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Original Article

A taskforce for national improvement of innovation implementation in radiotherapy

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A B S T R A C T

Background and purpose: Previous research among Dutch radiotherapy centres (RTCs) showed that 69% of innovations was simultaneously implemented in 7/19 centres, with a success rate of 51%. However, no structure to share lessons learned about the implementation process existed. Therefore, a national Taskforce Implementation (TTI) was raised to stimulate efficient implementation of innovations. The aim of the current study was to develop and pilot-evaluate a website for facilitating mutual learning on implementation issues.
Material and methods: First, we made an inventory in all Dutch RTCs on their 10 most valuable innovations between 2019 and 2022. In-depth interviews, structured according to the Consolidated Framework for Implementation Research, were performed on the four most mentioned topics. A website was built, and pilot evaluated 1 year after the launch, using a qualitative survey amongst the TTI members.
Results: In 13/18 centres, 19 interviews were conducted on 1) automation, 2) patient participation, 3) adaptive radiotherapy 4) surface guided radiotherapy and tracking. Most innovations (13/16) were implemented with a delay, with many comparable challenges: e.g. shortage of personnel (7/16) and prioritization of projects (9/16). The website allows users to upload and search for projects, including implementation experiences. After 1 year, 14 projects were uploaded. The qualitative evaluation was largely positive with room for improvement, i.e.75 % would recommend the website to others.
Conclusion: This study showed that RTCs experience comparable challenges when implementing innovations, thereby underlining the need for a platform to share implementation-lessons learned. The first concept of this platform was evaluated positively.

Introduction

Two recent studies found that approximately 112 out of 243 innovations (46 %) in several Dutch Radiotherapy Centres (RTCs) were not implemented in a timely fashion or failed completely [1,2]. Delay or failure of innovation projects can have at least four adverse consequences. First, failure of implementation affects the quality of care and outcomes. Continuous innovation in radiation treatment has been shown to increase the ability to identify and target tumours with a higher accuracy, thereby improving oncological outcome and reducing side-effects [3–6]. Consequently, delay or failure of innovation projects will result in slower improvement of outcome. Second, according to literature, through evolvement of radiotherapy, oncologic treatments become safer [7]. Therefore, it can be expected that delay or failure will also have a negative effect on safety improvement. Third, innovation projects not running as planned affect the efficiency of the clinic and even society. Due to the current global economic situation and the rising costs of healthcare, reducing healthcare costs and increasing the efficiency of all processes of care is a constant endeavour of all healthcare organizations, governments, policy makers and individuals [8]. This

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also applies to radiotherapy, where the ESTRO-HERO project [9] is focused to the concept of value-based health care (VBHC) [10,11]. This HERO project was launched to define a VBHC framework considering the specificities of radiation oncology in terms of types of interventions and treatment intent, outcomes generated and evidence required [9], also exploring potential trade-offs between efficiency and patient outcomes. Fourth, it can be expected that delay or failure of projects, can result in inefficient work processes or job stress, and affect work satisfaction [12].

In view of these adverse consequences when implementation fails, it is important to improve the innovation implementation success rate. Previous research among Dutch RTCs showed that 69 % of the planned innovations were simultaneously implemented in 7 out of 19 RTCs [13]. In addition, we found that there is no structure available to share lessons learned about the implementation process, such as are available for collaboration on research, developing guidelines etc. Therefore, in 2019 the Taskforce Innovation Implementation (TFI) was raised, consisting of 15 members: 5 radiation oncologists, 5 physicists, 1 research-Radiation Technician (RTT), and 4 managers, from 10 different RTCs in the Netherlands, aimed at improving implementation of innovations in radiotherapy. The TFI was an official subcommittee of the Quality Committee of the Dutch Society for Radiation Oncology (NVRO). The aim of the current study was to develop and pilot-evaluate a website for facilitating mutual learning on implementation issues of innovations that are ready for implementation. Prior to developing the website, we investigated the status of the innovation implementation processes in Dutch RTCs in order to develop insights and tools to reinforce mutual learning between Dutch RTCs regarding innovation implementation.

Methods

This project consisted of three phases: first, an inventory was made on the four most frequently mentioned innovation themes, and second, in dept interviews were held on the encountered barriers and facilitators during implementation of those innovations, and third, a website was built to facilitate mutual learning on implementation processes.

