an application estimating the operational costs to run the projects. The College is composed of a board of 8 radiation oncologists, nominated by the RO professionals and validated by the Belgian Federal Public Health Service. Additional experts are invited to participate to the meetings, including other radiation oncologists based on specific expertise, as well as medical physicists, radiation therapists and quality managers. All participants collaborate on a voluntary basis.

Over the past decades, the College has been successful in implementing and supervising a number of quality improvement initiatives, including the organisation of national delineation intervision projects, structured incident reporting using the PRISMA-RT methodology, national peer review clinical audits based on the IAEA QUATRO methodology and external dosimetry audits (BeldART) [15–22]. Within this multifaceted national program of quality assurance and improvement, a Belgian RO-QI project was launched, with the aim to define radiotherapy-specific QIs that could be collected in all RO departments in the country.

This paper describes the development of the project, the definition of the QI data set and how data were collected by and reported to the participating centres. Beyond presenting some high-level data that were collected, illustrating the most important trends observed across RO departments in Belgium, an evaluation of the value of this national QI initiative, as perceived by the participating departments, is presented.

Materials and methods

In 2015, following the national requirement to collect quantitative data annually, the College members started the development of the Belgian RO-QI program. The aim was to generate data to evaluate Belgian RO practice in the context of established guidelines of good clinical practice and to provide feedback to individual centres to improve their practice. Fig. 1 provides an overview of the different steps undertaken in the Belgian RO-QI project.

Development of the QI data set

After an initial brainstorming session in June 2014, it was decided to follow the Donabedian methodology to define a set of QIs. This is a well-known model that provides a framework for healthcare quality evaluation based on information collected from three different dimensions of care: structure, progress and outcome [23,24]. For each dimension, a small group of experts composed of radiation oncologists, medical physicists and quality managers was appointed to review available evidence. The 'structure group' focused on radiotherapy utilisation, availability of human and capital resources, workload and treatment complexity, largely based on information from the ongoing Health Economics in Radiation Oncology (HERO) project of the European Society of Radiation Oncology (ESTRO) and references from the International Atomic Energy Agency (IAEA) [25–31]. The 'process group' worked on the concept of collecting indicators that would allow defining the gap between the actual and optimal clinical practice, mainly focusing on available reports from France and The Netherlands [32,33]. The 'outcome group' suggested a set of clinical parameters with a focus on acute toxicity, selected from the Common terminology Criteria for Adverse Events (CTCAE) [34].

Following two rounds of review and discussion by the entire College, a definitive set of QIs was agreed upon through consensual agreement. This set tried to strike the right balance between the desire to collect a large number of data and the recognition of the practical limitations and data availability within the departments: besides structure indicators pertaining to the departmental level, patient-level QIs were defined for process and outcome, limited in number and pathology (breast, prostate and head-and-neck cancer).

Collecting QI data at national level

Once the QIs were agreed upon, a test phase was launched in June 2015, collecting the full set of structural QIs, but limiting the patient-specific QIs to a restricted number of patients (n = 5 per pathology/department). This was done by sending forms (Microsoft Access, 2007–2010) to all Belgian RO departments. This preliminary step allowed to validate the feasibility of collecting the

