Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Critical Reviews in Oncology / Hematology 164 (2021) 103402

Contents lists available at ScienceDirect

Critical Reviews in Oncology / Hematology

journal homepage: www.elsevier.com/locate/critrevonc

Radiotherapy based management during Covid-19 pandemic – A systematic review of presented consensus and guidelines

Zahra Siavashpour [a,*], Neda Goharpey [b], Mosayyeb Mobasheri [c]

[a] Radiotherapy Oncology Department, Shohada-e Tajrish Educational Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[b] Radiotherapy Oncology Department, Shohada-e Tajrish Educational Hospital, Tehran, Iran
[c] Medical Physics Department, Tarbiat Modares University, Tehran, Iran

ARTICLE INFO

Keywords:
Radiotherapy
COVID-19
Oncology
Pandemic

ABSTRACT

Treatment management of cancer patients in the radiation oncology departments during the current COVID-19 pandemic is challenging. A systematic review of published consensus/guidelines on the role of radiotherapy prioritization, suggested treatment protocols, and set up management was undertaken based on the PRISMA protocol and through PubMed/PMC, Scopus, Google Scholar, Web of Science databases until 01/20/2021. One hundred and sixty-eight publications or regional consensus were included. Summary of recommendations contained: (1) using hypo-fractionated (Hypo-F) regimens for therapeutic/palliative indications, (2) delaying radiotherapy for several weeks or until pandemic over, (3) omitting radiotherapy by replacement of alternative therapies or active surveillance, (4) applying safer patients' setup and preparation protocols, (5) developing telemedicine/telehealth service. To conclude, it is essential to carefully weigh the risk of exposure to COVID-19 infection and the benefit of treating cancer patients during the pandemic. Trying to have a global guideline facing this or any other probable crisis is crucial for health care service.

1. Introduction

The outbreak of coronavirus 2 (COVID-19) is a severe acute respiratory syndrome caused by severe acute respiratory syndrome-related coronavirus-2 (SARS-COV-2). The virus has impacted ordinary everyday life and medical approaches worldwide since about December 2019. Meanwhile, vulnerable patients such as cancerous ones are at substantial risk and need meticulous care to reduce and avoid all the possibilities of contracting the infection. Since the spread of COVID-19 is a severe and long-lasting catastrophe, termination or delay of treatment may jeopardize patient care and health. The radiation oncology centers are endeavoring to present guidelines on coping with this crisis.

There were two severe acute respiratory syndrome-related coronaviruses (SARS-CoV) and middle east respiratory syndrome-related coronavirus (MERS-CoV) in the 2002 and 2012 outbreak before this current pandemic, respectively (Saber Soltani et al., 2020; Hosseiny et al., 2020). However, the SARS outbreak has been controlled, with no human infection reported since 2003, but MERS' small epidemics continue to be notified (Hosseiny et al., 2020). World health organization indicated the initial diagnostic symptoms of this public health emergency as fever and flu-like symptoms and/or breathing difficulty with pulmonary ground-glass opacity (GGO) appearance in the computed tomography (CT) images (Novel Corona Virus Update [Online], 2021).

This rapidly expanding pandemic has impacted all daily life areas, especially the clinical routines of other life-threatening diseases such as cancer and its care in radiotherapy departments. Before the pandemic era, the radiotherapy area was categorized based on the risk of radiation exposure and contamination to controlled and uncontrolled areas (Radiation Protection in the Design of Radiothe and rapy Facilities, 2006). However, this pandemic adds other categorization based on the risk of viral infection. Many recommendations were presented by categorizing the treatment department area, room cleaning, sanitization, or disinfection protocols, staff preparation such as having a different level of protective clothing, protocols on setting treatment appointment time for the suspicious or high-risk patients, and urgent event handling (Wei et al., 2020; Starling et al., 1992).

Immunosuppression in cancer patients makes them more fragile during this crisis, and their treatment has been faced with a severe challenge. As the pandemic becomes more widespread, the population concurrently challenged by cancer and corona will increase across the world undoubtedly (Uzzo et al., 2021). Some recent multi-central

* Corresponding author at: Radiotherapy Oncology Department, Shohadaye Tajrish Hospital, Shahrdari avenue, Tajrish square, Tehran, Iran.
E-mail addresses: Z_siavashpour@sbmu.ac.ir (Z. Siavashpour), goharpey@gmail.com (N. Goharpey), mosayyebmobasheri@gmail.com (M. Mobasheri).

https://doi.org/10.1016/j.critrevonc.2021.103402
Received 14 July 2020; Received in revised form 17 February 2021; Accepted 18 June 2021
Available online 30 June 2021

studies find no meaningful associations between the COVID-19 mortality with any cancer type and anticancer therapies. In contrast, the other cohort or review ones conclude a higher prevalence and morbidity risk of COVID-19 in the cancer population. Some cohort studies reported a higher fatality rate than the other COVID-19 infected patients (Garassino et al., 2020; Zhang et al., 2020; Kuderer et al., 2020; Lee et al., 2020a; Poortmans et al., 2020; Chakraborty and Pandey, 2020).

Therefore, many departmental consensuses, original articles, rapid reviews, case/case series-reports, editorials, and national and international guidelines were presented in the last months addressing this compromised clinical condition.

Before the outbreak of this pandemic, numerous institutes and healthcare centers applied telehealth services (Parashar et al., 2020; Wright et al., 2020). Developing this service has been highlighted, and it plays an essential role in decreasing unnecessary hospital admission, specifically in the spread of the COVID-19 era (Zhao et al., 2020). This service can be used for online patient's visit and consultation, online image or lab data review (e.g., to minimize the CD handling), online/offline treatment evaluation/verification, and online patient's follow-up using real-time two-way video/audio communication mostly for the cases with low and intermediated priority (Parashar et al., 2020).

However, telemedicine is not a possible option for patients who need radiotherapy as a therapeutic/palliative treatment method. Therefore, radiotherapy (RT) resources and departments have been tried to adjust management protocols to make an optimal decision on delivering the best care to all cancer patients with radiotherapy indications (Slotman et al., 2020).

Rapid recommendations were presented by global resources such as the American Society for Radiation Oncology (ASTRO), European Society for Radiotherapy and Oncology (ESTRO), National Health Service (NHS), Cancer Core Europe (CCE), Royal College of Radiologists (RCR), European Society for Medical Oncology (ESMO), etc. on the patients and staff care and prioritizing the patient's treatment strategies. The foundation of these guidelines has been based on safety, avoidance (RT omission when there is a severe risk of infection and its related morbidity), rescheduling (deferring/delaying RT), and shortening (using hypo-fractionated RT (Hypo-F RT) schedule) (Slotman et al., 2020; Gundavda and Gundavda, 2020). However, these rapid publications of consensus can also be confusing, especially when there is not a gathered and organized schema.

Despite the improvements of cancer care and radiotherapy facilities and knowledge, there are still many limitations in the radiotherapy department centers' infrastructure that do not let them obey some of these recommendations. Therefore, to propose practical solutions, it is necessary to consider the facilities, technologies, and substructures of medical and radiotherapy centers in all countries. For categorizing the recommendations, it is essential to pay attention not only to the prioritizing of patient's cancer stage but also the national-specific RT departments practices, their reimbursement system of healthcare, scientific and experimental preparation of the treatment team, and the impact of national legislations undertaken during the crisis (Achard et al., 2020; Kochbati et al., 2020).

This study aimed to overview the presented guidelines of radiotherapy national/international organizations or individual departments' consensus during this pandemic regarding patient care. This would lead to having a compact and comprehensive radiotherapy database of recommendations for any ongoing crisis that will threaten the healthcare system. Also, any radiotherapy department can choose one of these consensuses that match his facilities and knowledge.

2. Materials and methods

2.1. Searching strategy

To perform this review searching strategy for systematic review was followed, and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) chart was designed (Moher et al., 2009, 2015). Searching was performed through the English language literature using the PubMed/PMC, Scopus, Google Scholar, Web of Science databases up to 01/20/2021.

Using Medical Subject Headings (MeSH), the following search terms were selected for coronavirus: coronavirus, SARS-CoV-2, COVID-19, COVID19, 2019-nCoV, SARS2. The search terms chosen for radiation therapy were: "radiation, radiotherapy, brachytherapy, teletherapy, and intraoperative radiation therapy". These terms were combined using the logical operator of "AND" and "OR" properly to give all relevant publications containing coronavirus in the radiation therapy field. In the Scopus database, the search was through title, abstract, and keywords. In the Pubmed/PMC, it was through the title and abstract. Through title and keyword in Google Scholar, it was through topics and titles in the Web of Science. For Web of Science and Google Scholar, the search results were restricted from 2019 to 2021. Finally, obtained search results were exported, and duplicated records were omitted after merging into EndNote™ (Clarivate Analytics, version X7) reference management software. Then, two of the researchers reviewed the results and removed irrelevant records by inspecting titles independently.

2.2. Inclusion and exclusion criteria

Articles were qualified for inclusion if they contained guidelines, consensus, or recommendations on radiotherapy standards of care for cancer patients during the COVID-19 pandemic. Single or multidepartmental consensus for the treatment of each patient's cancer type was included. Also, international radiotherapy guidelines and review articles that addressed radiotherapy and COVID-19 issue were considered. Published international/national consensus for applying different patient's preparation strategies in radiotherapy departments during the current pandemic also included. The proposed approach for delaying, continuing as pre-pandemic protocols, or deferring the RT techniques/fractionation for each discussed cancer type were addressed. Dedicated priority to choose one of these mentioned approaches confronted with each cancer patient considering his disease stage, age, performance status, and risk of infection was extracted from the published studies. To an article be excluded, both authors had to agree or consult with the third to decide if the literature was not relevant or have some unclear aspect or bias or not containing practical recommendations involving radiotherapy practice during coronavirus crisis. Moreover, publications that addressed all cancer treatment strategies, except radiotherapy, such as surgery, chemotherapy, and hormonotherapy, were excluded. The published studies in journals without peer-reviewing proceedings and the articles that just including reports of case studies or case series were also excluded.

2.3. Study screening and data collection process

A protocol was designed for data extraction following the purpose of this review by three of the authors. Besides, every independently extracted data was discussed later by two of the authors. Conflicts were resolved by referring to the third researcher. Tables and figures were designed by two authors and review by the third one, finally.

Published data were considered and presented in this review, and therefore no approval of a research ethics committee was sought.

3. Results

Eventually, considering the explained search, extraction strategy, and inclusion/exclusion criteria yielded 168 involved publications deemed eligible. PRISMA flowchart summarizing the results of the literature search and study selection is illustrated in Fig. 1.

Lots of published recommendations exist to guide radio-oncology teams during the COVID-19 crisis. Recommendations support implementing standard/hypo-fractionation radiotherapy regimens, considering omission of radiotherapy for some cases with a high risk of coronavirus

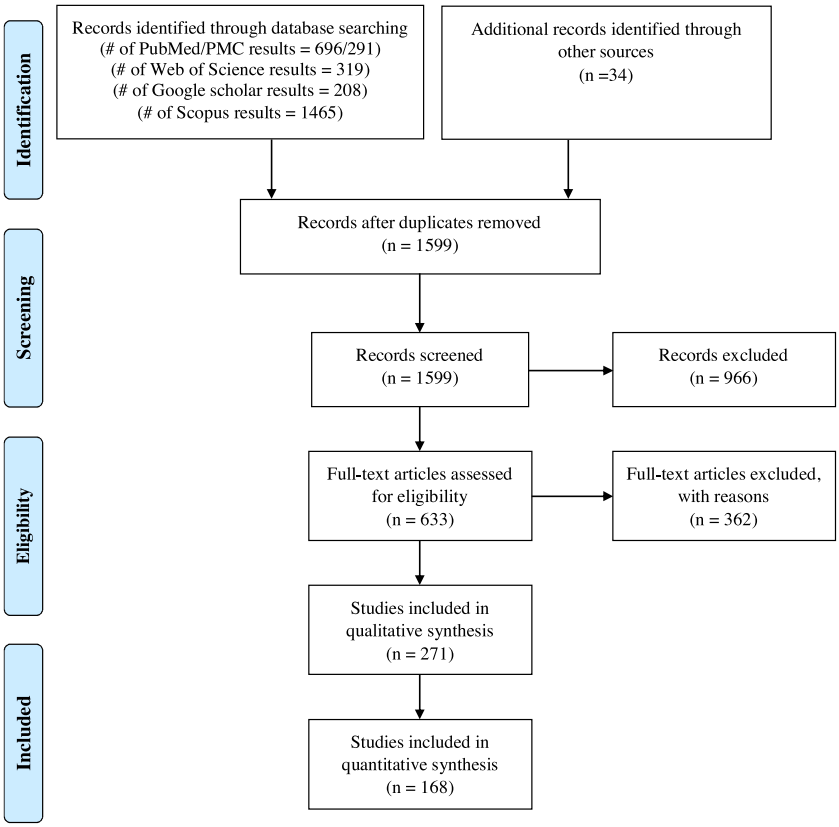

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flowchart summarizes the literature search results and study selection.

infection, and implementing alternatives to the previous patient's preparation/fixation techniques. Moreover, there was consensus to delay radiotherapy/chemoradiation therapy for those with lesser priority, such as the elderly or fragile case. All of the included recommendations, guidelines, and consensuses are presented in Tables 1–4.

Figs. 2 and 3 illustrate the distribution of selected papers versus the cancer type and the distribution of included documents concerning the countries that presented them, respectively. As shown, the number of guidelines and consensus is almost related to the frequency of cancer type with radiotherapy indication as one of the treatment strategies. For instance, breast, gynecological, and prostate cancer include more than 32 % of all diagnosed cancer type. About 23 % of all cancer patients who need to receive radiotherapy also have one of these three malignancies around the world (Joiner et al., 2019).

4. Discussion

Numerous recommendations were consistently published to guide radiation oncologists in the era of the COVID-19 crisis. In the beginning, the radiotherapy of some cases was postponed; however, the pandemic has been taking an unexpectedly long time. Therefore, patient selection and prioritization protocols proposed alternative treatments and modification of delivery techniques (Chakraborty and Pandey, 2020). Making proper treatment comments require weighing the risk of infection exposure and the benefit of treatment in a careful manner. A comprehensive review was done to extract the essential recommendations and consensus for radiotherapy during the current pandemic. Fig. 1 summarized the results of the review based on the PRISMA protocol.

Fig. 2 indicates the distribution of papers versus the considered disease site in the coronavirus outbreak. As illustrated, the published recommendations' rate matches the frequency of the most common cancer type worldwide. As presented in this figure, about 24 % of the recommendations were related to the radiotherapy of breast and prostate malignancies. However, based on a recent meta-analysis, most death rates between COVID-19 infected cancer patients were associated with hematological malignancies followed by lung. The higher degree of immunosuppression utilized in treating patients with hematological malignancies was known as the reason for this significant death rate (Venkatesulu et al., 2020). Previous studies did not indicate any apparent connection between any anticancer treatment modality and the chance of COVID-19 mortality, while the higher intubation and fatality rate of cancer patients was reported (Garassino et al., 2020; Venkatesulu et al., 2020).

Fig. 3 shows the distribution of papers versus countries where released guidelines and determines treatment priorities for cancer patients during the coronavirus era. The countries extracted based on the publication's author affiliation or the propounded departments. About 29 % of these included articles came from the USA and UK based on this figure. Lots of the proposed radiotherapy guidelines are dependent on the existence of advanced radiotherapy facilities and techniques. Despite worldwide improvements in financial safety and service coverage, some significant gaps remain, particularly for the most vulnerable countries and nations such as the Asian and African countries. Many centers, even in developed countries, do not have MV/MeV radiotherapy facilities, based on the IAEA Directory of Radiotherapy Centers (DIRAC) database (I. A. E. A. (IAEA), 2021). Therefore, many centers cannot technically apply some of these recommendations, such as hypo-fractionated and short-course radiotherapy techniques.

According to Fig. 3, developing countries published less guidance to face this scope. They rarely addressed their consensus, which may be due to fewer radiotherapy centers/high-tech equipment comparing to the developed ones. Eventually, some of these prescribed consensuses or even international recommendations do not fit the facilities, equipment, and staff knowledge across the whole RT centers. Considering the availability of dedicated high-tech equipment and human resources and tailoring COVID-19 pandemic management strategies to the regional context was not only recommended but also seemed mandatory (Kochbati et al., 2020).

Table 1
Summary of international guidelines or national multi-cancer recommendation for teletherapy prioritization during COVID-19 pandemic.

