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Radiotherapy department reorganization during the COVD-19 outbreak: keys to securing staff and patients during the first weeks of the crisis and impact on radiotherapy practice from a single institution experience

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Abstract:	Introduction During the first weeks of coronavirus 2019 (COVID-19) outbreak in France, it was necessary to clearly define the organizational priorities in the radiotherapy (RT) departments. In this report, we focus on the urgent measures taken to reduce risk for our staff and for patients by reducing the number of patients on treatment. Materials and methods We reviewed the fractionation schemes for all patients in our department, including those on treatment and those soon to start treatment. Our goal was to decrease the number of patients coming daily to the hospital for RT and adapt our human resources to continue patients' care in the department and help to cover understaffed COVID-19

	sectors of the hospital. Results We identified 50 patients who were on treatment (n=6) or were going to start radiation soon as the CT scan simulation has been performed (n=41) and those for whom the CT scan was pending (n=3). The majority were women (64%) treated for breast cancer (54%). RT was delayed for 22 (44%). The majority were offered hormonal therapy as “waiting therapy”. Hypofractionation was considered in 21 (42%) patients with mainly breast cancer patients (18/21, 86%). The number of courses initially planned and re-planned due to the COVID-19 outbreak during the period March 15-May 31, 2020, were 1383 and 683, which represented a reduction of 50% (including delayed sessions) that allowed our reorganization process. Conclusion To conserve resources during the pandemic, we successfully cut down on the number of patients on treatment in a proactive fashion and adapted our organization to minimize the risk of COVID-19 contaminations. Departments across the world may benefit from this same approach.

Radiotherapy department reorganization during the COVD-19 outbreak: keys to securing staff and patients during the first weeks of the crisis and impact on radiotherapy practice from a single institution experience.

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ABSTRACT

Introduction

During the first weeks of coronavirus 2019 (COVID-19) outbreak in France, it was necessary to clearly define the organizational priorities in the radiotherapy (RT) departments. In this report, we focus on the urgent measures taken to reduce risk for our staff and for patients by reducing the number of patients on treatment.

Materials and methods

We reviewed the fractionation schemes for all patients in our department, including those on treatment and those soon to start treatment. Our goal was to decrease the number of patients coming daily to the hospital for RT and adapt our human resources to continue patients' care in the department and help to cover understaffed COVID-19 sectors of the hospital.

Results

We identified 50 patients who were on treatment (n=6) or were going to start radiation soon as the CT scan simulation has been performed (n=41) and those for whom the CT scan was pending (n=3). The majority were women (64%) treated for breast cancer (54%). RT was delayed for 22 (44%). The majority were offered hormonal therapy as "waiting therapy". Hypofractionation was considered in 21 (42%) patients with mainly breast cancer patients (18/21, 86%). The number of courses initially planned and re-planned due to the COVID-19 outbreak during the period March 15-May 31, 2020, were 1383 and 683, which represented a reduction of 50% (including delayed sessions) that allowed our reorganization process.

Conclusion

To conserve resources during the pandemic, we successfully cut down on the number of patients on treatment in a proactive fashion and adapted our organization to minimize the risk of COVID-19 contaminations. Departments across the world may benefit from this same approach.

INTRODUCTION

The outbreak of coronavirus disease 2019 (COVID-19) has been identified as a public health emergency in the world. Since December 2019, the oncology community has had to face an unprecedented situation for healthcare staff and patients. Many cancer patients, who frequently visit the hospital for treatment and disease surveillance, may be immunocompromised due to the underlying malignancy or anticancer therapy which may increase the risk of developing severe acute respiratory syndrome coronavirus-2 (SARS-CoV2) (1). During the first weeks of the COVID-19 crisis, it was necessary to respond effectively to the constraints imposed by ignorance of the virus, the increased risk of infection for staff and patients, and the lack of perspectives regarding the organizational priorities in the departments and the hospital. Thus, in the perspective for increased care and resource utilization during the COVID-19 pandemic, strategies had to be implemented to minimize interruption of cancer treatment, particularly in patients being treated with curative intent (2). In this report, we share the urgent measures taken to organize the rotation of staff schedules in our department and the changes in treatments schedules and duration of radiation therapy (RT), in addition to follow social distancing and hygiene practices as widely recommended in the pandemic (3).