Inventory of four most frequently mentioned innovation themes

At the end of 2020, we asked all 18 Dutch RTCs by email to provide their 10 most valuable innovations that were, were being or will be implemented in the period between 2019 and 2022. The most valuable implementations were defined as those 10 projects that were, in their opinion, most impactful for the institute with respect to for example required resources, complexity and/or importance [1]. The following information was acquired about the top 10 projects: a short description of the innovation, status of the implementation (planned, ongoing, finished), planned start and end date of the implementation and actual start and end date. When the RTC was unresponsive, we sent an extra notification and eventually phoned the contact person to invite the institute to participate.

The collected innovations were clustered in the following themes: automation, adaptive radiotherapy, patient perspective, delivery/tracking of the treatment, new treatment options, software, imaging, state of the art treatment, multidisciplinary care, optimization of workflow and other.

In depth interviews on implementation processes

All interviews were performed by the same interviewer and were conducted using Teams. They were focused on the four most frequently mentioned innovation themes by the interviewees. For each participating RTC, interviewees were chosen together with the contact persons of that RTC, by selecting them based on experience with one of the above-mentioned innovation themes, and their ability to have some "managerial insights" allowing them to focus on the processes and not only on the content of the innovation.

The interviews were semi-structured by using a questionnaire based upon the Consolidated Framework for Implementation Research (CFIR). The CFIR is a well-operationalized, multi-level implementation determinant framework which is often used to evaluate implementations [14,15]. It is validated based on predictive and discriminant validity [16]. The CFIR includes 39 constructs (i.e. discrete theoretical concepts) arranged across five domains, i.e. five groups of conceptually related constructs: (1) intervention characteristics; (2) outer setting; (3) inner setting; (4) individuals involved; and (5) implementation process (appendix A). All interviews were recorded, transcribed, and coded using template analysis. Coding was based on the determinants that were applicable to the implementation of the innovation according to the interviewee; the most frequently mentioned factors were summarized.

Development of a website for mutual learning on implementation processes and pilot evaluation

As a third step, a web-based platform was built for members of the Dutch Society for Radiotherapy and Oncology (NVRO) to share information about innovation implementation hurdles and innovation implementation research. The platform is a first step to stimulate mutual learning, not only on content which generally was already the practice, but also on the innovation implementation process what was novel.

The website was brought under the attention of the NVRO members in 2022, both via email, a presentation at the national scientific day of the NVRO, and at most of the RT departments. About 1 year after launching the website, a short pilot evaluation was performed, by 1) counting the number of uploaded projects and a qualitative survey amongst the 10 TFI-members from 7 RTCs. The survey addressed 21 questions (10 using a 5-level Likert scale, and 11 open questions) based on the website user satisfaction questionnaire (WUS)(17)which were categorized into general, layout, information, connection, language customization, and final questions [17]. The open and closed questions were randomly organized (See appendix B).

Results

First phase: ***Inventory of four most frequently mentioned innovation themes***

For the assessment of the 10 most valuable innovations, 12 / 18 RTCs (67 %) participated in the assessment. We clustered the 120 submitted innovation projects into the eleven themes mentioned in the methods section. The top four most mentioned innovation themes were a) automation and software (e.g. automatic planning, automatic contouring, n = 27 projects), b) adaptive radiotherapy (n = 14 projects), c) patient perspective (e.g. Patient Reported Outcome Measures (PROMs) and patient app, n = 17 projects), d) delivery and tracking of the treatment (surface guided radiotherapy and verification of breath hold, n = 16 projects). See appendix C for all projects and frequencies.

Second phase: ***In depth interviews on implementation processes***

In total 19 interviews were scheduled with 24 persons from 12 RTCs. Amongst the interviewees were 12 physicists, 5 radiation oncologists, 1 surgeon and 6 RTTs /project employees.

Three interviews focused on the implementation of innovations in general, while a specific project was discussed in the other 16 interviews.

Most mentioned delaying factors in the interviews regarding specific innovation projects according to the CFIR were (Table 1):

1. Resources (n = 10 projects). A shortage of time from personnel (n = 7 projects) was the most prevalent resource factor; Especially time from RTTs was scarce. Other lack of resources was budget (n = 2

Table 1
Delaying factors regarding specific projects.