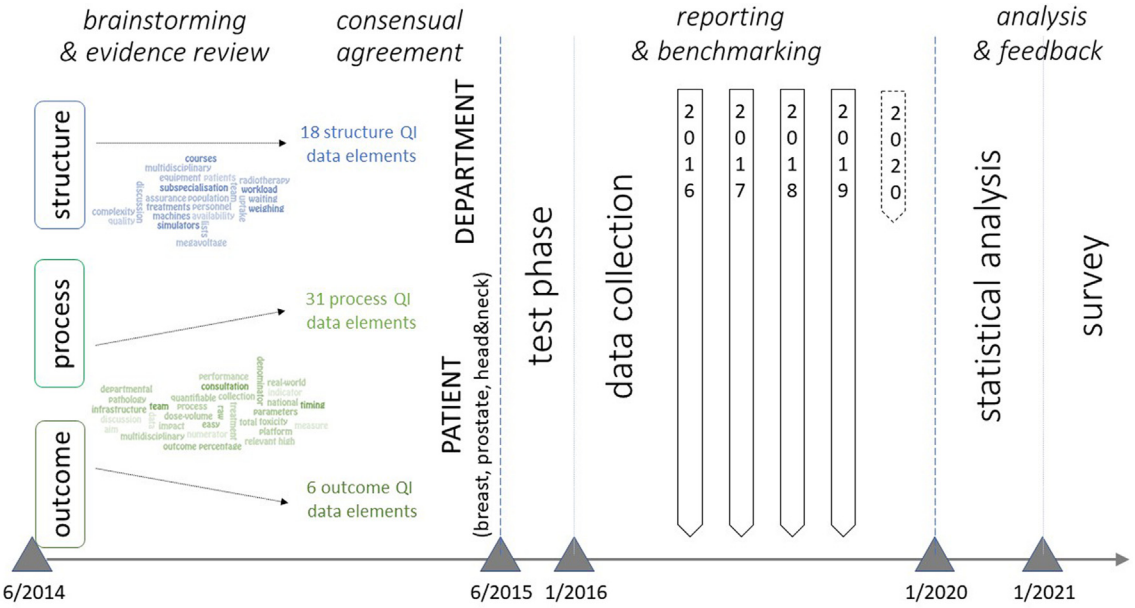

Fig. 1. Overview of the different steps undertaken in de Belgian RO-QI project.

required data but also to refine some of the requested data elements in order to obtain homogeneous and consistent records.

Once the data collection form validated, a broader capture of process and outcome QIs was started in 2016 (n = 25 patients/pathology/department, randomly picked and ideally consecutive) along with the structural QI data. This number was defined balancing feasibility at departmental level with the generation of a considerable dataset nationwide that would allow for the formulation of meaningful observations and trends. This data capture, initially using Microsoft Access, was transferred in 2017 into RedCap's (Research Electronic Data Capture) web-based software platform [35,36]. Data collected were encoded into RedCap through a department-dedicated link, provided to the department's quality manager and the head of department.

QI collection of all primary accredited Belgian RO departments was performed on a yearly basis. In 2015, this amounted to 25 departments, but following the fusion of two departments, this became 24. Eight departments operate satellite sites and these were also included in the data collection process (13 satellite sites in 2016 that decreased to 11 in 2020) – two of which participate in the QI project independently from their primary site [37].

Data analysis

The collected data were centralized and analysed in Microsoft Excel (2016 MSO), to generate both a global yearly report for the Federal Public Health Service and individualized and anonymized benchmarking documents, in which the departments can identify their performance compared to the other Belgian departments. This work was carried out by a quality manager dedicated for 0.3 full time equivalent to the College's QI project and clinical audits' organisation. Descriptive statistics were used to summarize both the individual department's and national data with most findings summarized in graphical format to allow for overall visualisation of the department's data versus the national trends.

Feedback on the QI project

In 2021, a survey sent out to the Belgian RO community evaluated the usefulness of the project, the ease of the data collection and the perceived importance and scientific validity of the collected QIs. This survey, consisting of 52 questions (see appendix 1), was generated in REDCap and sent to all accredited Belgian RO departments in January 2021 including the 2 satellite sites that independently participated in the project (n = 26). The data was extracted into Microsoft Excel for data analysis (Microsoft Excel, 2016 MSO).

Results

After validation through the feasibility test phase, a data set consisting of 55 QIs was defined, to be collected on yearly basis (see Table 1 and Table 2). This is composed of 18 structural QIs and 37 process and outcome site-specific QIs: 11 process and 1 outcome QI for breast, 11 and 2 for prostate and 9 and 3 for H&N cancer, respectively. Site-specific QIs were collected for 25 patients per pathology and per department - of which outcome QIs focused on acute toxicities.

The complete QI dataset was collected on a yearly basis from 2016 until 2019 with a mean overall participation rate of 95 % of all RO departments (24 primary departments). Sixteen of the 24 departments were actively involved in the QI project on a yearly basis; departments that did not clarified that this was mostly due to the lack of a quality manager within the department and/or lack of time. Two departments were unable to collect data on 25 H&N cancer patients due to the limited number of patients treated in their department. For those departments that participated and for all included patients, there was a 98,8% QI data completion rate.