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
CNS	Re-irradiation for patients with recurrent GBM		GBM: - age ≥ 65 yrs: Hypo-F RT - age < 65 yrs (KPS ≥ 70): standard fractionation (Noticewala et al., 2020a) GBM: fractionation type depends on KPS (Combs et al., 2020)
	Asymptomatic meningioma Low-grade glioma Pituitary adenoma Craniopharyngioma Pilocytic Astrocytoma Trigeminal Neuralgia Schwannomas	Low-grade glioma	High-grade gliomas and spine tumors Benign tumors (with progressive neurologic symptoms) (Wright et al., 2020)
	GBM: Age > 60 yrs – methylated Low-grade glioma Asymptomatic meningioma Grade I-II and AVM	Asymptomatic meningioma, Asymptomatic AVM Asymptomatic schwannoma	GBM: reduction of fractionation (Simcock et al., 2020)
		Benign CNS tumor (up to 3months from diagnosis) (Montesi et al., 2020a) Low-grade gliomas (Slotman et al., 2020)	
		Low-grade glioma (as much as possible)	High-grade glioma (Hypo-F RT: 40·5 Gy/ 15 frs or 25 Gy/ 5 frs) (Starling et al., 1992)
		Benign tumors	GBM: - Age > 60 yrs, KPS: 60 - 70: Hypo-F RT (35 Gy / 10 frs or 40 Gy / 15 frs) - Age > 60 yrs, KPS < 60: 35 Gy / 7 frs weekly or 25 Gy / 5 frs - Age < 60 yrs, KPS > 70: 60 Gy / 30 frs - Age < 60 yrs, KPS < 70: Hypo-F RT (40 Gy / 15 frs)
		Low-grade gliomas	
		Grade I-II meningiomas Recurrent meningiomas Schwannomas Pituitary adenomas Craniopharyngiomas	Anaplastic astrocytoma Pineoblastoma PNET Medulloblastoma Germ cell tumors Anaplastic ependymoma
		Grade II ependymoma	Brain metastasis (whole brain: 20 Gy / 5 frs) Oligo brain metastasis with controlled extracranial disease Primary CNS lymphoma (Jalali et al., 2020) Continue any progressing RT: - High priority: Large benign tumors with acute symptoms (pressure, loss of sight); posterior fossa tumors (malignant or non-malignant) causing life-threatening hydrocephalus. - High-intermediate priority: Medulloblastoma; Young Grade 3 glioma - Intermediate priority: High-grade glioma in young fit patients - Low priority: Small benign tumors; HGG in elderly, low-grade glioma (Neuro-oncology treatment guidance during COVID-19 pandemic, 2021)
	GBM: Age > 65 yrs (esp. in poor PS)	Anaplastic oligodendroglioma (up to 4–6 month)	
			High-Grade Glioma: Standard of care (surgical resection followed by RT) Considerable tumor volume (gliomatosis) Involvement of brainstem/spinal cord Grade III astrocytoma Delicate or older patients: Hypo-F accelerated course (34 Gy /10 frs or 40.05 Gy / 15 frs and 25 Gy / 5 frs for smaller tumors) IDH-wild-type and IDH-mutant glioma: shorten RT courses (Vordermark, 2020a)
	Low-grade glioma asymptomatic meningioma G1–2		Glioblastoma, Frail/elderly (40 Gy / 15 frs or 25 Gy / 5 frs) (Kochbati et al., 2020) GBM: - Aged ≥ 65 yrs with excellent PS: Hypo-F RT (40 Gy /15 frs) - Aged < 65 yrs with good PS (KPS ≥ 70): standard fractionation (60 Gy / 30 frs) -Poor PS (KPS < 50): palliative regimens (34 Gy /10 frs or 25 Gy /5 frs) (Noticewala et al., 2020b)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		- Grade 1, Grade 2, and Grade 3 meningiomas - Schwannomas	- Meningioma: (Hypo-F RT) Grade 1, Grade 2: 25 Gy / 5 frs Grade 3: 45 Gy in 15 fractions -Schwannomas: frameless SRS/ Hypo-F RT (25 Gy / 5 frs)
	GBM: Elderly with poor KPS/unmethylated	- Low-grade gliomas	-GBM: Elderly with poor KPS/methylated: 34 Gy /10 frs or 5 Gy weekly × 6 weeks Younger patients good KPS: Hypo-F RT (60 Gy / 20 frs (SIB technique) -Medulloblastoma: Start with posterior fossa boost and then switch over to craniospinal RT with VMAT/IMRT -Cystic craniopharyngiomas: For all post-op patients, start on RT (Balakrishnan et al., 2020)
	Asymptomatic meningioma grade I-II Asymptomatic AVM	Grade 3 glioma (anaplastic oligodendroglioma) for 4–6 months	Non-co-deleted (anaplastic astrocytoma) Hypo-F RT: 40 Gy/15 frs or 30 Gy/6 frs (Hinduja et al., 2020)
		Low-grade gliomas	Newly diagnosed glioblastoma, IDH wild-type, the lower WHO grade gliomas, IDH-mutant with relevant clinical manifestations, and adult medulloblastoma: -Standard RT for younger fit patients with GBM (60 Gy / 30 frs) or Hypo-F RT with 60 Gy / 20 frs (SIB)
		Low-grade astrocytoma and 1p/19q co-deleted tumors	- Hypo-F RT for poor PS and age> 70 yrs (40 Gy /15 frs or 34 Gy /10 frs) -For medulloblastoma: craniospinal RT (4–6 weeks after surgery) with a possible start of the posterior fossa boost (IMRT or VMAT) (Stepanović and Nikitović, 2020)
			GBM: 45 Gy/15 frs (Hypo-F RT) cCRT: especially for old-age patients (care of myelosuppression) (Elkhouly et al., 2020)
	Adjuvant RT: -Meningioma (benign and atypical) -Pituitary adenoma, schwannoma, and low-grade glioma	- SRS for asymptomatic AVM by few months - Adjuvant RT for primary spinal tumors in minimally symptomatic patients or patients with stable neuro-deficits	- Hypo-F RT: high-grade glioma including children with diffuse intrinsic pontine glioma (40 Gy/15 frs in 3 weeks, 30–35 Gy/10 frs in 2 weeks, or even once-weekly - Standard of care RT: Children with medulloblastoma, ependymoma, and intracranial germ cell tumor (Gupta et al., 2020a)
	Multiple brain metastases	Low grade: RT after 3 months	CNS: No changes Hypo-F RT for glioblastoma Cranial Radiosurgery: No changes Brain metastases glioblastomas (Carvalho et al., 2020)
	Adjuvant: replace alternatives (prioritize by age and other comorbidities) Keloids Small COMS choroidal melanoma Asymptomatic glomus tumors Slow-growing small basal cell (with mild or no symptoms) Asymptomatic cutaneous (non-pigmented carcinomas located in low-risk anatomic regions)	Adjuvant: prioritize by age and other comorbidities Postop RT for salivary gland tumors (up to 12 weeks after surgery) Low-grade unresectable salivary gland malignancies Recurrent parotid/skull base pleomorphic adenoma Medium-large COMS choroidal melanoma Symptomatic choroidal melanoma Symptomatic or secretory paragangliomas Symptomatic cutaneous non-pigmented carcinomas High-risk postop cutaneous non-pigmented carcinomas	Radical: Do not defer until a rationale alternative (Simcock et al., 2020) Definitive RT: SIB techniques (standard or accelerated) (De Felice et al., 2020) Radical RT and High-risk postop cases (Wright et al., 2020)
Head and Neck		COVID-19+ patients (until recovery) COVID-19+ patients till recovery Delay but not more than 4–6 weeks: - Oropharyngeal (T2N + M0) - Laryngeal tumor (T3N1M0) - Laryngeal glottic (T1bN0M0)	Definitive (reduction of fractionation) (Simcock et al., 2020) Elective priority treatments (Montesi et al., 2020a) HNSCC: radical RT, post-operative RT for involved margins (Thomson et al., 2020a) Patients with mild respiratory symptoms HNSCC as radical RT and postop RT for positive margins (accelerated CRT schedules (6 frs / week), or SIB technique) (Lancia et al., 2020)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		- Metastatic hypopharyngeal (T4N1M1) - Oral cavity (pT2pN2aM0)	
	Palliative RT		Continue the standard fractionation scheme (Starling et al., 1992) High priority: - Curative treatment (Hypo-F RT (65 Gy/30 frs or 55 Gy /20 frs over four weeks rather than 70 Gy / 35 frs) - Adjuvant treatment (positive margins): SIB in postop cases - Palliative: short fractionation schedules (25 Gy / 5 frs, 20 Gy / 5 frs, 30 Gy / 6 frs with IMRT, or 8 Gy / 1 fr depending upon clinical scenario) (Roques and Prestwich, 2021)
	Adjuvant RT (lower/intermediate risk of recurrence)		Elderly patients (> 70 yrs): Hypo-F RT or SBRT (35−44 Gy / 5 frs every other day) Oropharyngeal Cancer (early stage): RT only (HPV+) / CRT if not RT alone (HPV-) Laryngeal Cancer: supraglottic/ subglottic, glottic cancers, hypopharyngeal cancers (RT only) Nasopharyngeal Cancer: preferred CRT if not RT alone Salivary Gland Cancer (e.g., parotid cancers): preferred primary surgery otherwise RT or SBRT Oral cavity: surgery if not induction of chemo, pre-op RT, or definitive RT / SBRT (35−44 Gy /5 frs) Postop HNC (For high-risk HNC post-resection, adjuvant RT alone (Parashar et al., 2020) RT plus/minus chemo if it is equal to surgery with adjuvant therapy (Vordermark, 2020a) Radical and postop RT for involved margins with higher priority compared to adjuvant RT for minor risk factors: Hypo-F RT (cCRT: conventional or mildly Hypo-F RT of ≤ 2.4 Gy / fr) Salivary glands of paranasal sinuses (Locally advanced): high-linear energy transfer carbon ions radiotherapy (CIRT): Hypo-F RT of 16 frs over 4 weeks (Ronchi et al., 2020) Non-surgical approach (definitive IMRT) for OSCC: -Accelerated conventional fractionation RT:70 Gy/35frs (over 6 weeks) -Accelerated Hypo-F RT: 60 Gy/25frs (over 5 weeks) -Accelerated HypeF-RT: 64 Gy/40frs (1.6 Gy/fr twice daily, at least 6 hours apart] over 4 weeks) (Hosni et al., 2020) Orbital/intraocular tumors: Frameless Hypo-F image-guided volumetric modulated arc (stereotactic RT) 25 Gy/5frs over 1 week (Manjandavida et al., 2020)
	Adjuvant RT: R0 resection and minor risk factor	Post-op RT in patients with salivary gland tumors until 12 weeks after surgery	Curative treatment – High priority patients: - Hypo-F RT: 65 Gy /30 frs or 55 Gy / 20 frs over 4 weeks -cCRT -Accelerated fractionation without chemotherapy (6 frs per week) / SIB (Hinduja et al., 2020) Recurrent nasopharyngeal carcinoma: techniques of extreme Hypo-F RT -SRS: 12.5 Gy; 18 Gy -SBRT: 24 Gy /6–8 frs; 18 Gy/3 frs; 48 Gy /6 frs; 34 Gy/2–6 frs; 54 Gy/18 frs; 33 Gy/3–5 frs; 30 Gy /5 frs (Svajdova et al., 2020) Short-course Hypo-F accelerated RT in non-nasopharyngeal HNSCC: stage II-III-IV (55 Gy/20 frs in 4weeks) (Gupta et al., 2020b) Intermediate sinonasal tumors: cCRT or RT Not to delay RT for more than 4–6 weeks (Hypo-F RT):

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			-High priority for treatment: radical RT for HNSCC and adjuvant RT for HNSCC with involved margin / High-growth mass and who undergoing curative radical (chemo) RT -Lower priority: adjuvant RT for HNSCC with minor risk factors -Limited and selected cases of OSCC, T4a laryngeal SCC, and advanced sinonasal malignancy: cCRT or RT -Radical RT in less aggressive cancers (definitive RT or adjuvant RT in rapid proliferating cancers with residue after surgery) -Adjuvant RT incomplete resection patients and palliative RT (lowest priority) (Salari et al., 2020) Oropharynx/larynx: CRT/RT for curative intent Oropharynx (Early stage): RT preferred to surgery Oropharynx (Locally advanced): cCRT Locoregional advanced hypopharyngeal: cCRT (fit patients) Nasopharynx (stage II-IV): NACT followed by CRT (IMRT) Early glottic cancer: RT Oral cavity (early resectable) and high-risk factors such as margin positivity and perinodal extension: cCRT (definite overall survival benefit) Nasopharynx (stage I): RT (Talapatra et al., 2020) Head-and-neck: RT as the main treatment (Carvalho et al., 2020) Hypo-F CRT for head and cancer (68–70 Gy /34–35 frs; 60–66 Gy /30 frs; 55 Gy /20 frs): 65 Gy/30 frs rather than standard fractionation 70 Gy/35 frs Locally advanced laryngeal cancer: 67.2 Gy / 28 frs Hypo-F RT alone: 60 Gy/25frs (T1-T3 N0-N2c HPV + and T1-T2 N0 HPV-) Oropharyngeal patients: 60 Gy/30 frs Hypo-F accelerated RT: 64 Gy / 25 frs Locally advanced disease: IMRT (55 Gy/20 frs) (Vreugdenhil et al., 2020)
Breast	Age > 70 yrs: - Completely excised (margin ≥ 1 mm) - Low-risk invasive disease (pT1/pN0, grades I-II, LVI negative, ER+, HER2-, without extensive intra-ductal component) Age > 55 yrs: - DCIS < 2·5 cm, grades I-II, and margin ≥ 1 mm Adjuvant: replace alternatives (prioritize by age and other comorbidities) DCIS (except ER-negative DCIS with positive margin) Age > 65 yrs: - Early-stage (grade 1 or 2), less than 30 mm in tumor size, node-negative ER+/ HER2- (adjuvant endocrine therapy) Age ≥ 70 yrs Tumor < 20 mm Grade I No angio-lymphatic or perineural invasion	After breast-conserving surgery Low-intermediate risk invasive disease (pT 1-2 /pN0) DCIS (Koch et al., 2020) Adjuvant: prioritize by age and other comorbidities (Samiee et al., 2020) Inflammatory BC or mastectomy Node+: TNBC or HER2+ disease Post-mastectomy with four or more nodes+ Residual node + disease after NAC PMRT with 1-3 tumor + nodes Node-: TNBC or HER2+ (BCT) Positive margin after BCT for invasive BC with no alternative Age <40 yrs: - BCT, node-negative with >1 additional high-risk features (LVI+, PNI+) - ER- DCIS with a positive margin after surgery Up to 12 weeks in new patients	Bleeding Painful inoperable local-regional disease Symptomatic metastatic disease Progression of disease during neoadjuvant chemotherapy (Dietz et al., 2020; Breast cancer in the COVID-19 era [Online], 2021; Luther and Agrawal, 2020) Post-mastectomy Nodal irradiation After immediate reconstruction: Hypo-F RT Boost: Hypo-F RT or integrated with whole-breast irradiation

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
	ER +, PR +, HER2 negative, Ki67 < 10 % Low or medium grade DCIS including non-palpable tumors, size < 25 mm with free margins Age ≤ 65 yrs (or younger with relevant co-morbidities)		Whole breast and node irradiation: −26 Gy / 5 frs and 29 Gy at the tumor bed with an integrated boost dose of 5.8 Gy (IMRT, VMAT, IGRT) Partial irradiation of the breast: - Intra-operatively (30 Gy / 5 frs or 37·5 Gy /10 frs twice daily on the tumor bed with negative margin) Pre-op irradiation: −40·5 Gy / 15 frs (54 Gy concomitant boost delivered 3·6 Gy daily) Elderly patients without indication for surgery: - Weekly 6·5 Gy for five weeks for a total of 32·5 Gy (a boost of two 6·5 Gy frs) (Pardoa et al., 2020) Node negative tumors without boost RT (28–30 Gy in once weekly fr over five weeks or 26 Gy in 5 daily frs over one week)
	An invasive tumor (up to 30 mm) Grade I-II, ER+, HER2- and node- (endocrine therapy) DCIS Boost RT (unless age ≤ 40 yrs, or over 40 yrs with significant risk factors for local relapse) Nodal RT: - Post-menopausal women for T1, ER+, HER2- G 1-2 tumors with 1-2 macro-metastases Boost RT (unless for age ≤ 60 yrs, high-grade tumors, inadequate margins) Age ≥ 65 yrs: Invasive breast cancer < 30 mm Clear margins Grade 1-2, ER+, HER2– Node- (planned for endocrine therapy) Low-risk DCIS or active surveillance/ carcinomas (Combs et al., 2020) CALGB/PRIME II		Breast/chest wall and nodal (moderate Hypo-F RT) (Coles et al., 2020)
	ER + DCIS (esp. if take hormone)	ER+DCIS	Intact breast
	Breast Conservation-DCIS Invasive disease Low risk-older patients Invasive disease Genomic profile low risk, Age ≥ 50 ER+, Her2- without other adverse pathologic features	Invasive breast cancer	Post-mastectomy and/or regional node(RT with moderate Hypo-F RT (42·5 Gy/16 frs or 40 Gy/15 frs) (Achard et al., 2020)
	Post Mastectomy: T 1-2 N1	All other	Non-metastatic inflammatory Locoregional disease progressing via chemo (Wright et al., 2020) Partial (APBI) RT or IORT Whole breast +/-LN Whole breast + LNs /Chest wall/ PMRT Chest wall/whole breast/RNI Chest wall/PMRT Postmenopausal ER+/Her2- G 1-2, T1, 1–2 SLN (mi) (reduction of fractionation) (Simcock et al., 2020)
	Early-stage Low-risk elderly breast cancer Boost in selected patients Nodal irradiation in selected patients Elderly patients with low risk of relapse (except for moderately or extremely Hypo-F RT)	Breast conservation	(Moderate) Hypo-F RT to the chest (Parashar et al., 2020)
	Elderly patients (underwent adjuvant endocrine therapy) Hormone-sensitive stage I and II	Early breast cancer (Low-risk): Postop RT by six months Up to 3 months from diagnosis to treatment (Montesi et al., 2020a) Adjuvant RT: up to 8 weeks	Moderately or extremely Hypo-F RT regimens (Vordermark, 2020a) Moderate Hypo-F RT FAST: Once weekly fractions over five weeks (28−30 Gy) FAST-Forward: five daily fractions over one week (26 Gy) (Lancia et al., 2020) Normal fraction: young women (50−66 Gy) Hypo-F RT protocol: elderly women (42–53·2 Gy /15–19 frs) (Amaoui et al., 2020)
	Adjuvant RT: age ≥ 65 yrs, with T1/T2N0 luminal tumors (endocrine therapy)	Early-stage breast cancer (Slotman et al., 2020) Early cases (in situ neoplasia, small invasive carcinomas, luminal tumors): up to 2 months after the surgery Patients underwent chemotherapy before RT: up to 8 weeks	Early cases (in situ neoplasia, small invasive carcinomas, luminal tumors): - IORT or accelerated partial breast RT (if available)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			- Whole breast +/- LN: Hypo-F RT (5frs) (Starling et al., 1992)
	Breast conservation DCIS Invasive disease Low risk (esp. older patients) Age > 50 yrs, ER+, Her2- Post-mastectomy T1–2 N1 (LN + breast cancer) (Marcus and Mahajan, 2020) DCIS, RH+ Adjuvant: Age < 65 yrs (receiving hormonal therapy DCIS age > 65 yrs (low-risk criteria) (Ismael et al., 2020)		
			Emergency preop breast RT: 26 Gy / 5 frs +/- Boost (SIB:6 Gy / 5 frs or Sequential 10 Gy / 2 frs) Complete response tumor: 26 Gy / 5 frs Palpable tumor: 26 Gy / 5 frs + Boost (SIB:6 Gy /5 frs totally 35 Gy / 5frs or sequential 10 Gy / 2 frs)
	Negative axilla		Negative axilla: Not or 26 Gy / 5 frs to levels 1–4 if node-positive at presentation before primary systemic therapy Positive axilla (N1): 26 Gy / 5 frs to levels 1–4 Positive axilla (N 2-3 +IMN): Standard 3 week RT or 26 Gy / 5 frs to levels 1–4 (Brunt et al., 2021)
	- Age ≥ 65 years (younger with comorbidities) + invasive breast cancer < 3 cm with clear margins + grade 1/2 + ER + and HER2- + node- planned for endocrine therapy - Omit boost or shift to Hypo-F RT (except in patients < 40 years age and whom with a high risk of local recurrence)		Neoadjuvant RT (40 Gy in 10 fractions then 30 Gy in 5 fractions over 1 week): - Invasive breast cancer with no systemic therapy option - Completion of all neoadjuvant therapy and triple-negative breast cancer - Loco-regional cancer progression/poor response despite the use of all available neoadjuvant therapies
	- Omit nodal RT for Postmenopausal women with T1, grade 1–2, ER+, HER2- a tumor with 1–2 macro metastases requiring WBRT following BCS and sentinel node biopsy		Adjuvant RT (26 Gy in 5 daily fractions over 1 week or 28–30 Gy in 1 weekly fraction over 5 weeks): - Others who recognized to need whole or partial breast or chest wall: (Manoj Gowda et al., 2020)
	Boost: age > 50 yrs with HR + and/or small HER2+ RT in which survival is not affected: - age ≥ 65 yrs with an early stage, HR+, HER2-, node-, grade I-II - after excision of a low-to-intermediate grade ER + DCIS.	If the boost is necessary: - postponed up to 3 months forhigh-risk patients and up to 6 months for low-risk patients Delay of definitive radiotherapy for good-risk tumors	HR+, HER2- (Adjuvant setting): 42.6 Gy / 16 frs or 40 Gy / 15 frs (Hypo-F RT) (Raghavan et al., 2020)
		Postop RT: for several weeks or even months	Adjuvant local RT in early-stage breast cancer: 26 Gy /5 frs over 1 week is non-inferior to 40 Gy / 15 frs over 3 weeks for (UK FAST-forward trial) (Upadhyay and Shankar, 2020)
	boost RT in selected patients	adjuvant RT: up to 3 months after surgery	Hypo-F RT for adjuvant treatment (Ng et al., 2020a)
	Certain non-invasive carcinomas with good prognosis factors (Age > 40 yrs, tumors < 2.5 cm, low and intermediate grade, and sufficient surgical margins ≥ 2 mm) Age > 65 yrs (or with comorbidities) with invasive BC with good prognostic factors (grade 1–2, hormone-positive, tumors < 3 cm, Node-, HER2-)	adjuvant RT: -low-risk disease	Adjuvant RT for high-risk BC: -Stages T3 or N-positive
	Boost for patients > 40 yrs without risk factors (LVI, high grade, hormone-negative, and positive surgical margins)	-In-situ carcinoma (CIS) by 3–6 months For postmenopausal patients > 65 yrs with stage I or II and hormone-dependent	-Stages T1/T2N0 with risk factors (LVI, high grade, margins+, and HR-) Hypo-F RT: 42 Gy / 15 frs