Domain	Category	Barrier	n
Innovation	Adaptability	Adapt wishes and requirements	1
		Variable bladder fill*	1
	Design	Privacy issues	1
	Innovation costs	Costly acquisition process	1
	Complexity	Device defects	1
Outer setting	Partnerships & connections	Collaboration with external parties	3
		Coordination within the region	1
	Critical incidents	Covid-19 pandemic	6
	Policies & laws	Obtain licenses	1
Inner setting	Available resources	Staff/time shortages	7
		Budget	2
		Availability of medical devices	1
	Compatibility	Compatibility of systems	1
		Technical hiccups	1
		Modification of software	1
	Relative priority	Prioritising	9
Individuals	Motivation	Resistance	3
	Innovation recipients	Variation in patient population	1
	Capabilities	Skills patients	1
	Innovation deliverers	Device delivery	2
Implementation	Planning	Quantifying requirements in plan	1
		Problems with training	3
		Decisions regarding facilities	1
		Project expanded	1

*A variable bladder fil was mentioned as a barrier for the implementation of the innovation "automatic delineation".

projects) and availability of medical devices for innovation (n = 1 project).
2. Prioritization of projects (n = 9 projects). Projects were delayed due to a change in priorities during the implementation process, requiring resources to be made available for other, higher prioritized projects.
3. Covid-19 pandemic (n = 6 projects).
4. Planning of projects (scheduling, n = 6 projects).
5. Collaboration with external parties (n = 3 projects). Differences in expectations between parties were mentioned as one of the reasons.
6. Resistance to the innovation (n = 3 projects). RTCs implementing surface tracking often mentioned that they encountered resistance in (part of) the RTT group.

For implementation in general, the most frequently identified factors for delay were a shortage of personnel (n = 2 interviews) and prioritization of projects (n = 2 interviews) as well (Table 2). We did not find specific barriers per innovation theme.

Regarding the implementation process, most of the projects were initiated by people in the workplace (n = 12 projects) and just a few by the management. The managerial involvement in the implementation process varied between the different RTCs and types of innovations. In some cases, innovation projects only needed approval from management before starting the implementation process. In all other cases there was no managerial involvement. In most cases, other RTCs, user groups or manufacturers were consulted before the innovation was implemented (n = 12 projects). Generally, those consultations mainly focused on the content of the innovation and (if discussed) only partially on the implementation process itself. Implementation plans were not routinely used in all institutes. The presence of complete implementation plans was scarce; shorter versions (including limited aspects of implementation such as planning, required resources etc.) were available in nine RTCs and three RTCs did not have an implementation plan at all. Formal evaluation of the implementation process and changes in workflow, e.g., to discover challenges and delaying factors, was rarely performed (n = 3 projects).

Table 2
Delaying factors for projects in general.

Domain	Category	Barrier	n
Outer setting	Policies & laws	Policies regarding CE marking	1
Inner setting	Available resources	Staff/time shortages	2
	Relative priority	Prioritising	2
Individuals	Motivation	Resistance	1
Implementation	Planning	Unrealistic planning	1

Third phase: ***Development and pilot evaluation of the website***

Based on the findings of this study, we built in the following components: projects, community, application for advice, and education & literature (see appendix D). In the section "projects" all members of the NVRO can upload their innovation projects. The uploaded projects should include information about the content of the project, the implementation process and possible barriers, in an easy searchable way. In this way, it was expected to facilitate getting information about the experiences in other centres and to know which centre to reach out to before implementing a similar innovation. The **"community"** was set up to discuss topics about implementation innovation and advice from the members of the NVRO on topics related to innovation implementation can be asked for via **"applying for advice"**. The taskforce then will give an advice or if the taskforce feels they do not have the required expertise, they will involve experts in that particular field. In the section "**education and literature"** relevant conferences, workshops and literature on innovation implementation are shared.

The first pilot evaluation showed that the TFI-members were generally satisfied, and would use and recommend the website, which could act as a fundament to build on creating a digital source of the taskforce for knowledge sharing of innovation implementation. The results of the evaluation are presented in Fig. 1 (closed questions) and Table 3 (open questions).

Discussion

We have built a website to facilitate mutual learning on implementation issues of innovations. A first pilot evaluation was positive, although there was also room for improvement. Monitoring how often the website is used after the initial phase, in combination with regular updates via the weekly Newsletter of the NVRO/ Dutch Society for Radiation Oncology, will be continued to enhance sustainability.

Top 4 most frequently introduced innovations in the Netherlands. We found different innovation themes being implemented in the period 2019–2022, compared to our previous inventory in 2016 (5 years earlier). At that moment, the top five consisted of advanced RT techniques (like IMRT, VMAT, SBRT/SRS); protocol optimization (for example regarding Treatment Planning System, imaging, IGRT etc,); and patient-flow innovations (13). Because the innovation landscape for all RTCs has changed considerably within a five-year period, this indicates that the innovation implementation progress in the Netherlands is substantial, despite the reported success rate of timely innovation implementation of only 51 %. Nevertheless, similar hurdles in implementation were still mentioned, indicating that mutual learning can still be improved.