The majority of data from the satellite sites was collected through the primary departments. In most cases, satellite site

Table 1
Structural Quality Indicators.

Quality Indicators	Element measured
External beam radiotherapy (EBRT)	
Equipment availability	Number of EBRT equipment available per department
Mean age of EBRT equipment	Overall age of the available EBRT equipment
Type of radiation available on EBRT equipment	The types of radiation available on the EBRT equipment (photon/electron/both)
Equipment capable of Intensity Modulated Radiotherapy (IMRT) delivery	Number of equipment capable of IMRT delivery
Type of Image Guided radiotherapy (IGRT) available on equipment	Number of equipment capable of different types of IGRT (kV, MV, volumetric..)
EBRT treatments delivered	Number of EBRT treatments delivered
EBRT sessions delivered	Numbers of EBRT sessions(=fractions) delivered
Sessions per EBRT treatment	Average number of sessions (=fractions) delivered per EBRT treatment
Used EBRT treatment technique	Proportion of types of treatment techniques used per department (2D, 3D, static IMRT, volumetric IMRT, stereotactic)
Brachytherapy treatments (BT)	
BT activities	Number of BT treatments per department
Type of BT equipment	Types of BT equipment available (manual/manual afterloading/remote afterloading)
Used Isotopes in BT activities	Type of isotopes used per indication per department
Application types in BT activities	Types of applications used in BT activities (intracavitary, interstitial, other)
Used applicator types in BT activities	Types of applicators used in BT activities (strand of seeds, mini-cylinders, wire…)
Used operation modes	Type of delivery mode used in BT activities
Intraoperative radiotherapy (IORT)	
IORT activities	Number of IORT treatments per department
Human resources	
Staffing levels	Number and full time equivalent of staff (radiation oncologists, medical physicists, Radiation Therapists, quality managers) available per department
Radiation Oncologist (RO) specialisation	Level of pathology-specific expertise/RO

(EBRT: External Beam Radiotherapy / IMRT: Intensity Modulated radiotherapy/ IGRT: Image guided radiotherapy/BT: Brachytherapy/IORT: Intraoperative radiotherapy/RO: Radiation Oncologist).

Table 2
Patient-related process and outcome Quality Indicators, per pathology.