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		disease, or patients with significant comorbidities: by 3–6 months	Ultra Hypo-F RT: 28/30-Gy in once weekly fractions over 5 weeks or 26-Gy in 5 daily fractions over 1 week as per the FAST and FAST Forward trials (N- tumors without boost). (Ismaili and El Majjaoui, 2020)
	Boost: age > 50 yrs with ER+, HER-2- invasive type tumor without other adverse pathologic features Standard BCS RT: age > 70 yrs with small, grade I-II, and HR + tumor RT after excision for low-intermediate grade DCIS, particularly in women over 60 yrs		Adjuvant RT: Hypo-F RT (42.4 Gy /16 frs or 40 Gy / 15 frs) and standard regimen (50 Gy / 25 frs) for regional lymph nodes involvement (Mahmoodzadeh et al., 2020)
	After BCS: - Low-risk elderly (≥ 65 yrs): WBRT for stage I, ER+/HER2− receiving adjuvant endocrine therapy, without impacting survival - DCIS: WBRT, especially for ER + disease receiving adjuvant endocrine therapy, without affecting overall survival. - Invasive disease with low-risk genomic profile -Boost: in invasive disease (except for patient ≤40 yrs or with positive margin) and in situ (except for positive margin; no survival benefit except for high-risk diseaseAfter mastectomy: T 1-2 N+	Low-risk elderly (≥65 yrs): WBRT for stage I, ER+/HER2− receiving adjuvant endocrine therapy, without impacting survival	-Patients already on adjuvant RT -Adjuvant postop RT within 2–4 months post-surgery, for high-risk BC patients (inflammatory BC, N-positive, TNBC or HER2+, residual disease after neoadjuvant therapy, young age <40 yrs) - Adjuvant postop RT within 5–6 months post-surgery for low/intermediate-risk BC patients (age < 65 yrs and stage I–III luminal cancer, or positive margins), with starting endocrinal therapy (Elghazawy et al., 2020)
	Abandon RT: - Patients > 65 yrs, tumors up to 30 mm, N0, ER+, HER2-, G 1-2, margins ≥ 2 mm, DCIS, especially with ER+, patients on hormone therapy.	Postpone RT up to 20 weeks after the completion of surgical or systemic treatment: -Tumor T1, T2, N0 hormone-sensitive, HER2, > 40 yrs, patients on hormone therapy, unfavorable prognostic factors (close margins, G3)	Breast, Elderly, N- (40 Gy / 15 fr, 28.5 / 5 frs, or 26 Gy / 5 frs) (Kochbati et al., 2020) -Begin RT up to 8 weeks after the completion of surgical or systemic treatment: Inflammatory breast cancer, massive metastases to ≥4 lymph nodes, massive LVI, TNBC with N+, yp N+, and regional recurrence. -Begin RT up to 16 weeks after the completion of surgical or systemic treatment: T4, TNBC, N0, yp T + and N0, LVI (NOS), Invasive cancer in patients < 40 yrs, ER + with 1–3 N + and other unfavorable prognostic factors (G3, LVI) (Łacko et al., 2020)
	Good risk DCIS: Low/intermediate grade, < 2.5 cm, margin >3 mm EBC: -Age >70 yrs, post BCS - T1, N0, ER+, margins clear -Age >65yrs, ER+, N0, T1/T2 (up to 3 cm), clear margins; grade 3 or LVI Boost dose for DCIS / EBC (>60 yrs) Adjuvant RT (DCIS): low-risk cases (age ≥ 50 yrs with no necrosis, low grade, small tumor size, at least 2 mm margins) Invasive breast cancers (node-negative): post-op, patients aged ≥ 65 yrs with HR + tumors	DCIS: up to 12 weeks EBC post BCS: delay RT without chemotherapy up to 20 weeks Good risk DCIS: ER/PR+, EBC/DCIS ER + disease with N1a nodes (1-3 nodes)/ Node negative TNBC/Pathological N0 post-NACT / LVI	EBC: Young premenopausal women Locally advanced breast cancer Boost dose for EBC: - Hypo-F RT -SIB or concomitant boost (daily or weekly) −5.2 Gy single fraction after ultra- Hypo-F RT Inflammatory breast cancer/Residual nodal disease after NACT/N2 disease (4 or more nodes)/Recurrent disease/Node positive TNBC/Extensive LVI (Hinduja et al., 2020) Adjuvant RT (DCIS): higher-risk cases (Hypo-F RT) -APBI:40 Gy/10rs, 38.5 Gy/10 frs twice a day over 5–8 days -FAST FORWARD regimen for WBI: 26 Gy / 5 daily frs Node negative invasive cancer: -Low-risk patients aged 40–64 yrs (maximum tumor size 3 cm, ER+) APBI: 30 Gy / 5 frs daily (IMRT) or 40 Gy / 10 frs daily (3D CRT) WBI: 40 Gy / 15 frs (standard Hypo-F or FAST FORWARD regimen)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			During DORSCON Red: APBI using 30 Gy / 5 frs or WBI using 26 Gy / 5 frs Other patients (age ≤40 yrs; or high-risk, age > 40 years; or tumors > 3 cm, high grade, ER-, HER2+ or involved margin), WBI or PMRT for tumors > 5 cm or positive margin): -Standard Hypo-F RT 40 Gy/15 frs or the FAST FORWARD regimen If the boost is indicated: simultaneously (48 Gy /15 frs or sequentially as 10.5 Gy/3 frs During DORSCON Red: WBI or PMRT using 26 Gy / 5 frs Node positive invasive cancer: - N1 disease: adjuvant RT to the breast/chest wall and ipsilateral supraclavicular fossa (and axilla) using standard Hypo-F RT 40 Gy / 15 frs or 26 Gy / 5 frs - Adjuvant RT to IMNC with N2 disease using standard Hypo-F RT 40 Gy /15 frs Boost: simultaneously using 48 Gy / 15 frs or sequentially 10.5 Gy /3 frs During DORSCON Red: adjuvant RT using 26 Gy /5 frs (Chan et al., 2020)
		All adjuvant RT except high-risk patients (T 3-4, N 2-3, TNBC or young age)	Adjuvant RT: 40 Gy / 15 frs + SIB for BCS (10 or 16 Gy / 5 or 8 frs) (Elkhouly et al., 2020)
	Age ≤ 65 yrs with significant comorbidities with invasive ductal carcinoma ≤ 3 cm, ER/PR+, Her2-, margin-free, grade I-II, N-: RT		Breast or chest wall and nodal RT: Moderate Hypo-F RT (40 Gy / 15 frs over 3 weeks followed by boost)
	Age ≤ 40 yrs with relevant comorbidities: Boost RT		Node-negative tumors: 28–30 Gy once a week (over 5 weeks) or 26 Gy / 5 frs daily (over 1 week) (Talapatra et al., 2020)
	Low-risk elderly (> 70 yrs) with favorable tumors	Postpone RT start up to 16 weeks Interruption for a suspected or confirmed case of COVID-19 (15 days)	Selected patients (> 60 yrs, breast only RT): 26 Gy / 5 frs (Carvalho et al., 2020)
		Whenever possible: up to 12 weeks after surgery	-Foregoing RT: Age ≥ 70 yrs, tumor size < 2 cm, grade 1, no signs of poor local prognosis, clean surgical margins, N-, HR+, and HER2-. -RT with ultrashort schemes: Age ≥ 50 yrs, tumor size < 3 cm, pN0, grade I–II, luminal A PBI either by IORT (at the time of lumpectomy/quadrantectomy) or by RT (30 Gy/5 frs and 6 Gy on tumor bed with margin) -Pre-op RT: For older patients: Hypo-F RT (32.5 Gy/5 frs for 5 weeks) with 13 Gy / 2 frs boost Lymph nodes: 27.5 Gy / 5 frs (Martin et al., 2020) Hypo-F breast RT for 1 week (Kwek et al., 2021) Selected patients: 28.5–6 Gy / 5 frs with DIBH over 1–2 weeks (Dong et al., 2020)
		Postop RT in NSCLC and PCI in SCLC	RT for curative treatment (stage III NSCLC LS-SCLC and palliative NSCLC
		COVID-19 positive patients	Radical RT or sequential CRT for stage III NSCLC (Hypo-F RT) Inoperable Stage I NSCLC: SBRT (Lancia et al., 2020)
		Consolidation of oligometastatic and oligoprogressive NSCLC (Stage I)	Limited-stage SCLC (Wright et al., 2020)
Lung	SCLC-Extensive		N0-Inoperable (T1-T2 peripheral) NSCLC (locally advanced) NSCLC N+ SCLC (Simcock et al., 2020) Lung cancer: concomitant CRT (Hypo-F RT: 55 Gy / 20 frs) (Amaoui et al., 2020)
		Early-stage (non-biopsied, slow growth, advanced age, or comorbidities) Oligometastatic patients	

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		Consolidation RT or PCI in patients with SCLC and extensive disease. PCI in patients with SCLC with limited disease (Starling et al., 1992)	
	SCLC Extensive disease (Marcus and Mahajan, 2020)		
			NSCLC: stage I-II NSCLC (SBRT) stage II (node positive) - III NSCLC, stage IV NSCLC SCLC: limited-stage (stage I-III), extensive-stage (stage III-IV) Palliative RT (Rathod et al., 2020) NSCLC (curative treatment: SABR) Stage I-II patients (1-3 frs): - 30−34 Gy /1 fr for tumors < 2 cm and ≥ 1 cm from the chest wall - 48−54 Gy / 3 frs over one week for peripheral lesions - Mild Hypo-F RT (45–60 Gy / 4–8 frs) for central and ultra-central lesions Stage II-III patients: - 55 Gy / 20 frs Stage III inoperable: - Accelerated Hypo-F RT (45 Gy /15 frs) SCLC (curative treatment: SABR) Stage I-II SCLC (3–5 frs) in peripheral lesions: - 60 Gy /3 frs - 48 Gy / 4 frs - 50 Gy / 5 frs Limited-stage SCLC: - Early or upfront cCRT (thoracic RT / 15 days: 45 Gy / 30 twice daily 1.5 Gy frs) are comparable to the twice-daily regimen: 40−42 Gy /15 daily frs or 50−55 Gy / 20–25 daily frs) PCI: 25 Gy / 10 frs Palliative: - single-fraction RT (8 Gy): For patients with symptomatic (i.e., pain, hemoptysis, etc.) or medical emergency (non-brain) metastasis (SVCO or spinal cord compression) (Liao et al., 2020) 2. SABR for tumors within 2·5 cm of the chest wall: 54 Gy /3 frs (If PTV overlaps the chest wall: 54 Gy / 3 frs or 48 Gy / 3 frs) 3. SABR for moderately central tumors: 50 Gy / 5 frs 4. SABR for tumors >5 cm (treated with caution) 5. Hypo-F RT for central/ultra-central early-stage tumors not suitable for SABR: 50−60 Gy /15 frs Stage III NSCLC (accelerated fractionation ((55 Gy / 20 frs)/ IMRT/VMAT) Early-stage SCLC: SABR for T 1-2 N0M0 Limited-Stage (LS) SCLC (good PS): 40 Gy / 15 frs (Faivre-Finn et al., 2020) Curative-intent RT (reduction of the fraction) Early-stage NSCLC: 1.single-fraction SABR: 30–34 Gy for tumors ≤ 2 cm, > 1 cm from the chest wall Non-surgical treatment (esp. elderly patients with locoregionally advanced tumors or oligometastatic disease) (Vordermark, 2020a) SCLC: -CRT followed by PCI for limited-stage disease -Chemotherapy followed by RT and PCI for extensive-stage disease RT alone if chemotherapy is challenging. Peripheral stage I/IIA NSCLC (SBRT) Stage IIB/III NSCLC: sequential radiation and chemotherapy RT: definitive treatment, pre-op treatment, and postop RT, extra-capsular extension or

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			positive margins, gross residual disease (Parashar et al., 2020) Peripheral early-stage NSCLC (T1-T2): Single-Fraction SBRT (34 Gy / 1 fr vs. 48 Gy / 4 frs) Central Lung Tumors: Multi-fraction SBRT (Sylvia et al., 2020) Treating lung cancer with SBRT in 1–5 frs (Upadhyay and Shankar, 2020) NSCLC: -CRT for stage III - Palliative or ablative radiotherapy (SBRT): compression of airways or bleeding SBRT (reduced from 8 frs to 5 or 3) and palliative RT in single or 2 frs (8–10 Gy or 17 Gy, respectively). SCLC: - CRT for limited-stage - Palliative or ablative radiotherapy (SBRT) (Omeroglu Simsek, 2020)
	Thoracic consolidation radiotherapy extensive stage		
		Postpone initiation of treatment by 4 weeks: -Post-Operative Radiotherapy (PORT) NSCLC - Prophylactic Cranial Irradiation (PCI) SCLC	Use less treatment sessions: - SABR as possible. - Hypo-F RT regimens (Bakhribah et al., 2020) - Stage I NSCLC: 45–54 Gy /3 frs or 48–50 Gy / 4 or 5 frs or 30–34 Gy /1 fr in select patients (SBRT/ablation) - Locally advanced NSCLC (stage III): 60 Gy / 24 frs or 55 Gy / 20 frs or up to 60 Gy / 15 frs (Hypo-F RT schedule) - Limited-stage SCLC: twice-per-day RT (cCRT) PCI for age < 75 yrs (Singh et al., 2020)
		Extensive-stage SCLC: PCI	
	Extensive SCLC (PCI or palliative intent)		Locally advanced (palliative): - 40 Gy / 15 frs - 39 Gy / 13 frs - 16 Gy / 2 frs (Kochbati et al., 2020)
	SCLC, Extensive: - PCI		NSCLC, T1/2N0M0, medically inoperable; peripheral: -SBRT 30−34 Gy/single fr (T1 N0M0) −54 Gy / 3 frs in 1.5 weeks (Eligibility includes T1, 2 (<5 cm), T3 < 5 cm, chest wall involvement positive, no mediastinal or bronchial tree invasion) −48 Gy / 4 frs daily RT
	- Consolidation thoracic RT in extensive-stage disease	Stage I-IIIB tumor operated: Short delay in RT if R0 resection	NSCL, T1/2N0M0, medically inoperable, central: - 60 Gy / 8 daily frs −70 Gy / 10 daily frs −50 Gy / 5 daily frs Stage III, Locally advanced NSCLC: −55 Gy / 20 frs with concurrent /sequential chemotherapy −60 Gy /15-20 frs NSCLC, advanced- inoperable, large for Palliative RT: 8 - 10 Gy/ 1-2 frs SCLC, localized: 40-42 Gy /15 daily frs (Hinduja et al., 2020) Curative treatment for stage III NSCLC: Hypo-F in cCRT strategy (60–66 Gy / 22–30 frs and 50 Gy / 20 frs) Inoperable stage II-III NSCLC Limited stage SCLC Palliative NSCLC (spinal cord compression or SVCO) Early-stage NSCLC: SABR:30–34 Gy /1 fr to 48–54 Gy / 3 frs Central tumors: Hypo-F RT (50–60 Gy /15 frs) Inoperable early-stage NSCLC and operable NSCLC: SBRT Stage II NSCLC: definitive RT (Stepanović and Nikitović, 2020)

(*continued on next page*)

Table 1 (*continued*)

Cancer type		Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
				Early-stage disease: SBRT for tumors <2.0 cm (a single fraction of 30 − 34 Gy) Adjuvant Hypo-F RT: 50 − 60 Gy /25–30 frs Locally advanced disease (clinical stage III): cCRT (mild Hypo-F:50 Gy /20frs) SCLC extensive disease: 45 Gy/15 frs or 30 Gy /10 frs SCLC limited disease: SBRT (Arrieta et al., 2020)
			Adjuvant RT (pathological N2 or R1 post-op): after chemotherapy or 3 months after surgery	
			Patients with known SARS-CoV-2 or active COVID-19: for a few weeks until resolving symptoms and subsiding inflammation	Lung cancer: IMRT and proton beam therapy (Hwang et al., 2020)
			Delay RT for 1–2 months: sequential CRT instead of cCRT	Lung RT (palliative): 30-39 cGy / 10–13 frs (Elkhouly et al., 2020)
				SBRT or SABR for early-stage (<5 cm) node-negative NSCLC: −50-70 Gy/5-10 frs for central tumors -A single fraction of 24-34 Gy for peripheral tumors < 2 cm
			Delay SBRT for small, slow-growing tumors	
				Locally advanced lung cancer (stage III NSCLC): Hypo-F RT (55 Gy/20 frs) (Dingemans et al., 2020)
			Postponing SBRT in indolent tumors	NSCLC: SBRT: no changes Hypo-F for stage III without cC No Postpone RT start SCLC: Limited disease: no changes Extensive disease: PCI and thorax consolidation No Postpone RT start (Carvalho et al., 2020)
			NSCLC and SCLC: Interruption for suspected or confirmed case of COVID-19 within 15 days	
				High priority: -SCLC limited disease stage I/II and III: cCRT -Inoperable NSCLC Stage III: CRT (Concomitant or sequential) -Inoperable stage II to III: RT (contraindications for C) -Inoperable NSCLC stage II/III and SCLC limited disease: cCRT - SVCO or significant hemoptysis, spinal cord compression, or any threatening lesion: RT Medium priority: -Stage I: SABR or SBRT -Limited SCLC: PCI (after C) (Passaro et al., 2020)
			Adjuvant Post-op RT for R1 resection in NSCLC: at the end of adjuvant C or delayed up to 3 months from surgery (medium priority)	
		Extensive stage SCLC: MRI active surveillance instead of PCI (after C)		
			Adjuvant Post-op RT N2 R0 in NSCLC: at the end of adjuvant C or delayed up to 3 months from surgery (low priority)	
				Stage I NSCLC (SBRT): -Safe Zone: 30-34 Gy/1 fr; 54 Gy / 3 frs -Peripheral Lesions: 48 Gy /4 frs -Central Tumor: 50- 60 Gy / 5 frs vs. 60 Gy /8 frs Stage III NSCLC: - CRT: 60-66 Gy /30-33 frs Stage III NSCLC (RT Alone/sequential): - 55 Gy / 20 frs; 45 Gy / 15 frs LS-SCLC: - CRT 60-66 Gy / 30-33 frs over 6- 6.5 weeks, or 45 Gy /30 frs over 3 weeks (twice a day: 1.5 Gy) PCI: 25 Gy /10 frs (Counago et al., 2020)
		ES-SCLC: MRI surveillance	NSCLC: Post-op RT	
				Definitive: CRT (OSCC and OAC) if not Hypo-F RT (50 Gy/16 frs for tumors > 5 cm or 55 Gy /10 frs for tumors > 10 cm) Neoadjuvant: Hypo-F CRT (40 Gy /15 frs) Palliative (8 Gy / 1 fr or 20 Gy / 5 frs) (Jones et al., 2020a) Neoadjuvant therapy plus surgery vs. surgery vs. dCRT (Combs et al., 2020) Curative-intent esophageal cancer (Wright et al., 2020) Locally advanced (T2N + or T3+/Nany) operable esophageal carcinoma Neoadjuvant CRT (41·4 Gy / 23 frs or 40 Gy /15 frs) Inoperable esophageal cancer: dCRT (50 Gy / 25 frs)
Gastrointestinal	**Esophageal**			