Hurdles. Below, we concisely discuss prevalent hurdles and directions for solutions, leveraging insights from established literature. On the website there is a dedicated section (Education and references, appendix D, figure D5) that houses a comprehensive collection of relevant literature, addressing a wide range of implementation problems along with their corresponding solutions".

The most prominent delaying factor was the lack of resources. This is a well-known barrier for innovation implementation in radiotherapy (2). Currently, shortage of employees is a big problem in healthcare. Speeding up the implementation of AI can potentially help to reduce the number of employees needed for daily clinical care (e.g. treatment

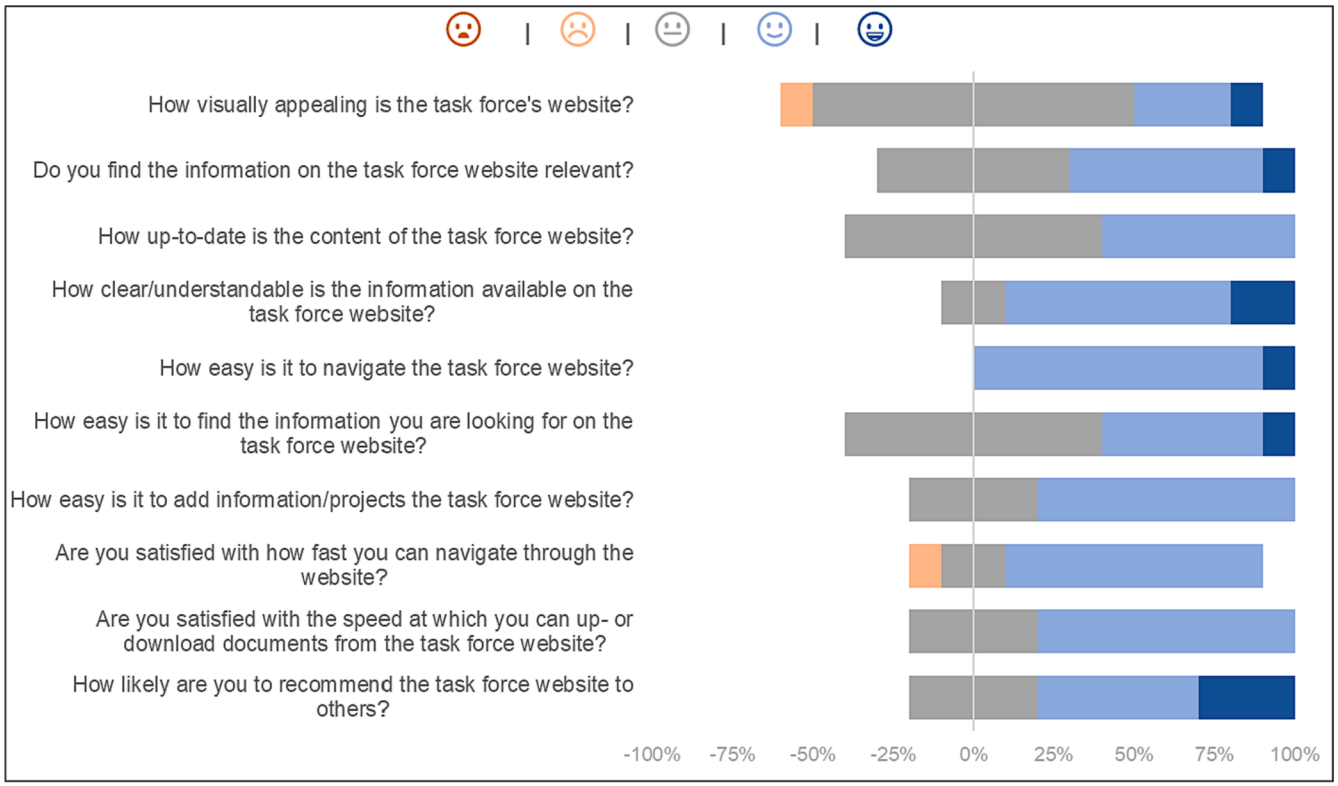

Fig. 1. Qualitative pilot evaluation (closed questions, on a Likert scale 1–5) of the website by TFI-members, represented as a diverging bars chart (1 = red; 2 = orange; 3 = gray; 4 = light blue; 5 = dark blue). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