MATERIALS AND METHODS

Department reorganization

Staff reorganization methods

Our goal was to rotate therapists in our department on a weekly basis. To accomplish this, we reviewed all the fractionation schemes of the planned patients to decrease the number of patients coming daily to the hospital for RT.

During the first week of the crisis, all 12 therapists maintained their regular schedule. During the second week, we extended the treatment slots on one linear accelerator and put our therapists on rotation six in a week to manage the treatments and the CT scan simulations that were maintained because of the need to treat some patients without delay.

For dosimetry and medical physics organization, we have four physicists and two dosimetrists. Pending the establishment of telework by our hospital administration, all these staff remained in the department during the first week to finalize the pending files and prepare recalculations of the hypofractionation of patients who were being under RT. After the second week, only two physicists and one dosimetrist per week worked in the hospitals. The other two physicists and dosimetrist worked from home using telework (4).

For our staff, it was important to limit their exposure to COVID-19 very quickly by reducing their visits to the hospital. Thus, we put half our doctors into telework in the second week. They ensured the visits using telemedicine for all the patients in remission scheduled for follow-up visits. Thus we drastically reduced the number of patients coming to the department. However, all new patients' visits were kept in the schedule to plan treatments according to the degree of emergency and their cancer prognosis.

After the second week, rotation of the medical staff rendered possible the deployment of our interns and residents to the emergency department and COVID-19 sectors as part-timers. Therefore, the organization of the medical resources in our department was systematically linked to their availability. We set up compensatory rest days for each of their on-calls days and were careful to systematically release them in the weeks during which they were involved elsewhere. For planned patients, the weekly visit was ensured using telemedicine in order to limit the length of time patients in the waiting room.

Organization for patients' planning

We distinguished three situations: 1. patients who had started their RT ("ongoing RT"; Group 1); For Group 1, the method chosen was to reduce the number of fractions by changing the planned fractionation in progress for the same biological equivalent of the dose; 2. new patients for whom CT simulation is pending (Group 2). For group 2, we practiced the selection of patients for whom the start of treatment could be postponed; 3. patients who had just had their CT scan simulation and were waiting to start treatment ("CT simulation performed"; Group 3). The CT scan planning and the start of the treatment depended on the disease prognosis and the possibility of starting with hormone therapy (HT)in the waiting treatment period, to be able to postpone RT for several weeks. Figure 2 present details of these groups.

Statistics

Pair-wise comparisons between the number of radiation courses initially planned and replanned according to the COVID-19 outbreak were performed using two-tailed paired Student's t-test. The p-value for statistical significance was set at 0.05 for sided comparisons. Statistical analyses were performed using the R software, Version 3.5.1 (R project, Vienna, Austria).

RESULTS

Staff and patients COVID-19 contaminations

After one month of staff rotation schedules and strict applications of the recommended prevention techniques (3), one Radiation Oncologist out of 8 who presented minor symptoms of COVID-19 and stayed at home for self-quarantine during 14 days after the last symptoms. None of the other 46 professionals working in our department had neither COVID19 symptoms.

Patients' treatment interruption for COVID-19 positivity

In the same period, among the 73 patients on treatment only three presented COVID-19 symptoms during their treatment period with a confirmation of the COVID-19 positivity test performed in the hospital. RT was stopped after confirmation of COVID-19 positivity. RT interruption was 12 days in one case of breast cancer, and 11 days in one case of esophageal cancer. After resolution of their symptoms, both patients resumed treatment and were treated at the end of the day. They entered the department via a separate entrance from the other patients. They were given masks to wear and both therapists present at the time of the sessions had full PPE masks and adopted maximal personal protection procedures. The third patient was receiving radiation for breast cancer. She developed a SRAS that required her hospitalization in the ICU. At the time of this report, she has been hospitalized for 15 days and is stable per her medical inpatient team.