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Definitive RT: Hypo-F RT (50 Gy / 16 or 20 frs) Palliative RT (6-8 Gy /1 fr for pain or bleeding, or 20 Gy /5 frs for dysphagia) (Tchelebi et al., 2020) If surgery or cCRT is challenging (RT alone) Pre-op RT just in case of availability of surgery in a few weeks Definitive RT Post-op RT (Parashar et al., 2020) Gastroesophageal junction (Montesi et al., 2020a) Priority level 1: Rapidly proliferating tumors currently being treated with radical RT with curative intent Priority level 2: Urgent palliative RT (malignant spinal cord compression: 8 Gy / 1 fr or 20 Gy / 5 frs) Priority level 3: - Radical RT for less aggressive tumors - Postop RT (determined residual disease after surgery in tumors with aggressive biology) Priority level 4: Palliative RT (alleviation of symptoms) Priority level 5: Adjuvant RT (Jones and Crosby, 2021) Neoadjuvant chemotherapy or CRT (Vordermark, 2020a)
	Palliative: alternatives to RT	Adjuvant CRT: up to 12 weeks	
	Resectable/ Unresectable (Marcus and Mahajan, 2020) Locally advanced (TanyNanyM0): - Neoadjuvant CRT - Adjuvant (Postoperative radiation)		Palliative RT (6-8 Gy / 1 fr) (Tchelebi et al., 2020) Perioperative: neoadjuvant chemotherapy/ CRT, adjuvant chemotherapy /CRT Preoperative RT to delay surgery Postoperative RT (Parashar et al., 2020) Non-surgical approach for non-urgent gastrointestinal cancer (Vordermark, 2020a)
	Adjuvant curative RT (Kochbati et al., 2020)		cCRT: 40 Gy / 15 frs For tumor 5 cm in length:50 Gy / 16 frs and up to 10 cm 50-55 Gy in 20 frs (Hinduja et al., 2020)
		Postpone RT up to 3 months in indolent disease (Carvalho et al., 2020)	
	Adjuvant curative RT (Kochbati et al., 2020)		
Gastric	Operable and resected cases: RT may be avoided		Palliation: Short fractionation schedules (Talapatra et al., 2020)
	Stomach: No neoadjuvant or adjuvant RT	Gastrointestinal: within 3 months Stomach: up to 3 months (Carvalho et al., 2020) Neoadjuvant/adjuvant pancreatic cancer (Wright et al., 2020)	
	Unresectable Unresectable (Marcus and Mahajan, 2020)		Locally advanced (Simcock et al., 2020)
	Following resection: - Negative margins: no role for adjuvant radiation therapy - Positive margins: Adjuvant chemotherapy		Borderline resectable pancreatic cancer - Neoadjuvant radiation therapy: SBRT (30-33 Gy / 5 frs) without SBRT, 25 Gy / 5 frs, or 30 Gy in 10 frs Unresectable/locally advanced: - Radiation therapy (SBRT/ single fraction (8-10 Gy) for palliation) (Tchelebi et al., 2020)
Pancreatic			Pancreatic cancer receiving dCRT (Hypo-F RT/CRT wherever feasible) Borderline resectable / resectable patients in lack of surgery (neo-adjuvant Hypo-F RT 25-35 Gy / 5 frs or CRT: 36 Gy / 15 frs) LAPC: Hypo-F CRT (45 Gy / 15 frs) or RT (25-35 Gy / 5 frs) Palliative RT (8 Gy / 1 fr) (Mukherjee and Jones, 2021)
	Palliative: alternative non-RT procedure		

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			CRT: prevent local recurrence (adjuvant) / decrease local progression (locally advanced) Unresected pancreatic adenocarcinomas: short-course SBRT (30-45 Gy / 3 frs or 25-45 Gy / 5 frs) Resectable preoperative CRT: 36 Gy / 2·4 Gy frs Resected pancreatic adenocarcinoma RT (tumor bed, surgical anastomoses, and adjacent lymph node) (Parashar et al., 2020) Locally advanced and borderline resectable: Multi-fraction SBRT (Sylvia et al., 2020) Locally advanced unresectable pancreatic cancers: - Hypo-F RT: 45 Gy/15 frs (cCRT) - Hypo-F RT: 25-35 Gy /5 frs (Hinduja et al., 2020)
	In case of the direct invasion of the bowel and stomach		
	Palliative (Kochbati et al., 2020) Resected pancreatic cancer: avoided adjuvant RT No neoadjuvant or adjuvant RT		Borderline pancreatic cancers: SBRT (Talapatra et al., 2020) Neoadjuvant SBRT (Carvalho et al., 2020)
Liver (HCC)			Early-stage HCC, Following resection, Intermediate stage HCC, Locally advanced HCC with vascular invasion (TACE/Y90 or SBRT) - Liver metastases: Chemotherapy then resection or RFA or SBRT (Tchelebi et al., 2020) BCLC 0 or BCLC A: SBRT and proton beam therapy BCLC B: RT (e.g., SBRT, proton beam therapy, or systemic RT BCLC C: -RT (45 Gy / 15 frs) -Patients with hepatocellular carcinoma and portal vein thrombosis: SBRT (Barry et al., 2020)
Gallbladder/ bile duct	Operable cholangiocarcinoma		Curative-intent gallbladder/bile duct cancer (Wright et al., 2020) Inoperable cholangiocarcinoma: Induction chemotherapy then RT (Tchelebi et al., 2020) RT for local control and at tumor bed (high-risk diseases, e.g., T4)
Colon			Preoperative (+/- concomitant chemotherapy) or postoperative RT (Parashar et al., 2020)
	Adjuvant: replace alternatives (prioritize by age and other comorbidities)	Adjuvant: prioritize by age and other comorbidities (Samiee et al., 2020)	
			Neoadjuvant treatment: Short-course RT (Achard et al., 2020) RT/CRT (Combs et al., 2020)
		Neoadjuvant/adjuvant	Curative-intent rectal cancer (Wright et al., 2020)
		Stage I disease:	Locally advanced (T2N + or T 3-4 /Nany) operable rectal: - Neoadjuvant radiation (long-course CRT / short-course RT: 5 Gy / 5 frs) - Inoperable: definitive RT - Preference: RT alone (52 Gy / 20 frs or 25 Gy / 5 frs) over long-course CRT (Tchelebi et al., 2020)
		-Adjuvant (low risk of local failure)	
Rectal			Elective priority treatments (Montesi et al., 2020a) Locally advanced (short-course RT: (25 Gy / 5 frs) T3N0-2 / T4 (Lancia et al., 2020) Short-course preoperative RT (Starling et al., 1992) Early and Intermediate Rectal Cancer: - SCRT/ CRT - T1/2N0: Hypo-F RT (25 Gy/5 frs) and delay Locally Advanced Rectal Cancer: Non-margin threatening disease: SCRT instead of LCRT In Threatening or involving the margin or pelvic sidewall:

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			-LCRT -SCRT -Delay or SCRT with a period of neoadjuvant chemotherapy (O'Cathail et al., 2020) Colorectal cancer (not elective) Palliative RT (if possible): SRS Neoadjuvant treatment of rectal cancer: short-course RT (Marshall et al., 2020)
	Post Op RT and palliative RT (if pain controlled)	Post Op RT and palliative RT (if pain controlled) Early / intermediate risk (Muirhead et al., 2021)	
		Stage T3: 6–8 weeks	T3 and M1: a short course of pelvic RT (25 Gy / 5 frs) + surgery (one-week interval) Conventional fractionation for postop rectal cancer (tumor bed plus boost) Unresectable cancer: RT alone Protons (Parashar et al., 2020) Long-course CRT (surgery: after 12 weeks) (Vordermark, 2020a) Intermediate risk: SCRT where needed Locally advanced: SCRT followed by chemotherapy
	Early-stage: Post-op RT	Low-risk cases	Adjuvant RT in T4, margin positivity, N2 disease High-risk cases: LCRT (Lewis and Talapatra, 2020) T 1-2 N+/T3N ± (with > 2 mm MRF-D): SCRT (25 Gy /5 frs) T3N ± (with ≤ 2 mm MRF-D)/T4 disease: LCCRT (45–50.4 Gy/25–28 frs) Unresectable: Brachytherapy with a dose of 10–20 Gy / 2–4 frs upon SCRT (Siavashpour et al., 2020) LCRT for threatening margins converted to SCRT: 25 Gy/ 5 daily frs (Hinduja et al., 2020) Possible neoadjuvant SCRT: 25 Gy / 5 frs followed (within 1 week) by surgery (unless T4b or extension into the anal canal) (Elkhouly et al., 2020) Locally advanced rectal cancer: - SCRT (25 Gy / 5 frs) followed by delayed surgery (5–13 weeks) In the case of involved circumferential margin or clinical T4 disease: - LCRT (50.4–54 Gy / 28-30 frs) (De Felice and Petrucciani, 2020a) Neoadjuvant SCRT: 25 Gy / 5 frs (Talapatra et al., 2020) Neoadjuvant RT: 5 Gy / 5 frs (followed by C between RT and surgery) (Carvalho et al., 2020) Curative-intent anal cancer (Wright et al., 2020) Local or locally advanced (TanyNanyM0) All non-metastatic cases (CRT) (Tchelebi et al., 2020) Elective priority treatments (Montesi et al., 2020a) dCRT: current standard of care Elderly patients (poor PS): less intensive treatment schedule: - Hypo-F RT 30 Gy /15 frs (cCRT) (O'Cathail et al., 2020) Standard radical CRT (Hypo-F RT: (30 Gy /15 frs or 30 Gy /10 frs) (Muirhead et al., 2021) Standard treatment: cCRT Low-risk/ high-risk elective nodal PTV T 1-2 lesions with residual disease, T 3-4 lesions, or N1 lesions Protons (Parashar et al., 2020) Non-metastatic cases: a) cCRT: standard fractionation schedules b) No cCRT: moderate Hypo-F RT (50 Gy/20 frs) (Talapatra et al., 2020)
Anal			

(*continued on next page*)

Table 1 (*continued*)

Cancer type		Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
Genitourinary	**Renal Cell Carcinoma (RCC)**			Where RT is the main treatment: No changes/ no postpone RT (Carvalho et al., 2020) Unresectable: 26 Gy / 1 frs or 14 Gy / 3 frs Poor surgical candidates: 25 Gy / 1 frs Medically inoperable: 24-48 Gy / 4 frs or 21-48 Gy / 3 frs (Parashar et al., 2020) Primary RCC in unresectable or comorbid patients: single-fraction SBRT (Sylvia et al., 2020)
	Bladder			Curative-intent bladder cancer (Wright et al., 2020) Muscle invasive (CRT) (reduction of fractionation) Muscle invasive, N0 – Bladder only (reduction of fractionation) (Simcock et al., 2020) Radical RT (shorten treatment schedule: 55 Gy /20 frs) Palliative RT: - Improvement of local symptoms (21 Gy / 3 frs) - Good local control (36 Gy / 6 frs) - Bleeding or local symptom control (8-10 Gy / 1 fr) (Birtle et al., 2021) Unresected bladder cancers (Whole bladder +/_ pelvic nodes): - Conventional or accelerated Hypo-F RT +/- boost ((55 Gy / 20 frs) or SIB to gross sites) (Parashar et al., 2020) No changes of RT: Hypo-F RT for bladder No Postpone RT start No interruption if the patient is a suspected or confirmed case of COVID-19 (Carvalho et al., 2020)
	Prostate	Low risk: Active surveillance	If an alternative exists (Prioritize by age and other comorbidities) (Samiee et al., 2020) Low and favorable intermediate-risk (primary setting if not detrimental) Low risk (using ADT, active surveillance, or hormonal deprivation) (Combs et al., 2020) Intermediate and high risk: delay of radical treatment by neo-adjuvant hormonal therapy strategies. All other curative-intent prostate cancers	High-risk: RT plus androgen deprivation (No shift towards increased use of extreme Hypo-F RT) (Achard et al., 2020) Early salvage RT over adjuvant RT after radical Shorter RT regimen (60 Gy / 20 frs or even 5-6 frs in total) (Lancia et al., 2020) Curative-intent high-grade prostate cancer (Wright et al., 2020) Reduction of fractionation: Intermediate/high risk, Prostate only High risk or M1 Low/intermediate risk Post-prostatectomy, Fossa only (Simcock et al., 2020)
		Low- favorable intermediate-risk	Unfavorable intermediate/high/very high risk, Postop Up to 3 months (from diagnosis to treatment) (Montesi et al., 2020a) Intermediate-to-high and high risk Salvage RT up to 1 month	
		Low- risk and intermediate-to-low risk: active surveillance	Oligometastatic patients (low-volume M1) with an indication for local RT: during hormonotherapy	Hypo-F RT: - 60 Gy / 20 frs - If CBCT or fiducial markers exist: 42 Gy/7 frs or 36 Gy / 6 frs, or 36·25 Gy /5 frs. Oligometastatic patients: 36 Gy / 6 frs (Starling et al., 1992)
		Low, favorable intermediate-risk (Marcus and Mahajan, 2020)	Low risk; intermediate risk, high risk (Slotman et al., 2020)	
		Oligometastatic HSPC	Very low-/ low-/favorable intermediate-risk disease Unfavorable intermediate-/high-/very high-risk Post-prostatectomy Clinical node-positive Oligometastatic Low volume M1 (Zaorsky et al., 2020)	

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		Localized low-risk (very low-, low- and favorable-intermediate-risk)	Localized high-risk (unfavorable-intermediate-risk, high-risk, and very high-risk)
		Oligometastatic HSPC	Advanced (clinical nodal involvement, BCR post-primary treatment, metastatic disease): - Early salvage RT over adjuvant RT - Node-positive prostate without metastases: ADT and Hypo-F RT - Painful bone metastases or bone metastases at high risk of fracture (weight-bearing bone): short-course palliative RT (Kokorovic et al., 2020)
	Low/very low risk	Intermediate-risk	Localized high-risk and very high-risk diseases with positive ganglions: (neoadjuvant androgen deprivation therapy) (Ismael et al., 2020)
		(No rush to initiate any prostate RT) Receiving neo-adjuvant hormonal therapy and not commenced RT	High priority: symptomatic palliative /radical high-risk/prostate bed Low priority: radical low/intermediate-risk prostate (Alonzi et al., 2021)
			Low, Intermediate, and High-Risk Prostate Cancer: - Moderate Hypo-F RT: 60 Gy / 20 frs, 70·2 Gy / 26 frs, or 70 Gy / 28 frs - Conventional fractionation: 66·6 - 90 Gy / 37 – 45 frs - Ultra- Hypo-F RT: 36·25 - 40 Gy / 5 frs or 30·5/5 frs (Parashar et al., 2020) Moderate and extreme Hypo-F RT (Sylvia et al., 2020)
		Low risk: kept on surveillance, no urgency in therapy Localized prostate cancer in the primary or postop: for several weeks or even months (Upadhyay and Shankar, 2020)	
			Very Low Risk -Low Risk and Intermediate Risk: - 78 Gy/39 frs (Conventional Fractionation) - 60 Gy/20 frs or 70 Gy/28 frs (Moderate Hypo-F RT) - 44.8 Gy/8 frs (Ultra- Hypo-F RT with MRIdian) - 35–40 Gy/5 frs (Ultra- Hypo-F RT with CyberKnife) Intermediate Risk and High - Very High Risk: - 78 Gy/39f (Conventional Fractionation) - WPRT 46 Gy/23frs or 37.5 Gy/15frs + high dose-rate interstitial brachytherapy (HDR-ISBT) boost 15 Gy/1 fr (Murakami et al., 2020)
	Brachytherapy	Low-volume metastatic: RT postponed until after the pandemic	Unfavorable intermediate-risk and High risk-Very high risk: Neoadjuvant RT (preferably Hypo-F and without fiducial marker or rectal spacer insertion) (Obek et al., 2020)
	Multiple neoplasms: -Omit RT in low and favorable intermediate-risk and for oligometastatic prostate cancer	Multiple neoplasms: -Postop RT for 2 weeks / Prostate cancer under ADT for 2 weeks -Delay RT for low/intermediate-risk prostate disease Prostate: Delay RT for very low, low, and favorable intermediate-risk disease	Multiple neoplasms: Hypo-F RT Unfavorable intermediate risk: 36.25-40 Gy / 5 frs or 60 Gy/20 frs High and very high risk: 60 Gy / 20 frs or 42.7 Gy/ 7 frs every other day (if age < 75 yrs) or 36.25-40 Gy / 5 frs N+: 36.25-40 Gy/5 frs or 60 Gy/20 frs Post-prostatectomy/salvage: 52.5 Gy/20 frs (Caicedo-Martínez et al., 2020) Ultra- Hypo-F RT in low/low-intermediate risk: 36.25 Gy/5 frs (Griffiths et al., 2021) Extreme Hypo-F: 36 Gy /6 frs for elderly, frail, or metastatic patients (Martell et al., 2020)
	Very low/low risk	Favorable Intermediate risk	Unfavorable Intermediate risk/High/very high risk/N+: -Modest Hypo-F RT: 60 Gy/20 frs -Ultra Hypo-F: 42·7 Gy/7 frs every other day or 36 Gy/6 frs (6 weeks) -SBRT: 5 frs -Adjuvant RT: Standard (33-35 frs) / Hypo-F RT (60 Gy/20 frs) in high-risk features