Quality Indicators	Element measured	Type of QI
Breast cancer patients *(excluding breast external radiotherapy treatments (EBRT) requiring nodal irradiation or bilateral breast irradiation; excluding patients benefiting from intra- operative radiotherapy (IORT) or brachytherapy)*		
Discussion in multidisciplinary (MTD) meeting	Use of MTD for patient discussion (and availability of data)	Process
Timely delivery of treatment after simulation	Time necessary to deliver the first fraction of the EBRT treatment after simulation	Process
Timely delivery of the treatment	Time required to complete the EBRT treatment as a function of the number of fractions prescribed	Process
Used treatment techniques	Proportion of treatment techniques used for breast patients	Process
Used image guided radiotherapy (IGRT) techniques	Proportion of IGRT techniques used for breast patients	Process
Use of respiratory motion management techniques	Proportion of left breast patients for which respiratory motion management technique is used	Process
Use of prone position	The use of the prone position for the EBRT treatment of breast cancer patients	Process
Used fractionation scheme	Dose prescribed to the high dose PTV and the boost considering the use of SIB, the number of fractions, the dose per fraction and the total dose (+frequency at which it is delivered)	Process
Use of concomitant systematic therapy	Use of concomitant systematic therapy	Process
D2 of target volume (breast)	Measured D2 of CTV (=PTVeval) of breast (Gy) on treatment plan	Process
Mean heart dose	Measured mean heart dose evaluated on treatment plan	Process
Breast acute toxicity grading (radiodermatitis)	Reported maximum acute radiodermatitis grading for breast cancer patients treated with EBRT only	Outcome
H&N Cancer patient *(excluding T1N0 glottis)*		
Discussion in multidisciplinary meeting	Use of MTD for patient discussion (and availability of data)	Process
Timely delivery of treatment after simulation	Time necessary to deliver first fraction of EBRT treatment after simulation	Process
Timely delivery of the treatment	Time required to complete the EBRT treatment as a function of the number of fractions prescribed	Process
Used treatment techniques	Proportion of treatment techniques used for H&N patients	Process
Used IGRT techniques	Proportion of IGRT techniques used for H&N patients	Process
Used fractionation scheme	Dose prescribed to the high dose PTV and the boost considering the use of Simultaneous Integrated Boost (SIB), the number of fractions, the dose per fraction and the total dose (+frequency at which it is delivered)	Process
Use of concomitant systematic therapy	Use of concomitant systematic therapy	Process
Mean homolateral parotid dose (Gy)	Measured homolateral mean parotid dose on treatment plan	Process
Mean controlateral parotid dose (Gy)	Measured controlateral mean parotid dose on treatment plan	Process
H&N acute toxicity grading (mucositis)	Reported maximum acute mucositis grading for H&N cancer patients treated with EBRT	Outcome
H&N acute toxicity grading (radiodermatitis)	Reported maximum acute radiodermatitis grading for H&N cancer patients treated with EBRT	Outcome
H&N acute toxicity grading (weight loss)	Reported weight loss for H&N cancer patients treated with EBRT	Outcome
Prostate cancer patients *(Excluding patients with prostatectomy Excluding patients also benefiting from brachytherapy treatment to the target volume)*		
Discussion in multidisciplinary meeting	Use of MTD for patient discussion (and availability of data)	Process
Timely delivery of treatment after simulation	Time necessary to deliver first fraction of EBRT treatment after simulation	Process
Timely delivery of the treatment	Time required to complete the EBRT treatment as a function of the number of fractions prescribed	Process
Used treatment techniques	Proportion of treatment techniques used for prostate patients	Process
Used IGRT techniques	Proportion of IGRT techniques used for prostate patient	Process
Use of implanted fiducials	Use of fiducial markers for prostate EBRT treatments	Process
Daily Online correction	Frequency at which daily online IGRT corrections are used	Process
Used fractionation scheme	Dose prescribed to the high dose PTV and the boost considering the use of SIB, the number of fractions, the dose per fraction and the total dose (+frequency at which it is delivered)	Process
Use of concomitant systematic therapy	Use of concomitant systematic therapy	Process
Rectum V50	Measured rectum V50 (%)	Process
Documentation of toxicity grading	Proportion of prostate cancer patients treated with EBRT for which there is a recorded toxicity grading	Process
Prostate acute toxicity grading (cystitis)	Reported maximum acute cystitis grading for prostate cancer patients treated with EBRT	Outcome
Prostate acute toxicity grading (proctitis)	Reported maximum acute proctitis grading for prostate cancer patients treated with EBRT	Outcome

(EBRT: External Beam Radiotherapy / IMRT: Intensity Modulated radiotherapy/ IGRT: Image guided radiotherapy/BT: Brachytherapy/ IORT: Intraoperative radiotherapy/ RO: Radiation Oncologist/ MTD: Multidisciplinary meeting/ SIB: Simultaneous Integrated boost/ PTV: Planning Target Volume/ CTV: Clinical Target Volume/).

activities are an integral part of the primary department's activities. In 2019, 2 satellite sites requested to have their own data collection and benchmarking documents. During that same year, one department stopped collecting patient-related QIs and in 2020, it was decided to pause the collection of patient-specific process and outcome QIs in order to allow for a thorough analysis of the data. All departments participated to the 2020 set of structural QI data.

Data analysis of the collected data and QIs generated department-specific reports sent to each department for inter-department benchmarking. An example of an analysis is illustrated in Fig. 2, in which the number of days lost during treatment delivery for H&N cancer patients are shown. Large inter-department variations can be observed. It was found that some departments favor compensating external beam radiotherapy interruptions (e.g. machine breakdown, maintenance) with twice daily fractionation doses schemes, while others do not adapt scheduling.

Organisational and clinical practice trends were observed over time, communicated to the departments through the benchmarking report and during annual College and department heads meetings [36]. The observed national trends are synthesized in Table 3.

Regarding the questionnaire sent in 2021 to obtain departmental feedback on the national QI project, 23 of the 26 (24 primary departments + 2 satellite sites) contacted departments responded.