Patients characteristics

On March 13th, there were 68 patients on treatment on Linacs and 5 patients planned for low X-ray energy (DARPAC) for skin cancers. After that date, our weekly chart rounds identified 50 patients, including 6 patients on treatment, considered to be eligible for an intervention either for delaying RT or changing fractionation of the RT already started or planned in the next days. Table 1 shows the characteristics of the patients included. Median age was 70.5y (36-94). The majority were women (64%) mostly treated for breast cancer (54%) and men treated for prostate cancer (26%). The majority of patients (68%) were planned for RT in the post-operative setting while 32% were planned for definitive RT.

Delay of RT

Among the 50 patients included in our study, RT was delayed for 22 cases (44%). Most were prostate (56%) and low risk breast cancer (39%) patients. The majority (19/22) were offered

hormonal therapy as “a waiting therapy”. Table 2 give the details about the delay of RT. The delay was <1, 2 and 3 months for one, 11 and 10 patients, respectively. Twenty-one out of 50 patients (42%) had altered fractionation schedules. The details of fractionation changes are presented in Table 3. In summary, the majority of hypofractionated schedules used for breast RT consisted of 45Gy in 18 fractions or 40Gy in 15 fractions ± 10 Gy or 15Gy in 2.5Gy per fraction instead of 50Gy in 25 fractions with boost of 16Gy in 8 fractions. Two patients had a modification of the RT duration without modification of the fraction. Among the 6 patients of the Group 1, the remaining dose was given with a more hypofractionated scheme in 5 cases while for the remaining case with breast cancer, the boost was omitted. In the Group 2, RT was delayed in all 3 cases and were offered waiting HT. In the Group 3, RT was delayed for 20 patients, altered fractionation (hypofractionation) was proposed for 16 patients and association of delayed RT and altered fractionation was offered in 4 patients.

The number of fractions initially planned due to the COVID-19 outbreak during the period of March 15th to May 31st, 2020 would have been 1383, which was reduced to 683 fractions; this represents a reduction of 50% and included the delaying of some sources. The difference was statistically significant (Figure 1). Figure 2 represents an overview of the management of our patients who were eligible to undergo a specific intervention that allows the reduction of the number of courses and their exposure during the outbreak.

DISCUSSION

The unprecedented COVID-19 crisis surprised the world. It has changed the way in which our hospitals and our departments operate on a daily basis. The arrival of the epidemic in Europe, and more precisely in Italy, was of incredible violence. Several parameters, such as: (i) no one was prepared for such a surge of infected patients in the hospital during the initial period; (ii)

lack of knowledge of the virus; (ii) fear of massive contamination of staff; (iii) absence of specific recommendations; (iv) lack of data largely, contributed to a significant heterogeneity in terms of staff and patients' organization and priorities for RT initiation or continuation of treatments already started.

The Radiation Oncology Departments of the affected countries had to adapt quickly and establish early new organizations with a practical definition of priorities (5). Thus, numerous recommendations and therapeutic options were developed to allow the optimization of department organization and function in order to provide and continue to deliver optimal therapy to all patients with cancer (6). One of the first papers published in March summarized discussions and held an "urgent online journal club" that provided some consensuses around themes of infection prevention, rationalization of workload and working practices in the presence of infection. Finally, the authors proposed to proactively prepare their departments with training and PPE and consider their infection control procedures for a pandemic more critical than the risk of omitting RT (7).

We were successful in rotating our healthcare personnel on an alternating weekly schedule thanks to reorganization of patients onto one machine, working from home, and a significant reduction (by 50%) of the number of treatments planned due to the COVID-19 outbreak (Figure 1). This enabled us to have human resources availability for the department in case staff falls ill, and to facilitate staff working elsewhere in the hospital should the need arise.