(*continued on next page*)

Table 1 (*continued*)

Cancer type		Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
				Oligometastatic: SABR (1 or 3 frs) Low volume M1: 5 or 6 frs (Hinduja et al., 2020)
			Radical treatment: up to 6 months if the patient receiving hormonal therapy	Possible Hypo-F: 60 Gy / 20 frs (IMRT) (Elkhouly et al., 2020) Low-risk and favorable intermediate-risk; unfavorable intermediate-risk, high-risk, very high-risk, and N + patients: 5 /20 frs Adjuvant/salvage RT: 20 frs Oligometastatic + low volume metastatic disease: 3–5 frs RT (Talapatra et al., 2020)
		Very low-risk	Low-risk and favorable intermediate-risk	
		Elderly with favorable tumors	Low or intermediate-risk in hormone therapy, and high risk with only one risk factor: RT after 3 months Postpone RT start Interruption for a suspected or confirmed case of COVID-19 within 15 days	Favor Hypo-F (Carvalho et al., 2020)
	Testicular	Seminoma, stage I (Simcock et al., 2020)		20 frs instead of the conventional 37 frs regimen (Kwek et al., 2021)
				Radical treatment: Do not defer until a reasonable alternative (Samiee et al., 2020)
			Postop cervical cancer (up to 8 weeks) Postop vaginal brachytherapy alone (up to 4–8 weeks)	Cervical cancer with extreme bleeding (Wright et al., 2020)
				All patients with curative intent RT: -Early-stage: definitive RT Pelvic RT remains the selective treatment (Reduction of fraction/preferred IMRT and SIB otherwise conformal RT esp. for node-negative) (Guidance for radiotherapy for gynaecological cancer and COVID-19 [Online], 2021) Pre-invasive, early-stage, locally-advanced disease: Hypo-F RT (Ramirez, 2020) Reduction of chemotherapy dose, plus RT or RT alone. Intact cervix: - Definitive RT (40 - 50 Gy) - IMRT or SBRT boost (Parashar et al., 2020) RT and cCRT (substitute surgery) (Vordermark, 2020a)
Gynecological	**Cervical**		Up to 8–12 weeks: - Inoperable cases or refuse surgery (Stage IA1, IA2) - Postop (Stage IA1-IB2) with indication for adjuvant RT - Postop cases with positive pelvic (or PA nodes), surgical margins, or parametria (CRT) - Metastatic disease with annoyance oral pain or minimum bleeding (palliative RT)	Locally advanced Inoperable cases (Stage IB3-IVA or Stage IB1-IIA1) Extreme bleeding secondary to cervical cancer (Elledge et al., 2020)
				Locally advanced: standard fractionation (46-50 Gy) followed by brachytherapy (HDR) (Amaoui et al., 2020) Not to change or postpone the fractionation (Starling et al., 1992) Early-stage disease: Radical CRT (prolonged delay of surgery >8 weeks) Local symptomatic central or para-aortic recurrence: Salvage RT Locally advanced disease ((IB3-IVA) - Hypo-F RT (39 Gy/13frs or 39–40 Gy at > 2.5 Gy per fraction in combination with concurrent chemotherapy) -IMRT: 40 Gy/15 frs to the whole with 48 Gy/15frs SIB to enlarged nodes (Dewan et al., 2021) Stage IB1, IB2, and IIA1: Neoadjuvant RT Postop status - high risk of recurrence: cCRT Stage IB3 and IIA2: Hypo-F RT Locally advanced (IIB–IVA): Hypo-F cCRT Cervical stump recurrence: RT Local recurrence within pelvis: cCRT Pelvic sidewall recurrence: RT (Lee et al., 2020b)
			Adjuvant therapy:12 weeks for adjuvant RT and 8 weeks for adjuvant CRT)	
			Postop status - the intermediate risk of recurrence: (cC)RT (up to 8 weeks after surgery)	

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
		Patients with suspected or confirmed COVID-19 (until COVID-19 is cured) Adjuvant RT: postponed within 12 weeks after surgery	In the case of RT is the primary treatment For patients with minimal risk of COVID-19 Emergency cases (Wang et al., 2020)
			Stages IB3, IIA2-IIIC2, and early IVA (cCRT): −50.4 Gy /28 frs (bulkier or node-positive) with 3DCRT −45 Gy / 25 frs with SIB to gross nodes −5 5-6 2.5 Gy / 25 frs with IMRT -RT boost (18 Gy / 10 frs) in the absence of brachytherapy Stages IA1, IA2, IB1, IB2, IIA1(cCRT for high-risk patients): 45 Gy / 25 frs with IMRT; if resource constraints, 3DCRT IVA (frank bladder or rectal infiltration) or IVB (palliative RT): 8 Gy/1 fr or 20 Gy/5frs (Hinduja et al., 2020) Stage II or III cervix with a radical/curative intent: Radical CRT (Talapatra et al., 2020) Uterine cervix: RT as the main treatment No changes, no postpone RT start, no interruption for suspected or confirmed case of COVID-19 (Carvalho et al., 2020) High priority: Locally advanced cervical cancer (stages IB3, IIA–IIB): Pelvic CRT Medium priority: Symptomatic localized recurrence (central, retroperitoneal lymph nodes): salvage RT (Colombo et al., 2020) a) Cervical dysplasia & cancer: Definitive RT over radical surgery b) Locally advanced cervical cancer: RT (without delay) (Alkatout et al., 2020)
		Adjuvant: if an alternative exists (prioritize by age and other comorbidities of the patient) (Samiee et al., 2020) Inoperable endometrial cancer Postop endometrial cancer (Wright et al., 2020)	
	Postop endometrial (scheduled for initiation chemotherapy)	Adjuvant RT: up to 3 months from surgery (unless there is a residual disease, positive resection margins, or aggressive histological subtype)	Locally advanced and high-risk groups (Hypo-F RT) (Guidance for radiotherapy for gynaecological cancer and COVID-19 [Online], 2021) Microscopic disease: 45 - 50 Gy / 25 frs Gross residue in postop cases (add boost: a total dose of 60 -70 Gy) Neoadjuvant RT: 45 - 50 Gy (Parashar et al., 2020)
Endometrial	Postop stage IA, grade I-II endometrioid carcinoma with higher risk features (age > 60 yrs, LVSI)	Postop stage IA, grade III or stage IB, grade I-II, and low-risk stage II endometrioid carcinoma	Patients with extreme vaginal bleeding
	Inoperable endometrioid carcinoma candidates for hormone therapy	Postop stage IB, grade III, and stage II endometrioid carcinoma	Inoperable patients with non-endometrioid histology (not candidates for systemic therapy)
	Postop stage III-IV: chemotherapy alone (+/−RT after chemo)	Postop patients with grade I -histology with positive nodes (Stage IIIC) Postop stage IA-IV non-endometrioid histology	Recurrent vaginal cuff disease (Elledge et al., 2020)
		In case of COVID + after 1-2 fr, further sessions may be postponed until 10–14 days after recovery from infection	The higher dose of 50.4 Gy instead of 45 Gy instead of a brachytherapy boost (Dewan et al., 2021) Surgical stage III and IV a: Adjuvant RT/ In case of pelvic RT: Hypo-F Pelvic recurrence: Hypo-F RT (Lee et al., 2020b) Stages IB Gr 3, Stage II (RT 8-12 weeks post-op): 45 Gy / 25 frs (IMRT preferred) Stage IIIA-IIIC (RT 6–8 weeks post-op): 45 Gy / 25 frs (IMRT preferred) Stage IVB (palliative): 8 Gy/1 fr or 20 Gy / 5 frs (Hinduja et al., 2020) High priority: -High-risk patients: Post-op RT ± C -Symptomatic unresectable primary tumor (not a candidate for surgery): RT

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Medium priority: -Intermediate–high risk: Brachytherapy -Isolated vaginal relapse after surgery: RT (curative intent) Low priority: Asymptomatic vaginal/pelvic recurrence: RT (Colombo et al., 2020)
	Stage I, G2-G3 intermediate-risk or Stage II, and Stage III: no RT according to comorbidities	Postpone RT start (3 months) Interruption for a suspected or confirmed case of COVID-19 within 15 days (Carvalho et al., 2020)	
Ovarian		Isolated locoregional relapse in patients with former surgery and chemotherapy	Bleeding or extremely painful disease in metastatic patients (not candidates for surgical or systemic therapies) (Elledge et al., 2020) Curative intent RT: - Radical RT for patients not appropriate for surgery (using IMRT for reduction of skin toxicity) - Adjuvant RT - Palliative RT: a single fraction to control symptoms until re-treatment is feasible (Guidance for radiotherapy for gynaecological cancer and COVID-19 [Online], 2021)
		Postop vulvar cancer	Locally advanced vulvar cancer-causing extreme pain (Wright et al., 2020) Bleeding or extremely painful lesions in metastatic patients Postop patients with ≥ 1 positive lymph node
	Postop stage IB-II (close margins not candidates for margin re-excision or possibly with + LVSI, tumor size $\geq$4 cm)	Postop patients with close/positive margins or involved nodes with no gross residual disease	Intact stage III/IVA disease Recurrent vulvar disease (not candidates for surgery and formerly not received RT) Intact recurrent inguinal or pelvic disease (not candidates for surgery) (Elledge et al., 2020) Locally advanced vaginal cancer-causing extreme pain (Wright et al., 2020) Neoadjuvant: CRT Radical: Locally advanced vulvar cancer with or without nodal involvement: CRT (SIB) (Garganese et al., 2020) Vaginal recurrence with bleeding: brachytherapy or RT (Lee et al., 2020b) Vulva, radical (CRT): 45 Gy / 25 frs + 18-20 Gy or 9-10 frs to gross disease (IMRT or VMAT only) / SIB to primary and nodes Vulva, adjuvant (Groin and pelvic RT in high-risk features): 45 Gy / 25 frs Vulva, palliative: 8 Gy/1 fr or 20 Gy / 5 frs (Hinduja et al., 2020)
Vulvar		Interruption for a suspected or confirmed case of COVID-19	No changes, No Postpone RT start Adjuvant RT (Carvalho et al., 2020) Radical RT (Alkatout et al., 2020)
		Adjuvant and Neoadjuvant: if alternative exist (Prioritize by age and other comorbidities) (Samiee et al., 2020)	
		Neoadjuvant/Adjuvant/Definitive RT	Severe pain Uncontrolled bleeding (Wright et al., 2020) Neoadjuvant and adjuvant: Hypo-F RT (Starling et al., 1992)
		Delay Postop RT for:	Soft tissue sarcoma:
		- Soft tissue sarcoma	- Preop RT for non-complex tumors not close to critical structures (few patients): Hypo-F RT using 25 Gy /5 frs
Sarcoma		- Fibromatosis	- Postop RT: Hypo-F RT (40 –45 Gy / 15 - 20 frs and 36 Gy / 6 once-weekly frs not for younger patients)
		- Ewing's sarcoma: postop RT for - Low grade tumors such as chordoma or lower grade chondrosarcomas Definite RT for: - Non-malignant locally aggressive condition - Low-grade tumors, including chordoma (slow-growing indolent tumors): delay for a couple of months	Bone sarcoma: Ewing's sarcoma: Surgery (1st local therapy) /definitive RT (curative treatment) - Postop RT based on resection histology - Definitive RT if surgery is not feasible/ suitable Non-Ewing's bone sarcomas (osteosarcoma, chondrosarcoma, chordoma) High-grade tumors: urgent RT

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Locally advanced high-grade tumors including osteosarcoma: definitive RT with shorter fraction schedules (Seddon and Zaidi, 2021) Soft-Tissue Sarcomas (NCC recommendations): Postop RT doses: RT (50 Gy) + RT boost (Negative margins: 10 - 16 Gy Microscopically positive margins: 16-18 Gy Gross residual disease: 20-26 Gy Using SBRT as a preop regimen (e.g., 35 Gy / 5 frs) for sarcomas (Parashar et al., 2020) Preop RT or chemotherapy: - High-risk surgery cases (e.g., retroperitoneal sarcoma) Adjuvant RT for soft tissue sarcoma: - operable grade II-III soft tissue sarcoma (not to defer surgery) (Vordermark, 2020a) Soft tissue sarcoma: protracted RT regimens (25 Gy /5 frs) if the disease is not close to critical structures
		Other forms of sarcoma	Hypo-F RT:40-45 Gy / 15-20 frs and 36 Gy /6 frs once weekly (except in young patients due to increased late RT related toxicities) (Hinduja et al., 2020)
	All optional or unnecessary radiation cases	All cases where chemo or other interventions to delay initiation of RT	All curable cases (delay of RT is not feasible) (Wright et al., 2020)
	Active surveillance for grade I–II primary CNS	Chemo-sensitive tumors: e.g., rhabdomyosarcoma and Ewing sarcoma, medulloblastoma, ependymoma, and germ cell tumors presenting with metastases	Standard RT if feasible for:
	Low-grade gliomas and craniopharyngiomas after primary biopsy or debulking surgery	Highly proliferative tumors: rhabdomyosarcoma,	- RT has a high effect on the outcome
	Poor prognostic tumors and palliative care	Ewing sarcoma, medulloblastoma, germ cell tumors, and ATRT	Hypo-F RT, change dose/fr from1·6–1·8 Gy to above 2·0 Gy: - Poor prognosis patients where RT shouldn't delay (neuroblastoma, rhabdomyosarcoma, Ewing sarcoma, and high-grade or diffuse midline gliomas) (Janssens et al., 2020)
Pediatric		Medulloblastoma/embryonal CNS tumors, RMS, Ewing Sarcoma, chemo-sensitive NRSTS, intracranial germ cell tumors, neuroblastoma, ependymoma	Priority 1: Radical RT (any delay or interruption of RT decreases cure) - Medulloblastoma - Embryonal CNS tumors/ pineoblastoma - RMS/ Ewings - definitive treatment/ incomplete resection - Intracranial Germ Cell tumors - Ependymoma G2/G3 - Nasopharynx/ Head and neck - Total body irradiation - Retinoblastoma - ATRT Priority 2: Urgent palliative RT (save the loss of function/ life) - Cord compression - Bleeding, hemorrhage - Pontine/ spinal diffuse midline or high-grade glioma Priority 3: Adjuvant RT (aggressive tumors or with recognized residue) RMS/ Ewings-complete resection - Wilms' tumor - Neuroblastoma - Chordoma/ Chondrosarcoma - Bone tumors - NRSTS - Hodgkin Lymphoma - Salivary gland tumors/ Adenoid cystic carcinoma - Esthesioneuroblastoma - High grade/ diffuse midline glioma other than pontine or spinal - Metastatic RMS/ Ewings - Meningioma G3/ anaplastic - Pineal parenchymal tumors
		Benign/ slowly proliferative tumors (whenever possible)	

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Priority 4: Palliative RT (control of symptoms to enhance the quality of life) -Symptomatic metastatic sites -Symptomatic local recurrence / re-irradiation Priority 5: Radical RT - Benign/ gradually proliferative tumors Craniopharyngioma - Optic pathway - Low-grade glioma - Desmoid-type fibromatosis - Pituitary Adenoma - Meningioma- G1/G2 - Myxopapillary Ependymoma (Mandeville, 2021) CNS tumors including medulloblastoma, grade II-III ependymoma, embryonal CNS tumors, intracranial germ cell tumors, atypical teratoid/ rhabdoid. Total body irradiation, retinoblastoma, nasopharynx, and head and neck malignancies (Hinduja et al., 2020) Considering Hypo-F where RT is required: Wilms tumor Low-grade glioma Palliative cases with urgent symptoms (Sullivan et al., 2020)
		Individualize interruption for a suspected or confirmed case of COVID-19 Consolidation therapy for high-grade lymphomas Low-grade lymphomas (most patient)	Pediatric tumors: No changes and no delay of RT (Carvalho et al., 2020) High-grade lymphomas with severe or life-threatening symptoms (Wright et al., 2020)
	HL: if RT not available		Peripheral T-Cell Lymphomas (PTCL): aggressive disease (Perini, 2020) Early-stage HL (RT elimination costs of 6–8% disease control) (Vordermark, 2020a)
	For ≥ 60 yrs: - for the palliative purpose where alternative treatment is available - for localized low-grade lymphomas if completely excised - for localized nodular lymphocyte-predominant HL if completely excised - in consolidation RT for diffuse large B-cell lymphoma/ aggressive NHL for those who have completed a full chemotherapy course with complete remission.	When there is no/little expected adverse effect: - for asymptomatic localized low-grade lymphomas; - for localized nodular lymphocyte-predominant HL - in a palliative setting for low-grade lymphomas in stable cases; - for whom develop COVID-19 infection before commencing RT	Using alternative Hypo-F RT when RT cannot be omitted or delayed to maintain high cure/ palliation rates without excessive toxicity (e.g., For patients with symptomatic sites of disease and Localized aggressive NHL, primary RT alone, and NK-/T-cell lymphoma) (Yahalom et al., 2020; Di Ciaccio et al., 2020)
Lymphoma and hematological malignancies	In a minority of cases, if alternative treatment options were available		Shortening of treatment via Hypo-F RT or limitation of total dose for hemato-oncological patients: - Painful osteolytic lesion caused by multiple myeloma in non-weight bearing bones after stabilizing surgery: 8 Gy/1 fr, 20 Gy/5frs, 24 Gy/8frs, and 30 Gy/10frs - Osteolytic lesion of multiple myeloma in weight-bearing bones (e.g., axial skeleton) without surgery: 20 Gy/5frs and 24–36 Gy/ 8-12 frs - Diffuse large B-cell lymphoma with the initial abdominal bulky disease after completion of six cycles of R-CHOP a) With no information on PET status: 27-30 Gy/ 9-10 frs b) PET-positive after treatment: 36 Gy/12frs - Early-stage indolent lymphoma in a noncritical location: 4 Gy/1 fr and 27 Gy/9 frs or 4 Gy/2 frs (Oertel et al., 2020) High-risk lymphomas (Carvalho et al., 2020)
Skin		Primary and resected skin cancers (if not use short courses and limit radiation to the mucosa)	Unresected SCC/BCC: - Primary tumors < 2 cm: 30 Gy / 5 frs over 2 weeks - Primary tumors > 2 cm: 45 - 55 Gy over 3 to 4 weeks, 10·2 Gy in 3 frs weekly