planning), so that these employees can be engaged in other innovation projects. Also, working agile with short sprints creates the opportunity to spend dedicated time on implementation in multidisciplinary teams, ensuring that the necessary employees can work jointly on a project [2]. Another important hurdle is the *prioritizing of projects* (n = 9 projects). In our view, this aspect should deserve more attention because we expect that continuously changing priorities will be frustrating employees and it will not yield an efficient implementation process. In management literature, prioritizing is described as the result of institutional factors and individual factors on the one hand and decision-making styles on the other [18]. Using conceptual frameworks based on these insights for prioritizing can help RTCs prioritize in a less interruptive way, because this framework helps to understand all the internal factors and external circumstances that affect the agenda for prioritization [18] From this point onward, one could try to control the factors that might hinder progress. Further investigation to the application of these insights from social sciences can help RTCs to keep their priorities more stable and to work more efficiently. In the meantime, RTCs should be reluctant to change priorities on a large scale.

In this study, collaboration was also reported as a delaying factor. Innovation collaboration (co-creation with complementary partners) has been shown earlier to be crucial for success, e.g., because it creates the ability to build on work of others, to engage in a direct way and knowledge and other resources can be shared and integrated [19]. However, detrimental effects are also reported because collaboration projects are constrained by the multi-party influence. More specifically, it depends, amongst others, on the cooperativeness of the participants despite the diversity of their needs [20]. We think that the ability to collaborate is an essential core competence that is required to improve the innovation implementation success rate. However, not many healthcare organizations methodically evaluate how well they perform in the area of collaboration and they do not often implement clinical leadership principles to systematically improve collaborative performance [21]. We suggest that the development of this competence should be included in the training program of residents, because in radiotherapy, collaboration for example with vendors of the medical devices, is extremely important.

A too optimistic planning should be avoided. This can be done by actively looking for information from other RTCs that already implemented the innovation. That is the main reason why we built the website.

Another mentioned barrier was resistance; this can be prevented by involving all employees, also RTTs, from the start, and by creating ownership for the implementation of the innovation. The way to reduce the complexity hurdle in radiotherapy is already described in previous studies [2,5] and can be summarized as working in an agile way, dividing a project into smaller subprojects, using multidisciplinary teams to jointly and concurrently spend time on the project to safeguard the implementation of subprojects.

It is recommended to write an implementation plan based on a validated framework to guide the implementation of complex innovations to foresee and to anticipate potential hurdles [22]. It can be helpful to use validated implementation tools, for example a prediction tool for timely implementation of innovations in radiotherapy [2].

Website. The website's main goal is to foster knowledge sharing in the field of implementation, effectively reducing duplicated efforts. By providing a platform for radiotherapy professionals to glean insights from the challenges faced by their peers at other centres, it empowers them to proactively develop strategies to overcome similar issues and to benefit from successful solutions already implemented elsewhere. We opted to establish a closed platform exclusively for Dutch radiotherapy professionals to ensure a seamless reporting process for implementation failures. Another reason why we did not yet choose for an international platform in this phase, is that implementation context varies in different countries. Moreover, we believe that a pilot design at a national level is a more prudent approach compared to a one-size-fits-all strategy. This is

Table 3
Qualitative pilot evaluation (open questions) of the website by TFI-members.

Open questions	Answers
1. What is the goal of the website?	All 10 TFI-members appeared to understand the purpose of the website well, which is knowledge sharing on implementing innovations.
2. How often do you visit the website?	TFI-members visited the website varying from 4 to 6 times per year to once a month or only when needed.
3. What information are you looking for on the task force website?	Depending on the need, members were looking for relevant literature and/or an overview of running projects (and its experienced issues).
4. Is the information offered on the task force website accurate?	TFI-members assumed the offered information is accurate.
5. Are you missing certain information on the task force website?	All 10 TFI-members mentioned that more projects should be uploaded on the website in order to keep it up to date and to distinguish the implementation and content issues. Also, adding the running time of the projects might be useful.
6. What do you think of the task force website home page?	TFI-members agreed that the home page showed a satisfactory overview.
7. Does the home page clearly show you where to go to view or add projects or literature?	All members consented that the home page presents the visitor with where to go to view or add projects/literature.
8. What do you think about the structure of the website and the interrelationship of the various sections?	Members were satisfied with the structure of the website and the interrelationship of the various sections.
9. Does the website use appropriate language?	All 10 TFI-members acknowledged that the website uses appropriate language.
10. What areas for improvement do you have for the website?	The suggested improvements were: uploading more content, providing an overview of projects (including tips and tricks) by visualizations, adding more information about organizational innovations, making use of menu bars, and improving accessibility.
11. What is your overall opinion regarding website satisfaction?	Members were generally satisfied.
12. Why would you recommend/not recommend the website?	All 10 TFI-members would recommend the website that might be useful for knowledge sharing.

primarily because the challenges associated with such an innovative endeavour can be more effectively managed through this phased approach.