In order to reduce the risk of COVID-19 infection of our patients, options such as delaying (44%) and shortening (42%) the RT course has been proposed. The decision was taken according to the timing with regard to the CT simulation and the clinical context.

For patients in group 1, we either eliminated the breast boost or reduced the number of boost fractions with increased dose per fraction for a same biologic equivalence (8, 9). Indeed, in patients with favorable prognostic factors, omission of boost to the tumor bed was reported as an option since it has minimal impact on local recurrence and no impact on survival (10). This is particularly true for patients over the age of 70y, which was the median value in our cohort. Early data from China suggested that cancer patients (1) and patients aged 65 years and older (11) had greater initial comorbidities, more severe symptoms, and were more likely to experience multi-organ involvement and death from COVID-19 as compared with younger patients.

In Group 2 that includes three elderly breast cancer patients for whom CT simulation was pending, primary hormone therapy was initiated for the 2-3 months before starting the delayed RT. This was decided according to French (12) and international (13) networks that recommend, for patients over age 65-70 y with lower risk stage I hormone receptor positive/HER2 negative cancers and DCIS, adjuvant endocrine therapy can be encouraged to defer/omit radiation without affecting overall survival. Indeed, when considering breast radiotherapy in patients aged >70y with tumors <2 cm, the CALGB9343 trial showed a superiority of combined whole breast irradiation plus tamoxifen over tamoxifen alone in terms of local control. However, this gain did not translate into an advantage for survival or breast preservation rate at 10 years (14).

For the prostate cancer patients, data on primary hormone therapy during 2-6 months before RT initiation for unfavorable intermediate (IR) and high risk (HR) patients are more robust in the literature (15). Also, in the COVID-19 pandemic context, primary androgen deprivation therapy

(ADT) has been recommended for further deferral of RT as necessary (16). In our cohort, 26% of the patients had prostate cancer. Among the 22 patients for whom RT was postponed by 2-3 months, 14 were treated by primary ADT for IR or HR prostate cancer (Table 2). None of these patients was in seen in adjuvant setting where our procedure is now according to the recent data from the TROG trial showing evidence that early salvage RT is preferred over adjuvant RT in all scenarios during a pandemic (16, 17).

In the other tumor sites presented in Table 3, the patient with skin cancer had already surgery with minimal risk factors for local recurrence, while the two patients with leukemia were respectively planned for total body irradiation and allogeneic bone marrow transplant and CNS irradiation, delayed by three and two months, respectively.

For fractionation, among the 50 patients, 21 (42%) were replanned with hypofractionation schedules. Moderate fractionation is already considered in many countries as the standard for patients who meet inclusion criteria in published trials, such as no nodal irradiation, no chemotherapy and no large breasts (18, 19). With the lack of robust data, with sufficient follow-up (20, 21), using severe or moderate hypofractionation in patients with nodal RT indications, we decided to use mainly 45Gy in 18 fractions rather than 40Gy in 15 fractions. Indeed, in our department, the first has been routinely used for aged patients and when four fraction a week are required. This schedule is reported elsewhere as safe in a large cohort out of the COVID-19 context (21). However, even if hypofractionation schedules are advocated by recent recommendations during the COVID-19 crisis (13), they should be used with high caution in

patients with regional node RT, as lung damage caused by COVID 19 infection may be worsened by prior or ongoing lung radiation-exposure (22).

For all already planned additional boosts, we also decided to change fractionation. The 10 Gy boost in four fractions-scheme was mainly planned. Patients who had to start their boost during the COVID-19 period had 12Gy in three fractions, instead of 16Gy in eight fractions planned initially. This scheme has been suggested by Coles and co-workers (13).

For the other tumor sites, we postponed all prostate cancer without a need to alter fractionation, given the slow tumor growth in prostate cancer. In one elderly patient with skin cancer who was planned for adjuvant RT, the 45Gy was changed to 30Gy in five fractions once a week, as planned in our ongoing phase 3 trial IMPACTE-01, comparing these two schemes. For the last two patients with high-grade lymphoma and sarcoma, hypofractionated schedules were planned to reduce the number of fractions according the biologic equivalent dose (8).