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Resected SCC/BCC: - 50 Gy / 4 weeks (2·5 Gy / fr) - 44 Gy / 10 frs in 4 days a week Melanoma Definitive cases: 35 Gy / 5 frs over a week for $< 3\ cm^2$ Postop: 30 Gy / 5 frs twice a week or every other day (Parashar et al., 2020)
		CM: - Patients with $\geq$ T2 disease for three months with negative biopsy margins - T0-T1 disease for three months if no macroscopic residue is detected at biopsy BCC: up to 3 months except for extremely symptomatic patients cSCC: - T1-T2a disease for 2-3 month except for prompt growth or symptomatic/ immunosuppressed patients (prioritize patients with $\geq$ T2b disease) MCC: - Around one month for patients with favorable T1b disease High-risk patients: COVID-19 infection, elderly, and/or weak patients (Baumann et al., 2020) Non-melanoma skin tumors (Slotman et al., 2020)	
	Adjuvant RT for BCC (with limited benefit) Definitive RT including incompletely excised Melanoma (involved high-risk nodal basins) NMSC BCC (definitive and postop) incomplete excised	cSCC, MCC, and rare skin pathologies incompletely excised: for 2-3 months Melanoma: LM, LMM, and melanoma in situ within 2-3 months	Definitive RT: cSCC, MCC, and rare skin pathologies (modified fractionation) (Rembielak et al., 2020) Melanoma: - MM: radical RT just for unsuitable patients for surgery or inoperable mucosal melanomas (modified fractionation as definitive RT) - Adjuvant RT – primary site: just for postop insufficient margins and more surgery is not possible or in high-risk cases, with involved margins (<1 mm) - Adjuvant RT – nodal basin: regional metastases from mucosal primaries - Patients at high risk of nodal recurrence (not candidates for systemic adjuvant therapy): 48 Gy / 20 frs, 40 Gy / 15 frs as Hypo-F RT Oligometastatic intracranial disease: SRS Standard palliative RT (excluding brain metastases): 20 Gy /4 frs instead of 20 Gy / 5frs, 30 Gy / 8 frs instead of 30 Gy/ 10 frs or single fraction of 8-10 Gy (Rembielak et al., 2021)
	Adjuvant RT (benefit limited) for patients with closely excised cSCC <1 mm or with minor risk factors (lower/intermediate risk of recurrence)	NMSC: SCC, MCC, and rare skin pathologies incompletely excised in 2-3 months	
		Suspend all treatment forms until the pandemic is over (Hinduja et al., 2020) Rare indications of Melanoma (e.g., lentigomaligna, lentigo malignant melanoma, and melanoma in situ) should be deferred for 2-3 months Radical RT for advanced SCC: COVID-19 positive patients: based on patient's and lesion's characteristics (site and size) Adjuvant RT for advanced SCC: COVID-19 positive patients Radical RT for advanced BCC: (both COVID-19 negative and positive patients): Multidisciplinary discussion based on the lesion size and location (priority for face lesion) Adjuvant RT for advanced BCC: COVID-19 positive patients	In palliative or case (e.g., bleeding or fungating skin nodules): Hypo-F RT (1-4 frs for 8-20 Gy) (Nahm et al., 2021) Radical RT for advanced SCC: COVID-19 negative patients: No delay, especially for a large lesion or palliative setting or facial lesion COVID-19 positive patients: Hypo-F RT (based on patient's and lesion's characteristics Dedicated COVID-19 positive RT pathways Adjuvant RT for advanced SCC: COVID-19 negative patients: Choice is based on patient's (age, comorbidities) and lesion's characteristics (location and size) Radical RT for advanced BCC (both COVID-19 negative and positive patients): Multidisciplinary discussion based on the lesion size and location (priority for face lesion): Hypo-F RT Adjuvant RT for advanced BCC (COVID-19 negative patients): Choice based on patient's

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			prognosis, age, comorbidities, and the location (priority for face lesion) (Tagliaferri et al., 2020)
	Skin : not treating (Carvalho et al., 2020)		
	Bone metastasis		Cord compression, superior vena cava obstruction, life-threatening bleeding: Do not defer until a reasonable alternative (Radical treatment) (Samiee et al., 2020)
	Multiple brain metastasis		
		Painful spine metastasis, Spinal cord compression or spine metastases with the epidural disease, Brain metastases <5 mm, Patients with stable or minimum symptomatic oligo-metastatic disease	Cord compression, Symptomatic brain metastases or brain metastases >5 mm, Malignant airways obstruction, SVCO, Severe pain from primary, Heterotopic bone (Wright et al., 2020)
			Brain metastases (SRS for good PS/SRS of resection cavity for postop) (Combs et al., 2020)
	Painful metastasis, uncomplicated, other systemic options Oligometastatic (e.g., prostate cancer) Postoperative radiotherapy (for pathologic fracture)		Bone metastasis, no fracture, +/- cord compression Bone metastasis, fracture/surgery Brain metastasis
		Painful metastases without impending structural/neurologic compromise	Esophageal bleeding/ dysphagia GBM, poor KPS Head & Neck SVCO Syndrome/Lung cancer Lymphoma, low grade Pelvic/GI bleeding (reduction of fractionation) (Simcock et al., 2020)
	CNS metastasis from NSCLC needing WBRT		
Palliative RT		Prostate cancer patients, breast cancer patients, benign CNS tumor (up to 3 months from diagnosis to treatment)	Urgent treatments: - Spinal cord compression, superior vena cava syndrome, life-threatening lower airway obstruction, digestive or respiratory hemorrhage, and life-threatening brain lesion (RT delivered within 24–48 h) Non-urgent treatments: - Painful metastatic bone lesions, lung cancer-causing chest pain or Pancoast syndrome, tumors causing nerve root and soft tissue infiltration, relief of impending airways or bowel obstruction (start of RT within seven days) Elective priority treatments: - Head and neck cancers, rectal and anal cancer, the gastroesophageal junction (Montesi et al., 2020a)
		Palliative non-emergent indications (Slotman et al., 2020)	
		Palliative intent in asymptomatic or oligosymptomatic patients	In cases of spinal cord compression, metastatic bone pain irresponsive to other treatments or micro-vascular bleeding: single fraction (Starling et al., 1992) Spinal cord compression, SVCO, or bleeding in confirmed cases of COVID-19 (Ismael et al., 2020) Symptomatic brain metastases: 20 Gy / 4 - 5 frs For COVID-19 patient: Palliative RT for a highly symptomatic patient (life expectancy > 3-6 months) and without any other therapeutic alternative (Amaoui et al., 2020)
	Painful bone metastasis patients (controlled by level 1 to 3 oral analgesics)	Adjuvant bone metastasis RT: MESCC: Adjuvant RT after surgery for 4 to 12 weeks Bone oligometastases and other SBRT indications: for a few weeks, esp. for hormone-sensitive tumors	MESCC: RT without delay (if surgical treatment is contraindicated or not appropriate) (Thureau et al., 2020) Very algic bone metastases refractory to analgesics: 8 Gy / 1 fr (Amaoui et al., 2020) Urgent cases: pain due to bone metastases, cord compression, SVCO, and tumor bleeding: 5-8 Gy/1 fr (single fraction) Hypo-F RT and single fraction palliative RT (Upadhyay and Shankar, 2020)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Treatment is limited to function- or life-threatening situations (e.g., spinal cord compression) The shortest possible course (e.g., single-fraction treatment for bone pain (Weisel et al., 2020) Palliative RT: spinal cord compression, uncontrolled bleeding from fungating tumors, and intractable pain (Ng et al., 2020a) RT for emergencies (spinal cord compression, symptomatic brain metastases) (Ismaili and El Majjaoui, 2020) Palliative RT, e.g., in painful bone metastases a single 8 Gy / fr (Mahmoodzadeh et al., 2020)
	Postop for a pathological fracture		Palliative treatment of bleeding/fungating inoperable breast mass, spinal cord compression, and symptomatic brain metastases (Elghazawy et al., 2020) Single or two weekly fractions for palliative thoracic RT (Bakhribah et al., 2020) - Single-fraction for bone metastases and spinal cord compression: 8-24 Gy / 1 fr - Airway obstruction:17 Gy / 2 frs (Singh et al., 2020)
	No spinal compression		Bone Mets, fracture/spinal compression, SVCO: 8 Gy / 1 fr (Kochbati et al., 2020) Stage IVB of cervical cancer: RT for cord compression/Brain metastasis (Dewan et al., 2021) BCLC C: Palliative RT in a single 8 Gy fr for symptomatic disease (local or metastatic) (Barry et al., 2020)
	Arteriovenous malformations: SRS or Hypo-F SRS		Brain metastases: - For solitary/limited brain met with good DS-GPA (single fraction frameless SRS) - Hypo-F RT:30–35 Gy / 5–6 frs - For multiple brain metastases/whole-Brain: Hypo-F RT (20 Gy / 5frs) Spinal cord compression: Hypo-F RT (8 Gy/ single fr or 20 Gy / 5 frs) (Balakrishnan et al., 2020) Palliative/temporary control of vulvar cancer: - Long course: 30 Gy/10 frs - Short course: 16 Gy/4 frs or 20 Gy/5 frs (symptomatic patients) (Garganese et al., 2020) Palliative treatment of head and neck malignancies (Short fractionation schedules): 25 Gy / 5 frs, 20 Gy / 5 frs, 30 Gy / 6 frs, IMRT over 2 weeks, or Single 8 Gy fr (Hinduja et al., 2020) Brain metastases: - For metastases <10 cc: single fraction treatment - SRS (replace neurosurgical options) - Postop: SRS to the cavity 5 Gy/fr for 7 frs - If life expectancy >3 months: 4 Gy/fr for 5 frs to the whole brain Spinal cord compression: 8 Gy in a single fraction Tumor bleeding: - 20 Gy / 5 frs given daily - Single fraction of 8 Gy SVCO: - 20 Gy / 5 daily frs - 8-10 Gy in a single fraction Painful bone metastases: 8 Gy single fraction (Hinduja et al., 2020)
		Thoracic patients with oligometastatic disease	Symptomatic metastases (pain, obstruction, or bleeding) palliative short course Hypo-F RT: 8 Gy/10 Gy or SBRT (Arrieta et al., 2020)

(*continued on next page*)

Table 1 (*continued*)

Cancer type	Hold/Omit irradiation	Delay of radiation if required	Continue irradiation/ Treatment
			Cord compression or bony metastases: 20 Gy/5 frs or 8-10 Gy/1 fr or 30 Gy/10 frs for good prognosis Breast palliation: 6 Gy for 5 to 6 weeks Brain metastases: where appropriate: SRS; all others: 20 Gy/5 frs or 12 Gy/2frs (daily) (Chan et al., 2020) Hypo-F RT: -Bone metastasis: 6–8 cGy/1 fr; 15 Gy/3 frs; 20 Gy/5 frs to a small radiation field - Brain metastasis: 20 Gy/5frs (Elkhouly et al., 2020) Palliative RT for melanoma: COVID-19 negative patients (No delay) COVID-19 positive patients: In case of pain or dedicated COVID-19 positive RT pathways (Tagliaferri et al., 2020) Brain metastases from lung cancer (whole brain RT) Short course Hypo-F RT: 20 Gy/5 frs; 30 Gy/ 10 frs (patients with better survival outcomes); 12 Gy /2 frs (once a week) in patients with poor PS Hypo-F boost of 10 - 15 Gy after WBRT Single fraction SRS as an alternative to surgery (oligo-metastases and controlled extracranial disease) (Mummudi et al., 2020)
	In patients with short survival		Malignant spinal cord compression: 8 Gy/1 fr (Cameron, 2020) Brain metastases: 20 Gy/5 frs Cord compression: 8 Gy/1 fr Tumor bleeding: 14.8 Gy / 4 twice daily frs; 20 Gy/5 daily frs SVCO: 17 Gy/2 weekly frs; 20 Gy/5 daily frs Bone metastases: 8 Gy/1 daily fr (Yerramilli et al., 2020a)
	The omission of whole-brain radiation: multiple brain metastases and limited life-expectancy (<3–6 months)		Single-fraction palliative RT for bone metastases/metastatic spinal cord compression (Gupta et al., 2020a) High priority: Spinal cord compression with potential neurological recovery Moderate priority: Palliation of symptoms like hemoptysis in lung cancer (Talapatra et al., 2020) Selected palliative treatments (Carvalho et al., 2020) High priority: Spinal cord compression, brain metastases, other critical metastatic lesions Low priority: Palliative RT for asymptomatic recurrence not amenable to surgery (Colombo et al., 2020) Pain or bony lesion: 8 Gy / 1 fr; Bleeding: 10 Gy / 1 fr; 20 Gy /5frs (If single fraction not possible, Hypo-F RT) Multiple brain metastases: 20 Gy / 5 frs (in the favorable subgroup) MSCC: 8 Gy / 1 fr (Counago et al., 2020) Symptomatic bone metastases: 8 Gy/1 fr (Kwek et al., 2021)
Benign Disease	Keloid, heterotopic Ossification, Actinic Keratosis	Benign Disease, Pituitary Adenoma, Fibromatosis Other: Actinic Keratosis, Recurrent/Refractory Fasciitis, other rare benign (Simcock et al., 2020) Benign tumors (schwannomas and asymptomatic meningiomas) (Starling et al., 1992)	
	Keloid, heterotopic ossification, actinic keratosis (Marcus and Mahajan, 2020)	Non-malignant indications (Slotman et al., 2020) Benign tumors: RT after 3 months (Carvalho et al., 2020)	

RT: radiotherapy, BT: brachytherapy, SBRT: stereotactic body radiotherapy, Hypo-F RT: hypo-fractionated RT, HypeF-RT: hyper-fractionated RT, SABR: stereotactic ablative radiotherapy. KPS: karnofsky performance status, ADT: androgen deprivation therapy, CALGB: cancer and leukemia group b; COMS: collaborative ocular melanoma study. SIB: simultaneous integrated boosts, ER: estrogen receptor, HER2: Human epidermal growth factor receptor 2, ATRT: atypical teratoid rhabdoid tumors, PCI: prophylactic cranial irradiation., CNS: central nervous system, GBM: glioblastoma multiform, PNET: primitive neuroectodermal tumor, RMS: rhabdomyosarcoma, AVM: arteriovenous malformation, OSCC: oesophageal squamous cell carcinoma, OAC:oesophageal adenocarcinoma, dCRT: definitive radiation chemotherapy, HCC: Hepatocellular Carcinoma, cCRT: concurrent radiation chemotherapy, TME: total mesorectal excision, SCRT: short-course radiotherapy, PS: performance status, GS: gleason score, ATRT : atypical teratoid rhabdoid tumors, BCC: basal cell carcinoma, SCC: squamous cell carcinoma, CM: cutaneous melanoma, cSCC: cutaneous squamous cell carcinoma, MCC: merkel cell carcinoma, MM: malignant melanoma, LM: lentigo maligna, LMM: lentigo maligna melanoma, NMSC: non-melanoma skin cancer, LVI: lymphovascular invasion, PTV: planning tumor volume, PMRT: postmastectomy radiation therapy, NAC: neoadjuvant chemotherapy, TNBC: triple negative breast cancer, BC: breast cancer, BCT: breast conserving therapy, NCCN: National Comprehensive Cancer Network, SRS: stereotactic radiosurgery, VMAT: volumetric modulated arc therapy, postop: postoperative, preop: preoperative, HNSCC: head and neck squamous cell carcinoma, ER: estrogen receptor,HER2: human epidermal growth factor receptor 2, DCIS: ductal carcinoma in situ, DCIS-RH+: hormone receptor-positive ductal carcinoma, LVI: lymphovascular invasion, PCI: prophylactic cranial irradiation, NSCLC: non-small cell lung cancer, LS-SCLC: limited stage small cell lung cancer, IMN: internal mammary nodes, SBRT: stereotactic body radiation, LAPC: locally advanced pancreatic cancer, MESCC: metastatic epidural spinal cord compression, GI: gastrointestinal, LVSI: lymphovascular space invasion, CALGB: cancer and leukemia group b; COMS :collaborative ocular melanoma study, HL: Hodgkin lymphoma, NHL: Non-Hodgkin lymphoma, NK: natural killer, BCLC: Barcelona Clinic Liver Cancer, OSCC: oral cavity squamous cell cancer, LCCRT long-course chemoradiotherapy, MRF-D distance from mesorectal fascia, R-CHOP rituximab, cyclophosphamide, hydroxydaunorubicin, oncovin, prednisone, PET positron emission tomography, EBC: Early breast cancer, IDH: isocitrate dehydrogenase, SVCO: superior vena cava obstruction, APBI: accelerated partial breast irradiation, WBI: whole breast irradiation, DORSCON, Disease Outbreak Response System Condition, IMNC: internal mammary nodal chain.

4.1. General prioritization of radiotherapy during COVID-19 pandemic

Tables 1 and 2 summarizes the prioritization strategies of common cancer types to mitigate the demand of EBRT and brachytherapy during this crisis retrospectively. Some authors categorized the priority scale in three levels of omission, delayed, and continuing the irradiation. Using the short-course irradiation or hypo-fractionated radiotherapy (Hypo-F RT) over normal fractionation is the most frequent and preferred standard of care for radiotherapy during the pandemic.

Recommendations support the utility of active surveillance in low-risk tumors, which permitted to defer the treatment based on the disease biology and pathology, for several months or until an expected fall or management of COVID-19 pandemic. Taking into account that deferred therapy should not lead to detrimental impacts on treatment consequences. Moreover, it suggested avoiding radiotherapy for patients with poor prognostic tumors in early-stages (e.g., Hodgkin's Lymphoma) and low-risk (e.g., postoperative radiotherapy for thymoma) disease. It was recommended to omit the treatment of palliative setting as long as the patient symptom can be under control by adopting alternative approaches, elderly patients with severe health circumstances, benign disease (e.g., keloids), and boost whenever possible (Wright et al., 2020; Simcock et al., 2020; Wallis et al., 2020). These approaches have been summarized in Table 1.

Based on the suggested prioritizations (Table 1), radiation treatment should maintain and continue according to the pre-pandemic schedule for patients underway of therapy unless the COVID-19 virus infects them. The treatment should sustain for urgent issues, where there is no alternative modality to radiation therapy and those with symptomatic metastatic disease with a life expectancy of at least 3–6 months. Preoperative RT has also been reported to buy some time for postponing surgery (Zhao et al., 2020). Deferral treatment commencement for patients with a potentially promptly growing tumor and curative intention can jeopardize outcomes and should be classified as a high priority level (Janssens et al., 2020).

Based on the published references (Tables 1 and 2), some cases including high- or intermediate-grade cancer, frail patients who are not eligible for surgery, hormone-sensitive cancers (e.g., breast and prostate cases), malignancies in locally advanced stages (e.g., breast, lung, cervix locally advanced cancers) should treat as the standard of care. Emergency cases (known as the urgent category) such as superior vena cava syndrome (SVCO), uncontrolled pain or bleeding, occlusion, and spinal cord compression are recommended for radiotherapy continuation with high priority (Ismaili, 2020b; Cruz et al., 2020).

Table 3 summarized the department's consensus for radiotherapy candidates during pandemic and indications of the feasible Hypo-F RT and short-course treatment regimens. Extending the use of an evidence-based Hypo-F RT schedule or simultaneous integrated boost (SIB) (e.g., for prostate, breast, and head and neck cases) and short-course radiation therapy (e.g., for rectal cancer) were recommended frequently. There are also other classifications based on (1) the urgent/critical and non-urgent/non-critical treatment indication, (2) high-risk/ high-grade pathological malignancy stages, (3) degree of cancer cell proliferation, (4) the feasibility of treatment options during the pandemic, and (5) patient's performance status (Wright et al., 2020; Combs et al., 2020; Simcock et al., 2020; Montesi et al., 2020b).