Impact of QI project: Nine departments (38,5%) stated that the QI project stimulated a change in organisational practice, i.e. by

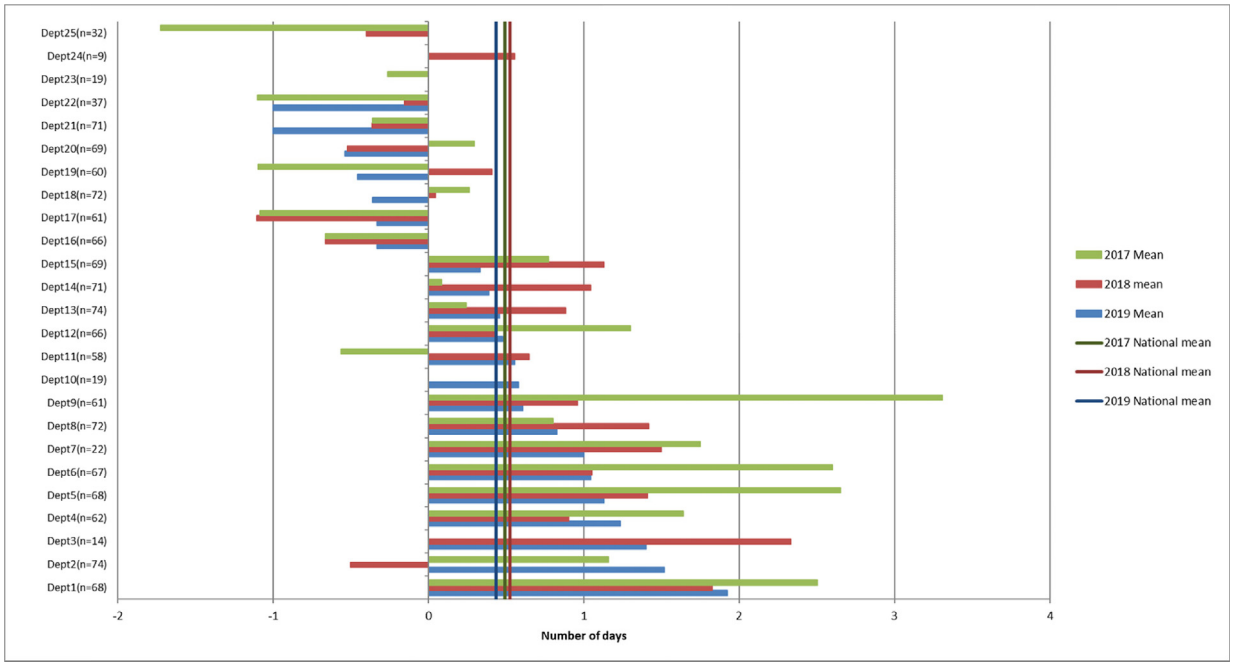

Fig. 2. Mean number of days lost in the delivery of EBRT treatment for H&N cancer patients per department from 2017 to 2019 (n = sum of the number of patients included the analysis in 2017, 2018 and 2019).

Table 3
National trends observed between 2016–2020 for the structural QIs and 2016–2019 for the process and outcome QIs.

Structural QI (2016–2020)	Process QI and outcome QI (2016–2019)
Increasing overall number of EBRT treatments delivered, by 1 %.	**Breast cancer patients**
Decreasing mean number of sessions/treatment (movement towards hypofractionation)	Trend towards more hypofractionation
	The use of static IMRT has overtaken 3D conformal treatments
Increasing use of IMRT and increasing number of stereotactic treatments	Low and decreasing proportion of patients affected by grade 2 radiodermatitis (from 20 % of patients to 10 % patients)
Stable workload of staff, although the number of sessions/RTT seems to have decreased (hypofractionation)	**Prostate cancer patients**
	Evolution towards hypofractionation (most importantly between 2018 and 2019)
	The use of volumetric IMRT and daily IGRT have become the norm
	Low and stable proportion of patients with proctitis grade 2 (10 %)
	Moderate and stable proportion of patients with cystitis grade 2 (20 %)
	Rare grade 3 and 4 cystitis (in less than 1 % of patients)
	H&N cancer patients
	Stable fractionation schemes with a majority of treatments being delivered with 30–35 fractions
	The use of rotational IMRT has become dominant (80 %)
	Decreasing percentage of grade 3 mucositis (-10 %)
	Decreasing grade 2 and grade 3 radiodermatitis
	Stable proportion of patients suffering from grade 3 weight loss (5 %)