CONCLUSION

There are two main priorities in the Radiation Oncology departments of the countries affected by the COVID-19 pandemic. Firstly, to quickly adapt a new organization to minimize staff exposure. The second is to minimize patient exposure. In this report, we showed the importance of early, clear procedures for protection and for rotating the medical staff and therapist schedules in order to ensure treatment continuation for patients who had already started RT and delay those for whom the benefit/risk, regarding COVID-19 infection, is not in favor of immediately starting RT. Departments across the world may benefit from this same approach.

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Table 1.
Characteristics of patients included in the intervention cohort during the first month of COVID-19 outbreak

Characteristics	**N = 50**	**%**
Age	Median	Range
	70.5	36-94
Gender		
Male	18	36%
Female	32	64%
Primary tumor		
Breast	27	54%
Prostate	13	26%
Palliative	3	6%
Hematologic	3	6%
Skin	3	6%
sarcoma	1	2%
Modality of RT		
definitive	16	32%
postoperative	34	68%
Intervention		
Delayed RT*	22	44%
Altered fractionation	21	42%
Delayed RT and altered fractionation	5	10%
Modification of the RT course duration (without fractionation modification)	2	4%

*: Hormonal therapy was initiated for 19 patients
1 patient also had a modification of the RT duration.
RT: Radiation Therapy

Table 2.

COVID-19 outbreak intervention for delaying radiation therapy

Delay in months	number of patients (N=22)	Primary tumor	n
< 1	1	Breast	1
2	11	Breast	3
		Prostate	6
		Skin	1
		Leukemia (CNS)	1
3	10	Breast	1
		Prostate	8
		Leukemia (TBI)	1
Median	2 months		

CNS: central nervous system; TBI: total body irradiation.

Table

Table 3.

COVID-19 outbreak intervention: altered fractionation schedules

	Initial fractionation schedule	**N**	**Modified fractionation schedule**	**N**
Breast	WBRT: 50 Gy/25fr 5fr/week+boost : 16 Gy/8 fr and RNI: 46Gy/23 fr	3	WBRT and RNI: 45 Gy/18 fr, 4 fr/week+boost : 15 Gy/6 fr, 4 fr/week	3
	WBRT: 50 Gy/25fr+boost : 10 Gy/4 fr and RNI: 46 Gy/23 fr	1	WBRT and RNI: 45 Gy in 18 fr, 4 fr/week+boost : 15 Gy/6 fr, 4 fr/week	1
	WBRT (reconstructed): 50.4 Gy/28fr +boost: 16 Gy/8 fr	4	WBRT: 50.4 Gy/28 fr+boost : 15 Gy/6 fr, 4fr/week *Altered boost fractionation only*	1
			WBRT: 50.4 Gy/28 fr+boost: 12 Gy/4fr, 3 fr/week *Altered boost fractionation only*	2
			WBRT: 50,4 Gy/28 fr+boost : 10 Gy/4 fr, 4 fr/week	1
	WBRT: 50 Gy/25fr+boost: 16 Gy/8 fr	12	WBRT: 50 Gy/25 fr+boost : 15 Gy/6 fr, 4 fr/week *Altered boost fractionation only*	1
			WBRT: 50 Gy/25 fr+boost: 1 2Gy/4 fr, 3 fr/week *Altered boost fractionation only*	1
			WBRT: 45 Gy/18 fr, 4 fr/week+boost : 15Gy in 6 fr, 4 fr/week	5
			WBRT: 45 Gy/18 fr, 4 fr/week+boost : 10 Gy in 4 fr, 4 fr/week	3
			WBRT: 40 Gy/15 fr+boost : 10 Gy in 4 fr, 4 fr/week	2
	WBRT: 50 Gy/25 fr+boost: 10Gy/ 4 fr	1	WBRT: 45 Gy/20 fr, 4 fr week+boost : 10 Gy/4 fr, 4 fr/week	1
Skin	WBRT: 45 Gy/15 fractions, 3 fr/week	2	30 Gy in 5 fr, 1 fr week, 6 Gy per 1 fr	1
			36 Gy/12 fr	1
Sarcoma	TB: 50Gy/25 fr+boost: 10Gy/5 fr,	1	TB: 50Gy in 20 fr, 4 fr/week+boost: 10Gy/4 fr, 4fr/week	1