4.2. Comprehensive cancer-based radiotherapy guidelines during the COVID-19 pandemic

Presented consensuses and recommendations of Tables 1–3 can be summarized based on the cancer type as follow:

4.2.1. Central nervous system (CNS)

In glioblastoma multiform (GBM) cases, age and karnofsky performance status (KPS) of patients introduced as the determining factors in choosing radiotherapy schedule and fractionation (e.g. KPS $\geq$ 70: 60 Gy / 30 frs, KPS $<$ 70 or elderly: 40 Gy / 15 frs, KPS $<$ 50: 34 Gy / 10 frs or 25 Gy / 5 frs) (Noticewala et al., 2020a). Continuing treatment was generally recommended for high-grade glioma cases with not poor KPS. For example, Hypo-F RT can be considered where there is not any probability of compromising outcome (e.g., for patients with brain metastases or O^6- methylguanine DNA methyltransferase (MGMT) promoter- unmethylated glioblastoma) based on the ESMO recommendation to reduce hospital visits (Weller and Preusser, 2020). Stereotactic radiosurgery (SRS) was suggested for solitary or limited brain metastases (up to four lesions with less than 4 cm maximum size) with good KPS patients. SRS with 15−24 Gy can be prescribed based on the maximum lesion size. Whole-brain radiotherapy (WBRT) is still introduced as the standard of care for more or/and larger brain metastatic lesions (Tables 1–3) (Di Franco et al., 2020).

4.2.2. Head and neck

For head and neck cancer patients, all indications for continuing the combined chemo-RT must be preserved following the acceptable delay time between diagnosis and RT (i.e., $\leq$ four weeks) or between surgery and RT (i.e., 6–8 weeks) (Belkacemi et al., 2020b). Radiotherapy omission was allowed just for benign or low-risk slow-growing lesions (Table 1). Delaying radiotherapy is also permitted not more than 4–6 weeks for COVID-19 positive cases or in cases such as melanomas, as indicated in Table 1 in detail. RT fractionation must be optimized using Hypo-F RT, simultaneous integrated boost (SIB), accelerated RT scheduling (6 frs / week), or SBRT techniques. Strong agreement was reported following ASTRO-ESTRO consensus to shift from the standard approach (2–2.4 Gy / fr) to the Hypo-F regimen (2.21–3.2 Gy / fr) or Ultra-Hypo-F

Table 2
Summary of international guidelines or national multi-cancer recommendation for brachytherapy prioritization during COVID-19 pandemic.

Cancer type		Hold BT and choose another treatment option	Delay BT until the end of the pandemic	Continue BT during the pandemic
CNS		Brain (For primary or metastases/adjuvant cases): - Avoid BT until pandemic solves - SRS/SRT for glioma or metastatic cases (Mohindra et al., 2020)		
Head and neck		Definitive/boost oral cavity/oropharynx, boost nasopharynx or any re-irradiation: - Avoid BT until pandemic solves - For COVID-19+ patients, continue EBRT rather than BT boost (Mohindra et al., 2020)		Oral tongue (pT1-T2, N0) high risk of local recurrence: - Adjuvant BT (39 Gy /fr in 7 days, twice daily instead of 60 Gy /30 frs by EBRT) (Aghili et al., 0) SSC of lip, oral mucosa, or nasal region cases: - Continue (Cyrus et al., 2020) If BT can be employed as a sole modality for cases such as the lip and oral mucosa (Barthwal et al., 2020) Recurrent nasopharyngeal carcinoma: time-sparing interstitial or intracavitary brachytherapy (if feasible) - ^{198}Au grains: 60 Gy - ^{125}I grains: 130 Gy; 120 Gy - HDR intracavitary: 24 Gy / 3 frs (Svajdova et al., 2020) Early-stage cases: - Use balloon- or multicatheter-based BT instead of EBRT ()
Breast		Switch interstitial BT to EBRT	Low-risk cases: Postpone interstitial BT for up to 16–20 weeks for ER + invasive cases or 12 weeks for DCIS (Mohindra et al., 2020) Patients prescribed for definitive or adjuvant therapy: - Shorten BT fractionation schedules	Early-stage: - Neoadjuvant endocrine therapy due to delay of surgeries during the crisis; - Adjuvant therapy after BCS - Deem BT as an equivalent option to EBRT - BT for APBI with a single-entry intra-cavitary or multi-catheter interstitial technique after surgery Invasive cases: - Induction of therapy for within 12 weeks after surgery, not more than 20 weeks (BT after BCS) (Williams et al., 2020)
		Accelerated partial breast irradiation (Exclusive): - Opt for EBRT according to local facilities (Chargari et al., 2020) Apply EBRT instead of BT (Barthwal et al., 2020)	Accelerated partial breast irradiation (Exclusive): - Postpone (8–12 weeks)	Very Low-, Low- and Intermediate Risk: -HDR-ISBT 27 Gy/2frs Monotherapy - ^{125}I LDR-ISBT Intermediate Risk High - Very High Risk: - HDR-ISBT boost 15 Gy/1 fr (Murakami et al., 2020)
Lung		For palliative and post-transplant stenosis: - Avoid BT until the pandemic solves (Mohindra et al., 2020)		Palliation with symptoms: - Continue BT ()
Gastrointestinal	**Esophageal**	-Palliative and re-irradiation: - Avoid BT until the pandemic solves (Mohindra et al., 2020) BT with Endoscopic procedures (esophagus or bronchus): - Omit and consider EBRT options (Chargari et al., 2020)		Avoid delaying the treatment using BT ()
	Hepato-biliary	Hilar Cholangiocarcinoma cases with COVID-19+ during RT: - Continue EBRT rather than BT boost		

(*continued on next page*)

Table 2 (*continued*)

Cancer type		Hold BT and choose another treatment option	Delay BT until the end of the pandemic	Continue BT during the pandemic
		Palliative unresectable malignant biliary obstruction or hepatocellular carcinoma cases (not for the transplant) and metastatic lesions: - Avert BT until pandemic solves (Mohindra et al., 2020)		
		For COVID-19+ patients: - Hypo-F-EBRT rather than BT boost	Preoperative or definitive postpone brachytherapy until pandemic solves (Hypo-F RT) (Mohindra et al., 2020)	
	Rectal			After SCRT: - For Unresectable, Medically inoperable, or Frail elderly cases: 10-20 Gy in 2-4 frs (Siavashpour et al., 2020)
	Anal	- Switch interstitial BT to EBRT - Switch to IORT if facilities are available (Barthwal et al., 2020)		
				Continue (Chargari et al., 2020) If BT can be employed as a sole modality for penile region cases (Barthwal et al., 2020)
			Low-risk patient: - Delay BT up to 3–6 months	High-risk patients: - BT as a boost, avoiding any deferent: 13·5 Gy /2 frs of BT alone or 15 Gy/1 fr as EBRT boost ()
		For COVID-19+ patients during EBRT: - Interrupt treatment to let recovery up to 10–14 days before restarting/plan for BT For COVID-19+ patients after 1 st session of HDR, defer 2nd fraction to allow recovery up to10–14 days	High-risk cases: - Delay all monotherapy BT	High-risk cases: - Defer starting EBRT and keep on hormone therapy–Consider EBRT boost instead of BT (Mohindra et al., 2020)
Genitourinary	**Prostate**		Low and intermediate-risk cases: - Delay BT for at least 3–6 months	For anxious patients, minimize the time of treatment (definitive) Definitive or adjuvant therapy (using endocrine): - Shorten BT fractionation schedules (Williams et al., 2020)
			Low-risk prostate cancer (Exclusive): - Postpone (8–12 weeks) Intermediate and high-risk prostate: - Postpone (8–12 weeks)	Low-risk prostate cancer (Exclusive): - Opt for surveillance Intermediate and high-risk prostate: - Opt for EBRT according to local facilities (Chargari et al., 2020) In centers where prostate BT is common: – all (HDR) monotherapy cases (2 implants) should be converted to HDR boost (single implant 15 Gy in 1 fr) or switching to EBRT or starting of ADT – EBRT that are due for HDR boosts (15 Gy in 1 fr) can be converted to 37.5 Gy/15 fractions, – For experienced centers, BT can be delivered using LDR (Barthwal et al., 2020)
		Brachytherapy should be avoided as far as possible		
			Temporarily defer certain specialized procedures (HDR-BT) (Kwek et al., 2021)	
			Positive COVID-19 patients: - Postpone up to 10–14 days - Increase dose by 5 Gy / week deferent (consider OAR constraints) - Keep on BT boost with PPE precautions	locally advanced cases (excluding verified or doubtful patients with COVID-19 infection) () Negative COVID-19 patients: - Finalize treatment within 7–8 weeks (Mohindra et al., 2020)
Gynecological	**Cervix**	When that is not feasible EBRT boost should be considered.		Chemotherapy/RT + BT ≤ 8 weeks (Williams et al., 2020) Boost: Continue for locally advanced case (Chargari et al., 2020) Adding approx. 5 Gy per week for each week of BT delay beyond seven weeks, respecting (OARs) tolerance doses (Barthwal et al., 2020) - Reducing the number of applications by delivering multiple fractions with each application - Using higher dose/fr (fewer fraction number) considering the indications (e.g., 3 × 8 Gy or 4 × 7 Gy) (Miriyala and Mahantshetty, 2020; ElMajjaoui et al., 2020; Kumar and Dey, 2020; Ismaili and Elmajjaoui, 2020) Adjuvant treatment: 9 Gy / 2 frs over 2 weeks, over conventional 7 Gy / 3–4 frs or 6 Gy / 5 frs (Upadhyay and Shankar, 2020)

(*continued on next page*)

Table 2 (*continued*)

Cancer type	Hold BT and choose another treatment option	Delay BT until the end of the pandemic	Continue BT during the pandemic
			9 Gy × 2 frs weekly (in patients with low volume disease post-RT and in whom inferior local control) (Kumar and Dey, 2020) Stages IB3, IIA2-IIIC2, and early IVA: Intracavitary HDR brachytherapy 3 frs Stages IA1, IA2, IB1, IB2, IIA1: Vault brachytherapy 12 Gy/2 frs (Hinduja et al., 2020)
		For centers with single brachytherapy operating: postpone at least 24 days or until the infection is resolved	Reduced number of fractions: 24 Gy/3 frs or 28 Gy/4 frs HDR ICBT: 7 Gy/4 frs at 1 week apart or 2 frs per day separated by a 6 h interval For patients >70 yrs, significant comorbidities, small tumors, or responding well to RT: -Shortened schedule (9 Gy /2 frs at 1 week apart) -Brachytherapy for cervical cancer (stage IB1, IIIB) (ElMajjaoui et al., 2020)
Uterine		Advanced cervical cancer: temporarily defer interstitial brachytherapy (Kwek et al., 2021) - Postpone BT but no more than 12 weeks after surgery (Williams et al., 2020)	- Standard treatment (preferably three frs) ()
		Inoperable definitive positive COVID-19 symptomatic patients: - Hold on RT for 10–14 days - Start BT after recovery (Mohindra et al., 2020) High-risk cases: - Postpone boost (8–12 weeks) - Opt EBRT according to local facilities (Chargari et al., 2020) Interstitial BT for definitive COVID-19+ cases: - Delay treatment up to 10–14 days after recovery - Increase BT dose by 5 Gy / week deferent (Mohindra et al., 2020) Intermediate risk endometrial cancer (Exclusive): Postpone (8–12 weeks) or opt for surveillance (Chargari et al., 2020)	
	Postop vaginal cuff cases: - Avert BT boost after RT if no adverse factor exists - COVID-19+ patients: postpone BT until pandemic solves	- Postpone BT up to 8–9 weeks after surgery - Postpone BT boost by 2–3 weeks after RT (Mohindra et al., 2020)	
Endometrial		Early-stage intermediate risk: - Postpone BT up to 12 weeks to 6 months based on patient comorbidities	
	Early-stage high risk	−7 Gy (to 0.5 cm depth) in 3 frs allowing 14 days inter-fraction interval	
		Stage II: - Postpone by 1–2 months - Postpone at least 24 days for COVID-19 positive cases (ElMajjaoui et al., 2020)	
	Stages IA Gr I-Gr III and IB Gr I-II: Vault brachytherapy if positive margins, suboptimal surgery	Stages IB Gr 3, stage II G1 and G2 with no high-risk features, stage IIIA-IIIC: Vault brachytherapy (Hinduja et al., 2020)	
		For patients with significant comorbidities: for 6 months	Patients who should start VVB: 7 Gy/3 frs (depth of 0.5 cm) with an interval spacing of 14 days between the fractions
		Intermediate-risk endometrial cancer: Delaying VVB up to 12 weeks	
	High-risk patients (received adjuvant RT): Omitting VVB	Stage II endometrial cancers: Adjuvant VVB (exclusively: if invasion < 50 % of the myometrium, G1 and 2 or after RT: if invasion > 50 % of the myometrium, G3): postpone brachytherapy by 1–2 months COVID-19 positive patient: postpone treatment (at least 24 days)	Stage II endometrial cancer with poor prognostic factors (if invasion > 50 % of the myometrium, G3), and for stage I high-risk endometrial cancer: Adjuvant RT and brachytherapy (ElMajjaoui et al., 2020)
		Stage I: - Postpone BT up to 1–6 months for patients with significant comorbidities	Advanced stage (ElMajjaoui et al., 2020)
Vaginal			Upper and lower vagina (Hinduja et al., 2020)
		Early vaginal cancer (stage I, < 5 mm of invasion) with significant comorbidities: postpone brachytherapy by 1–2 months	For advanced stage: CRT followed by vaginal brachytherapy (7 Gy/3frs)

(*continued on next page*)

Table 2 (*continued*)

Cancer type	Hold BT and choose another treatment option	Delay BT until the end of the pandemic	Continue BT during the pandemic
			Brachytherapy without any delay (curative treatment): stage I, < 5 mm of invasion, locally advanced stage (ElMajjaoui et al., 2020)
Vulvar	Vulva: radical, adjuvant and palliative (Hinduja et al., 2020)	low priority and only be carried out when operation theatre capacity allows it (Barthwal et al., 2020)	
Sarcoma		Postpone BT boost until pandemic solves. For COVID-19+ patients during RT, continue EBRT rather than brachytherapy boost (Mohindra et al., 2020)	
Pediatrics	Pediatrics indication: To be discussed on an individual basis (Chargari et al., 2020)		Soft-tissue sarcoma: - BT alone (HDR instead of LDR with iridium-192 wires) rather than 60−66 Gy / 1·8−2 Gy/ fr adjuvant EBRT () BT can be employed in specialized centers, especially for rhabdomyosarcoma (Barthwal et al., 2020)
Skin	Definitive cases: - Avoid BT until the pandemic solves (Mohindra et al., 2020)	Basal cell carcinoma (Exclusive): - Postpone according to functional risk Until it is suitable for the institute (Barthwal et al., 2020)	Non-melanoma skin cancers: - Use BT with fewer fractions, especially in inoperable patients () Basal cell carcinoma: - Do not postpone (Chargari et al., 2020)
	Hypo-F RT can be delivered in a twice-daily frs - Switch interstitial BT to EBRT - Switch to IORT if facilities are available (Barthwal et al., 2020)		
Keloids (Exclusive)	Omit BT and consider options (Chargari et al., 2020)		
Uveal Melanoma Palliative	BT should be avoided and replaced by Hypo-F EBRT (Barthwal et al., 2020)		Continue (Mohindra et al., 2020;)

RT: radiotherapy, BT: brachytherapy, EBRT: external beam radiotherapy, HDR: high-dose-rate, LDR: low-dose-rate, SCC: squamous cell carcinoma, PPE: personal protective equipment, IORT, intra-operative radiotherapy, Hypo-F RT: hypo-fractionated RT, ISBT: interstitial brachytherapy, VVB: Vaginal vault brachytherapy.

RT (e.g., 8 Gy / 1 fr or 20 Gy / 4 fr) for palliative cases, during the breakdowns and shortage of RT capacities. However, in these cases, concomitant chemotherapy was restricted to the RT regimen with a prescribed dose of less than 2.4 Gy / fr (Thomson et al., 2020b). It is recommended to continue brachytherapy of oral tongue cases with high local recurrence probability and SCC of the lip, oral mucosa, and nasal region. Switching to EBRT is preferred for COVID-19 positive cases, also patients and caregivers with a higher risk of infection (Table 2).

4.2.3. Breast

Based on a previous review, the RT of breast cancer in cases with locally advanced and inflammatory, residual positive lymph node (N2), recurrent, triple-negative node-positive, and extensive lymph vascular invasion categorized with high priority indication (Zaniboni et al., 2020). The most frequent thresholds for age and maximum tumor size were 65 years old and 2.5−3 cm, respectively. Standard Hypo-F RT (i.e., 40 Gy / 15 frs), the routine schedule for breast irradiation, is the most highlighted proposed technique during the pandemic. However, using FAST (26 Gy in 5 fractions once weekly) and FAST-Forward (26 Gy in 5 fractions daily) regimens were also emphasized for a patient requiring breast or partial breast EBRT (Tables 1 and 3) and a center that dedicated with IGRT. The omission of radiotherapy was proposed for low-grade elderly patients (or post-menopausal cases) with negative lymph node involvement, ER-positive and HER2-negative case for whom adjuvant endocrine therapy was planned (Table 1). Switching to EBRT instead of BT is highly recommended due to the additional demand for resources and hospitals. However, when BT is feasible, applying HDR accelerated partial breast irradiation (APBI) or LDR interstitial brachytherapy (LDR) technique using a single applicator or needle entry was proposed for early-stage disease. It allowed a maximum delay of 12 weeks for patients' RT of ductal carcinoma in situ (DCIS) cases with high RT indication (e.g., ER-negative with positive surgical margin).

4.2.4. Lung

Almost all related kinds of literature recommended continuing RT for non-small cell lung cancer (NSCLC), limited-stage of small cell lung cancer (LS-SCLC), or palliative setting (Table 1) during the pandemic. However, they proposed to hold off RT for the extensive-stage (ES-SCLC). Delaying the prophylactic cranial irradiation (PCI) of SCLC with both limited and extensive disease was highly recommended in the COVID-19 pandemic setting (Madan et al., 2020). The stereotactic body radiotherapy (SBRT) technique with a limited fraction number is the ideal RT option during the pandemic era. For instance, the fractionation suggested for the peripheral and central tumors of NSCLC was 54 Gy / 3 frs and 50 Gy / 5 frs, respectively. Besides, for limited-stage and extensive SCLC stage, 40 Gy / 15 frs and 25 Gy / 5 frs for radical and consolidation radiotherapy, and 25 Gy / 10 frs for PCI, respectively (Rathod et al., 2020).