(EBRT: External Beam Radiotherapy / IMRT: Intensity Modulated radiotherapy/ IGRT: Image guided radiotherapy).

favouring an increase of staff numbers and data centralization, necessary for QI monitoring. Five departments (22 %) stated that the project had an impact on their clinical practice with changes in fractionation schemes and treatment techniques used (i.e. implementation of breathhold techniques) and decreasing process times (e.g. between simulation and treatment start, overall treatment times). The QI project also stimulated better documentation of toxicities. All departments except one found the personalized yearly report of use to compare their performance levels to other departments/national trends.

Ease of data collection: Most data elements where considered easy to collect, although some departments expressed difficulty in collecting full time equivalent figures for staff (complicated by long medical absence or maternity leaves) and the actual number of fractions delivered on a yearly basis. Patient-specific data was also deemed quite easy to collect, although some difficulty was expressed in collecting data on the use of systemic therapy and dates of the multidisciplinary team meetings (MDT) – mostly in sites where these activities are held outside of the radiotherapy department's organisation. Furthermore, access to patient toxicities was often hindered by the fact that this is not always found in a well-structured manner in the health records.

*Importance of collected QIs (*Fig. 3*A):* All collected structural, process and outcome QIs were considered important to monitor, although questions arose concerning the workload parameter (number of treatments (sessions)/professional group), estimating that workload cannot solely be captured by the number of treatments/professional group. It was considered of less importance to monitor the use of MDTs as this is a national requirement.

*Reliability of collected QIs (*Fig. 3*B*): All data collected for the estimation of QIs were deemed reliable except for the documentation of acute toxicities, as the sample size was limited and there seemed to be significant inter-departmental differences in toxicity grading. Furthermore, some higher toxicity grading appearing after radiotherapy treatment delivery may not have been captured due to unavailability of patient follow-up data.

All participating departments agreed that the national QI project should continue. Half of them suggested that adjustments would be needed, e.g. integrating Patient Reported Outcome Measures (PROMS) and favoring data extraction automation to allow more patients and pathologies to be included in the project.

Discussion

Measuring the quality of care, using QIs, has in past decades slowly seeped into the healthcare setting with the aim to evaluate structures and processes impacting patient care and outcome [38,39]. Numerous publications have focused on the field of oncology, yet typically with a global vision on the oncological pathway of the patient and with little focus being attributed more specifically to radiotherapy [10]. As such, there has been a growing interest in defining radiotherapy-specific QIs that can be measured both locally and at a multicentric level and that can guide radiotherapy departments in setting up quality improvement initiatives. While several publications have mostly focussed on the development of general QIs [8,9,12,40,41], others have targeted disease-specific QIs with a focus on developing process QIs [11,42–47].

In Belgium, the development of radiotherapy-specific QIs has been recommended by the federal government, in the context of the National Cancer Plan, to help radiotherapy departments further optimise the quality of the delivered care. This task was embraced by the Belgian College of Physicians for Radiotherapy Centers, which successfully developed a set of QIs, collected on a yearly basis from 2016 until now and adhered to by almost all radiation