High grade Lymphoma	40Gy/20 fr, 5fr /week	1	36Gy/12 fr, 4 fr/week	1
Bone metastases	20Gy/5 fr, 5 fr/week	1	20Gy/4 fr, 4 fr/week	1

WBRT: whole breast radiotherapy; RNI: regional nodal irradiation; fr: fractions; TB: tumor bed.

Figure 1.

Number of radiation courses initially planned
and replanned according to the COVID-19 outbreak

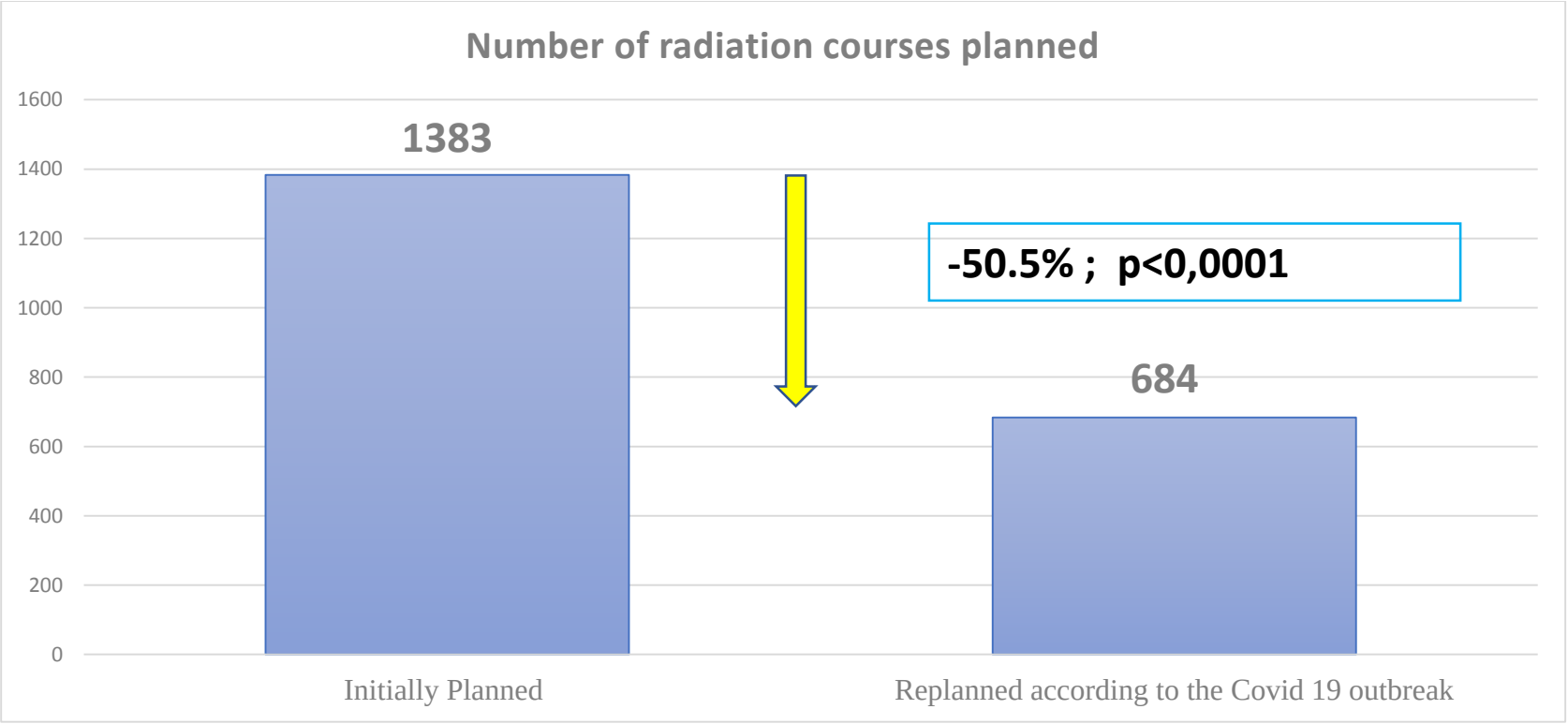
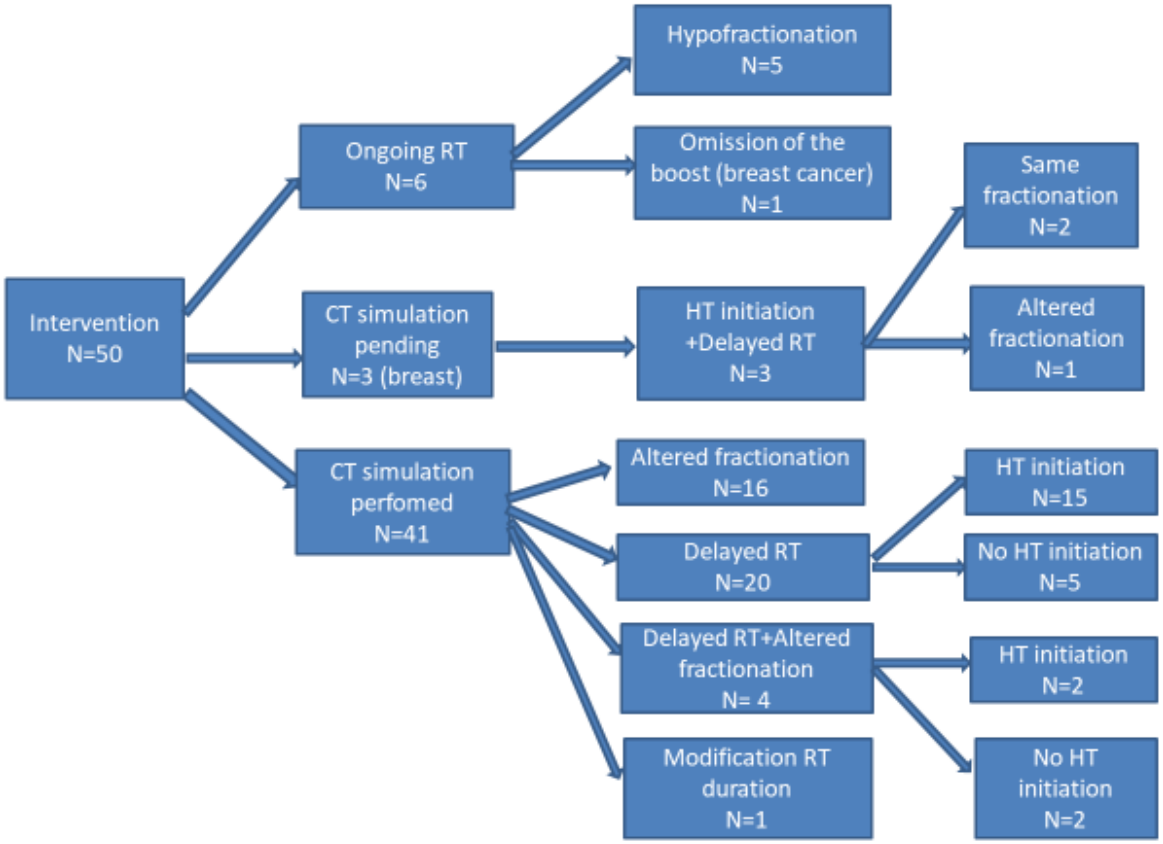


Figure 2.

Overview of patients' management in the interventional cohort



RT: radiation therapy;