Various industries have recognized the value of websites as a medium for disseminating knowledge on innovation implementation. Empirical evidence supports the notion that this practice significantly boosts firms' innovative capabilities [23]. The rise of internet-based information and communication technologies has been instrumental in facilitating the widespread sharing of knowledge through an array of technologies, collectively referred to as Web 2.0 technologies, such as social networking applications, web-based forums, wikis, and folksonomies [24–26]. Several key success factors have been identified for knowledge-sharing platforms. These factors encompass creating a sense of urgency, addressing fragmented awareness of problems and solutions, ensuring user-friendly systems, enabling efficient information retrieval, securing support from top management, and integrating knowledge management into departmental strategies. Furthermore, it's essential to recognize that knowledge transfer is not a one-way process but rather an iterative one, involving trial and error, feedback loops, and mutual adjustments between knowledge providers and recipients [24]. Effective communication among network participants, along with clear expectations and activities such as organizing meetings and promoting initiatives, are vital components in this process. In our current context, much like the initial phase of a knowledge portal in other industries, most initiatives are initiated by the webmaster [24]. While we acknowledge that not all conditions are currently met, our taskforce is committed to take insights from experiences in other industries into consideration. These insights will serve as a guide to enhance our performance and steer our ongoing efforts towards greater success.

Limitations. The website was built based on data acquired with interviews and subject to retrospective opinions of the interviewees about implementation hurdles that do not per se reflect reality and are subject to bias. To prevent bias as much as possible we used a validated implementation framework for the interview questions as is recommended in literature [27,28]. Also, during the interviews, data saturation seemed to be reached in the last interviews because no additional information could be obtained anymore [29]. A quantitative prospective study would be valuable for further validation of the results of this study.

Another limitation is that website was evaluated by TFI-members, i.e. people that were also involved in the development of the website. Consequently, the evaluation is probably positively biased. Nevertheless, from implementation literature suggests that we need champions to implement innovations, which also holds true for implementation of this website [30,31]. Once the TFI members have fulfilled their role as champion by drawing the attention of other society members to the website, the next step will be evaluation by all society members. Another current limitation of the website is that it is only accessible with login from NVRO. This might be a barrier for people to visit the page and become less effective for editing by other people. However, as a start we considered this was required to guarantee a safe environment for NVRO members to be transparent about implementation hurdles.

Conclusions

Most RTCs in the Netherlands are implementing innovations in the area of 1) automation (automatic planning, automatic contouring and software), 2) patient perspective (PROMs and patient app), 3) adaptive radiotherapy, 4) delivery and tracking of the treatment (surface guided radiotherapy and verification methods for breath hold). This is a completely different innovation portfolio than the previous inventory in 2016, indicating that innovation implementation in radiotherapy in the Netherlands goes quite fast. However, all RTCs experience comparable challenges when implementing innovations and most projects are characterized by a delay. Our study shows that RTCs mostly do not consult each other about the implementation process, even though they do discuss the content of innovations. In addition, full implementation plans are scarce. It is recommended to take note of foreseeable hurdles before the start of the implementation of a project, keeping in mind the most common hurdles found in this study, and to make an implementation plan/strategy to overcome these hurdles. A web-based platform to share knowledge and experience about implementation processes was built based on this study, and showed a positive first evaluation, but also room for improvement.

CRediT authorship contribution statement

Maria Jacobs: . **Hanneke Martinussen:** Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – review & editing. **Rachelle Swart:** Writing – review & editing. **Anne Gubbels:** Visualization. **Maarten Dirkx:** Writing – review & editing. **Hans de Boer:** Writing – review & editing. **Gabrielle Speijer:** Writing – review & editing. **Karin Mondriaan:** Writing – review & editing. **Katrien de Jaeger:** Writing – review & editing. **Johan Cuijpers:** . **Mirjam Mast:** . **Floortje de Vreugt:** Writing – review & editing. **Liesbeth Boersma:** .

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 data

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