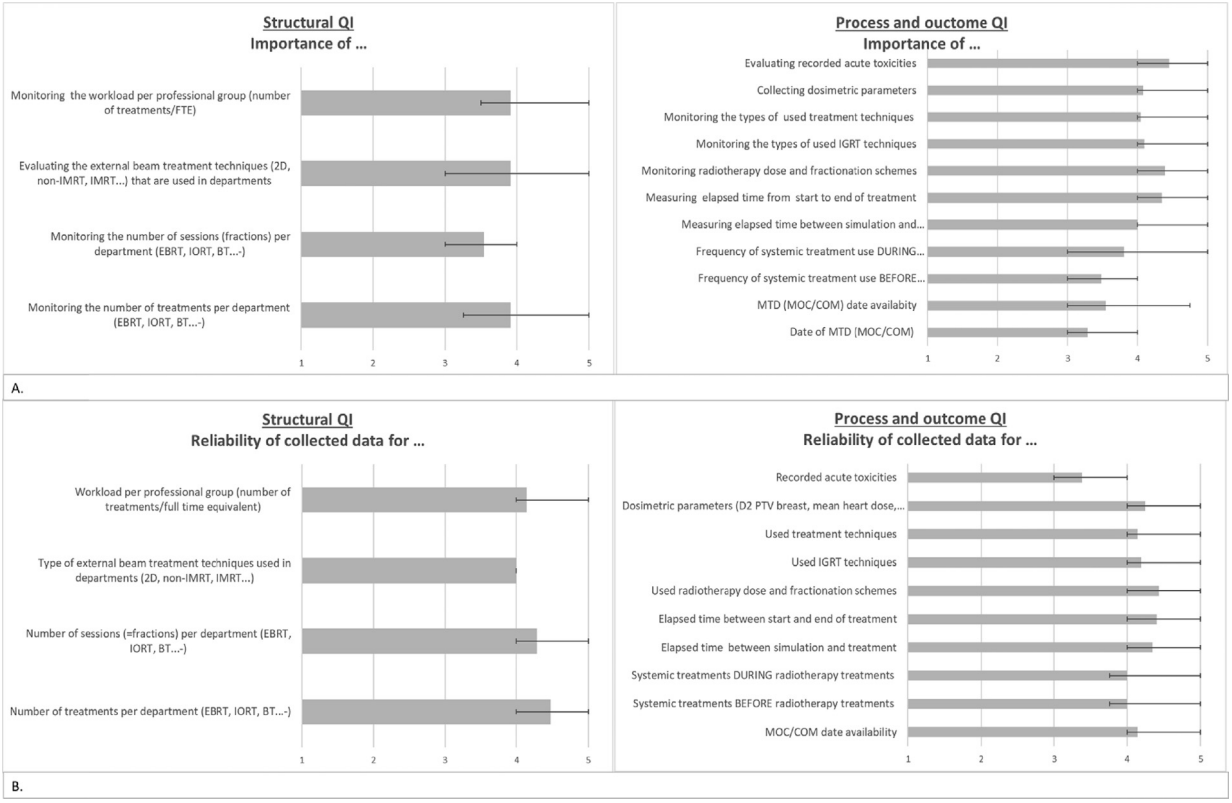

Fig. 3. Departments' evaluation of the level of importance of the collected QIs and of the level of reliability of the collected data (A) Departments' mean evaluation of the level of importance of the collected QIs (1- Not important; 5 - Very important). Error bars represent the interquartile range; (B) Departments' evaluation of the reliability of the data collected for the different QIs (1 – Not at all reliable; 5- Completely reliable). Error bars represent the interquartile range.

oncology departments. Although mandated by the federal government, participation of individual departments is on voluntary basis without financial incentives or disincentives. Equally high adherence is seen in other College initiatives (BeldART, intervision projects…) [17,18,20,21], suggesting a radiation oncology community strongly motivated to improve quality. Engagement of departments in this and other College projects is further stimulated by the organisation of yearly meetings in which the status of the College's projects is shared with department heads and their peers. Lastly, participation may have further been aided by the nature of the QIs themselves, defined using the SMART principle [48], and facilitated by the presence of quality managers in the radiotherapy departments. Indeed, since 2010, action 16 of the National Cancer Plan supports the financing of one quality manager per radiotherapy department [49]. The crucial role of dedicated quality managers in the implementation of quality improvement initiatives and setting up a quality management system has previously been demonstrated [50,51].

The yearly collection and analysis of QIs is a first step towards capturing real-life data portraying actual clinical practice and its potential impact on patient outcome, outside the context of controlled research settings. Although the number of patients included in the site-specific QIs was restricted, its analysis over time demonstrated the progressive clinical uptake of literature evidence, such as the increasing use of hypofractionation in prostate and breast cancer, and the uptake of IMRT and breathhold techniques [52–58]. The recorded acute toxicities have also shown encouraging results, with higher-grade toxicities ($\geq$3) typically being limited to 1 % of patients, except for dermatitis and mucositis in H&N patients.

Anticipating that radiotherapy parameters play an important role in toxicity - along with patient and tumour characteristics - analysis is currently underway to further elucidate the link between practice and outcome. While the number of patients for which data was collected was purposely chosen to not overburden departments with the data collection process, this may limit the analysis. A larger number of patients and moving towards big data analyses is the ambition, but can only realistically be undertaken with the automation of data extraction from existing radiotherapy information systems or hospital electronic health records [59–64]. This path is currently investigated in the Belgian landscape. In the meantime, it is either foreseeable to slightly increase the number of included patients or to collect QIs on a department-based level (e.g.: treatment technique generally used for a pathology and not collected on individual basis).

When defining QIs, it is important to clearly document the attributes of the measured QIs including its definition and specifications, rationale, inclusion/exclusion criteria and its goals [38,64]. It is also important to ensure that the collected QIs are reliable (=level of reproducibility) and valid (=level of accuracy) [65]. In this context, it is noteworthy that QI data were collected by the departments themselves, possibly introducing a risk of bias or subjectivity. The introduction of an independent data quality check might be considered to eliminate or minimize this risk.

While the level of reliability of the data was not statistically tested using the recommended procedures, the departments' perception on data reliability was sought through a survey in 2021. In general, the data collected were deemed reliable for most of the measured QIs, with the exception of the acute toxicities, which were considered too variable between RO professionals and departments, and not always in line with what can be expected from the literature. Hence, it is recommended to standardize the grading amongst participants, either using detailed guidelines or through the organisation of courses meant to harmonize practice. Another way to overcome this possible bias is to introduce PROMS, in which patients themselves evaluate their physical and psychological well-being and quality of life, and that have been found reliable in capturing actual side effects [66,67]. Another limiting factor in the collection of acute toxicities is the variable timeframe in which they could be collected, again a pragmatic approach to limit collection burden. However, it is well-known that toxicities may still vary considerably between end of treatment and 1 month thereafter, especially in hypofractionated regimes. This limitation could again be tackled by the implementation of PROMS [68,69].

Similarly, the validity of the collected QIs has not been formally tested. However, as stated by the paper of Rubin et al., the validity of a QI can be assessed by "evaluating whether the measure represents the process domain of interest as judged by the audience of users" [65]. The 2021 survey demonstrates that the majority of QIs were felt to be valid to collect and monitor, with the exception of the MDT meetings and the use of systemic therapy.

After the successful implementation of this project, it is of importance to define the next steps of the project keeping in mind the above-mentioned limitations and potential for improvement. This will include the discussion of the QI's dataset with pathology-specific radiation oncology experts outside the College, and may require consulting stakeholders outside de field, such as data scientists, health economists, health service managers or patients. The review of the QI's dataset should also be based on the experience acquired by other teams involved in QI implementation and monitoring. While other national QI initiatives do exist, it is not always an easy task to obtain a comprehensive view on all on-going initiatives. The creation of an international platform allowing for the centralization of QI initiatives and their results should be considered to foster exchange of knowledge and best practice.

In conclusion, the monitoring and benchmarking of QIs is recognised as a valuable tool in the establishment and evaluation of quality improvement initiatives. The establishment of a QI project for radiation oncology in Belgium has been shown feasible to implement on a national level, resulting in a high participation rate amongst radiotherapy departments, who positively evaluated the project. The analysis of the collected QIs and the generation of personalized benchmarking documents have shown to guide departments in setting up quality improvement initiatives on a departmental level.

However, the foundation that underlies quality is that it is a continuously evolving improvement process, requiring a regular update of the clinical, technical and organisational needs. Moreover, QIs should be embedded in a broader quality management framework, also including incident reporting and peer reviewed clinical audits, as required by the Euratom directive [14,70]. In Belgium, the former is addressed by PRISMA-RT, the latter by the national implementation of B-QUATRO audits [14]. It has moreover become clear that taking the QI project to a higher level will require optimisation and automation of the data collection process, ideally including external data quality checks and the patient perspective through PROMs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

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