4.2.5. Gastrointestinal

Continuing CRT or neoadjuvant RT for esophageal cancer treatment using the Hypo-F RT regimen was frequently recommended (e.g., 50 Gy

/ 16 frs for tumors up to 5 cm, 55 Gy / 10 frs for tumors up to 10 cm in length, and 40 Gy/15 frs for neoadjuvant Hypo-F dCRT) (Jones et al., 2020a). Surgery can be postponed up to 3 months for these cases (Belkacemi et al., 2020b). Tumor length was defined as a restricting factor for dose per radiotherapy fraction (Tables 1 and 3).

SBRT (e.g., 24–60 Gy /1–5 frs), proton therapy, or systematic RT was suggested for the liver malignancies based on the cancer stage (Aitken et al., 2020). For locally advanced pancreatic cancer continuing with Hypo-F RT with/without SBRT technique is recommended for both unresected (single fraction SBRT (8−10 Gy) for palliation) and resected cases (SBRT: 30−33 Gy / 5 frs and without SBRT: 25 Gy / 5 frs, or 30 Gy /10 frs) (Tchelebi et al., 2020). For operable cholangiocarcinoma, surgery can be the option of cancer management. Avoiding BT was suggested for patients with esophageal- and cholangial-carcinoma until the pandemic and the risk of virus transmission reduces.

For locally advanced rectal cancer (LARC), delaying radiotherapy is not recommended to decrease the recurrence rate and increase anal sphincter preservation probability (Siavashpour et al., 2020). However, neoadjuvant short-course radiation therapy (SCRT) (i.e., 25 Gy in 5 frs) with postponed surgery (up to three months) for the intermediate- to high-risk patients can be an optimum choice based on the recommendations of the pandemic setting to decrease the frequency and duration of the patients' exposure. However, distance from the mesorectal fascia (MRF-D) is considered a restricting factor for SCRT selection. Long-course chemoradiotherapy (LCCRT) (i.e., 45−54 Gy in 25–30 frs) was suggested for patients with MRF-D $\leq$ 2 mm to safely delay the surgery and improve the chance of clinical response. Adjuvant RT can be omitted or postponed for early-stage and low-risk cases (Madan et al., 2020). Delaying or omitting rectal BT is recommended for all patients except for unresectable lesions, frail elderly, or medically inoperable ones (Siavashpour et al., 2020; Mohindra et al., 2020). It was suggested to continue the anal cancer radiotherapy by Hypo-F RT regimen (e.g., 30 Gy / 10−15 frs) or following the standard treatment. However, switching from BT to EBRT or IORT was suggested in these cases (Tables 1–3).

4.2.6. Genitourinary

Delaying or omitting surgery for muscle-invasive bladder cancer (MIBC) patients and choosing treatment options like RT and chemotherapy may be suboptimal. However, in the COVID-19 pandemic, this delay has been avoidable due to operating room closure and saturation of ICU beds (Sarkis et al., 2020). Therefore, some recommendations were proposed for treating these patients using RT even by curative or palliative indication. Hypo-F RT was the dominant suggested regimen by, for example, 55 Gy / 20 frs and 21 Gy / 3 frs for curative and palliative purposes, respectively (Table 1). SIB technique can also be applied for the unresected cases. It's better to continue RT, but with a Hypo-F regimen (e.g., 24 Gy / 1−4 frs) for unresectable or medically inoperable renal cell carcinoma (RCC) cases.

In prostate cancer, EBRT omission and active surveillance (AS) were recommended for very low-, low-, and intermediate-to-low-risk cases during the pandemic. 3–6 months delaying radiotherapy and using AS, ADT, or hormonal deprivation can be chosen for low risk, intermediate-to-high, high-risk, or localized prostate cancer in a post-operation setting. It is recommended to continue radiotherapy for high-risk and advanced cases with curative intent. The Hypo-F RT regimen is highly preferred (Tables 1 and 3). This irradiation regimen (e.g., 36 Gy / 6 frs) is also suggested for oligometastatic disease (Belkacemi et al., 2020b). Radiotherapy omission of low-stage seminoma was also preferred. Shortening the BT fractionation of intermediate- and high-risk prostate cancer (e.g., 15 in one fraction) or ultimately shifting to the EBRT to reduce the risk of patient exposure to the infection is proposed during the pandemic.

4.2.7. Gynecological

In gynecological cancer, adjuvant treatment after surgery with curative intent has a high-priority for radiotherapy (Uwins et al., 2020). For example, not postponing EBRT or BT was highly suggested for locally advanced cervical cancer (Tables 1 and 2). In invasive uterine cervix carcinoma, it was proven to have lower tumor control and higher recurrence risk when the overall treatment time (OTT) exceed more than seven weeks, especially for squamous cell carcinoma (SCC) (Mohammadi, 2019; Siavashpour, 2016). Tanderup et al. suggested an additional 5 Gy dose to the high-risk CTV (CTV_{HR}) to compensate for the local control loss if the OTT increases from one week to more than seven weeks (Tanderup et al., 2016). Therefore, the proposed consensus tried to align these principles and keep the OTT less as possible, even by hypo-fractionated brachytherapy (Table 3). Continuing EBRT in advanced stages or palliative situation of endometrial, ovarian, and vulvar cancer was also recommended during this crisis. Postponing BT for intermediate-risk gynecological malignancies except for cervical cancer or COVID-19 positive patients is also proposed (Table 2).

4.2.8. Sarcoma

Preoperative RT of soft tissue sarcoma (STS) is not generally accepted due to the higher risk of wound complications after radiotherapy. However, there are also some benefits for this neoadjuvant RT, such as the lower risk of tumor cell seeding during operation, lesser organs at risk exposure during radiotherapy. In the pandemic, two more benefits of decreasing the OTT and the risk of exposure to virus infection were added to this neoadjuvant treatment, especially for large border-line resectable sarcomas using the Hypo-F regimen (e.g., 28 Gy / 8 frs or 25 Gy / 5 frs) (Spalek and Rutkowski, 2020). SBRT is a good treatment option for these patients with unresectable or lung metastases from sarcoma. Preoperative RT for Ewing's sarcoma cases can be an option where surgery is not feasible or suitable (Gulia et al., 2020). In specialized and dedicated centers, HDR-BT can be employed for soft tissue cases such as rhabdomyosarcoma.

4.2.9. Pediatric

The oncologists recommend following the standard treatment for pediatrics as long as the radiotherapy has the most efficient clinical consequence (Janssens et al., 2020). Radiotherapy omission was just recommended for low-grade cases or where the palliative care is intended based on the pediatric part of Tables 1 and 2. Five priority levels were defined for continuing radiotherapy of pediatrics, dedicating higher RT priority to the medulloblastoma, high-grade ependymoma, retinoblastoma cases, and lower priority to the low-grade glioma and meningioma cases (Table 1). Continuing the brachytherapy of pediatric patients has also been emphasized in the pandemic period (Table 2).

4.2.10. Lymphoma

For aggressive disease, T-Cell and high-grade lymphomas, or for symptomatic patients continuing radiotherapy should be selected. However, RT was recommended for even early-stage Hodgkin lymphoma (HL) (Vordermark, 2020b). Radiotherapy can be ignored in old patients with low-grade lymphomas or when good results were obtained after surgery or chemotherapy (Table 1).

4.2.11. Skin

Definitive RT of melanoma, unresectable SCC and basal cell carcinoma (BCC), and rare cases of Merkel cell carcinoma (MCC) were suggested during the pandemic (Table 1). However, adjuvant RT's omission can be chosen for BCC, melanoma, and SCC with low relapse risk and when the limited benefit is expected. Delaying radiotherapy up to 3 months was proposed for non-prompt growing disease or rare skin pathologies, which were incompletely excised.

4.2.12. Palliative

Radiotherapy omission and switching to the supportive care accomplished with medical therapies were proposed for patients with short life expectancy (days to few weeks) during the coronavirus pandemic setting. These patients are usually in critical conditions that need supportive immobilization or even getting help from palliative sedation to reach

Table 3
Summary of radiotherapy departments' consensus for suggested dose/fractionation during COVID-19 pandemic based on the cancer type.

Cancer type		Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
CNS	**Glioblastoma**	USA (Noticewala et al., 2020a)	✓		60 Gy / 30 frs	Not recurrent cases	a) KPS ≥ 70: 60 Gy / 30 frs b) KPS < 70 or elderly: 40 Gy / 15 frs c) KPS < 50: 34 Gy / 10 frs or 25 Gy / 5 frs
		Canada (Patrick et al., 2020)	✓		60 Gy / 30 frs		40 Gy in 15 frs OR 25 Gy in 5 frs dCRT should be limited to SIB techniques in the standard (5 fractions per week) or accelerated schedule (6 fractions per week)
		Italy (De Felice et al., 2020)	✓		Almost a sequential technique		
Head and neck		Canada (Huang et al., 2020)	✓			HNSCC HPV + T1-T3N0-N2c (TNM-7), HPV– T1-T2N0 HNSCCs, and select stage III HNSCCs	60 Gy / 25 frs (5 weeks; 2·4 Gy / frs)
		India, USA (Gupta et al., 2020c)	✓		1·8–2 Gy / fr		Hypo-F RT: 55 Gy / 20 frs
		UK (Higgins et al., 2020)	✓		35 frs regimens		20 frs regimen
		USA (Kang et al., 2020)	✓			Treatment guidelines for curable patients -Nasopharynx a) T1N0 b) All other M0 patients - Nasal cavity and paranasal sinuses (T1-T4) - Oral cavity (T1-T4) - Oropharynx and unknown primary a) p16-positive a1) T1N0-T2N0 a2) Any T3, T4, or N+ b) p16-negative b1) T1N0-T2N0 b2) Any T3, T4, or N+ - Larynx a) T1N0 glottic larynx b) T2N0 glottic larynx c) T1-T2N0 supraglottic or subglottic larynx d) T3, T4, or N + glottic larynx; all other larynx -Hypopharynx a) T1N0-T2N0 b) Any T3, T4, or N+ Treatment guidelines where LRC is important	Treatment guidelines for curable patients -Nasopharynx: a) RT alone (69.96 Gy/33 frs or 70 Gy/35 frs) b) CRT (69.96 Gy/33 frs or 70 Gy/35 frs) -Nasal cavity and paranasal sinuses: Adjuvant RT (60–66 Gy/30–33 frs) + cC In the absence of surgery: Definitive CRT: 70 Gy/35 frs + cC -Oral cavity: Definitive CRT: 70 Gy / 35 frs + Cc (proton therapy if feasible) Adjuvant RT (60–66 Gy/30–33 frs) + cC In the absence of surgery: Definitive RT (70 Gy/35 frs) Consider proton therapy if feasible. -Oropharynx and unknown primary: a1, b1) T1N0-T2N0: Definitive RT (69.96 Gy/33 frs or 70 Gy/35 frs) a2, b2) Any T3, T4, or N+: Definitive CRT (70 Gy/35 frs) + Cc - Larynx: a) Definitive RT (63 Gy / 28 frs) b) Definitive RT (65.25 Gy/29 frs) c) Definitive RT (70 Gy/35 frs or 69.96 Gy/33 frs) d) Definitive CRT (70 Gy/35 frs) + cC -Hypopharynx a) Definitive RT (69.96 Gy/33 frs or 70 Gy/35 frs) b) Definitive CRT (70 Gy/35 frs) + cC

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
					-Recurrent HNC in need of re-irradiation:	Treatment guidelines where LRC is important Recurrent HNC in need of re-irradiation:
					a) Postop patients	a) Conventionally fractionated RT (60−66 Gy/30–33 frs)
					b) No surgery: >2 y from RT or good KPS	b) Conventionally fractionated RT (70 Gy/ 35 frs)
					c) No surgery and rapid recurrence from first course	c) Quad Shot (3.7 Gy/frs twice daily × 2 consecutive days = 1 cycle; may repeat cycle every 3–4 weeks for up to 4 total cycles)
					Severe restrictions or limitations in radiation oncology operations	Severe restrictions or limitations in radiation oncology operations
					-Larynx	-Larynx:
					a) T1N0 glottic larynx	a) Definitive RT (50–52.5 Gy/16 frs)
					b) T1-T2N0 glottic	b) Definitive RT (51 Gy/ 20 frs)
					c) Larynx	c) Definitive RT (55 Gy/ 20 frs)
					- Oropharynx	- Oropharynx:
					a) T1-T2N0-N1 oropharynx	a) Definitive IMRT (66 Gy/ 30 frs)
					b) p16+ T1N1-T2N2b or T3N0-T3N2b with	b) Definitive CRT (60 Gy/ 30 frs) + cC
					≤10-pack-y smoking history	-Locally advanced HNC: a) Definitive CRT (55 Gy/ 20 frs) + cC
					-Locally advanced HNC (oral cavity, oropharynx,	b) Definitive CRT (55 Gy/ 20 frs) + cC
					hypopharynx)	c) Definitive RT (51 Gy/ 20 frs)
					a) T1N0-T4N3 SCC b) T1-T4N2-N3 SCC c) T3-T4N0 or any N + SCC	
	Canada (Al-Rashdan et al., 2020)	✓		Hypo-F RT (42·5 Gy / 16 frs)	All refereed	- APBI (27 Gy / 5 frs) for suitable (40 % of referred) - Hypo-F RT - 45 Gy / 18 frs - 40 Gy / 15 frs ± 10 Gy - 15 Gy / 6 frs - Boost: 12 Gy / 3 frs
	France (Belkacemi et al., 2020a)	✓		50 Gy / 25 frs with 16 Gy / 8 frs boost		
	Canada (Koch et al., 2020)	✓		a) Standard fractionation (50 Gy / 25 frs) b) 50 Gy / 25 frs for BBI and 40 Gy / 15 frs or 42·4 Gy / 16 frs for WBI c) Conventional boost 50 Gy / 25 frs or 40 Gy / 15 frs		a) Hypo-F RT (40·5 Gy / 15 frs) for breast RT, including regional node irradiation b) UK FAST-Forward trial technique (26 Gy/ 5 frs daily for WBI or PBI) c) 10 Gy / 4 frs as boost
Breast	Iran (Samiee et al., 2020)	✓				40 Gy / 15 frs
	Italy, Portugal, Belgium, Australia, Switzerland, Poland (Thureau et al., 2020)	✓		Standard fractionation (50 Gy / 25 frs) or moderate Hypo-F RT (40 Gy / 15 frs)	a) All breast/chest wall and nodal RT b) All patients requiring RT with node-negative tumors c) Accelerated partial breast RT can also be considered for selected low-risk patients d) Omission RT and boost RT for the elderly or no significant risk factors for local relapse.	a) 40 Gy / 15 frs b) 28-30 Gy / 5 frs (1 fr/ week) or 26 Gy / 5 frs daily c) 30 Gy / 5 frs (over 2 weeks)
	USA (Dietz et al., 2020)	✓			a) High priority case (Locally advanced or inflammatory patients) b) Selected patients undergoing breast RT (without regional-nodal RT)	a) 42·5 Gy / 16 or 40 Gy / 15 frs b) 28·5 Gy / 5 frs (1 fr/ week)

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
					c) boost should be reserved for patients with the greatest absolute benefit (e.g., positive margins, age $\leq$ 40)	
					Adjuvant irradiation	Adjuvant irradiation
					a) Any breast cancer (first choice)	a) Hypo-F RT (boost with Hypo-F RT or even integrated with whole-breast irradiation (complete the treatment in 15 frs)).
					b) Eligible for ultra-short schedules	b) Ultra-short schedules (5-7 frs)
					c) Whole breast and node irradiation	c) A 26 Gy / 5 frs (daily) and 29 Gy at the tumor bed with an integrated boost dose of 5·8 Gy
					d) Partial breast irradiation (for eligible ones)	d) 5 frs $\times$ 6 Gy for a 30 Gy dose or 37·5 Gy in 3·75 Gy / fr (twice daily) on the tumor bed with a negative margin. (Brachytherapy can also be an alternative)
	Spain, UK (Pardoa et al., 2020)	✓		Hypo-F RT	Neoadjuvant irradiation	Neoadjuvant irradiation
					a) All the case with delayed surgery	a) 40·5 Gy / 15 frs in the breast with 54 Gy concomitant boost delivered 3·6 Gy daily.
					b) Selected cases	b) 26 Gy / 2·6 Gy/ fr and concomitant 29-30 Gy boost in 5·7-5·8 Gy / frs at the tumor bed.
					Elderly cases	Elderly cases Hypo-F RT: -weekly 6·5 Gy dose delivered for five weeks for a total of 32·5 Gy -A boost of two 6·5 Gy / fr can be −5·5 Gy / fr will be delivered up to a total dose of 27·5 Gy if axillary nodes are to be included.
	UK, Netherland, Italy, Australia, Israel, Spain, Denmark, France, Norway, Brazil (Coles et al., 2020)	✓			a) Patients that require RT with node negative tumors (not require a boost)	a) 28-30 Gy / 5 frs (1 fr / week) or 26 Gy / 5 daily fr
					b) Patients that require RT breast/chest wall and nodal	b) Moderate Hypo-F RT: 40 Gy / 15 frs
	UK (Higgins et al., 2020)	✓				Hypo-F RT: 26 Gy / 5 frs
	France (Beddok et al., 2020)	✓				Hypo-F RT
	Slovenia (Orazem and Ratosa, 2020)	✓		Normo-fractionation and Hypo-F RT		Increase of Hypo-F RT n (from 65% to over 80%) - Moderate Hypo-F RT (42·5 Gy / 16 frs or 40 Gy / 15 fr) for majority of stages - Hypo-F RT (26 Gy / f frs daily or 28·5 Gy / 5 frs once-weekly)
	Switzerland (Achard et al., 2020)	✓		Normo-fractionation or moderate Hypo-F RT		
	Zambia, USA (Lombe et al., 2020)	✓		50 Gy / 25 frs	a) Breast Chest wall	a) 28·5 Gy/5 frs for 5 weeks
					b) Breast supraclavicular + chest wall	b) 40 Gy/ 10 frs
					All eligible patients adopting the Fast-Forward regimen	Ultra-Hypo-F RT: 26 Gy / 5 frs + A single boost dose of 6 Gy was delivered using an IMRT technique for deeply seated tumors and a single electron field for superficial tumors
	Belgium (Machiels et al., 2020)	✓		40 Gy / 15 frs		
	Canada (Patrick et al., 2020)	✓		40 Gy / 15 frs		Hypo-F RT: 26 Gy / 5 frs

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
	Egypt, Morocco, Saudi Arabia, USA, Jordan (Elghazawy et al., 2020)	✓		50 Gy / 25 frs	a) Partial breast irradiation (EBRT) b) Partial breast irradiation (IORT) c) WBRT +/- regional lymph nodes d) Chest wall +/- regional lymph nodes	a) 30 Gy/5 frs, daily 28.5 Gy/5 frs, daily 38 Gy/10 frs, twice a day b) 20 Gy once c) -Hypo-F RT: 40.05 Gy/ 15 frs, daily, 3DCRT - Extreme Hypo-F RT (node-negative, without boost): 28.5 Gy/5 frs, weekly or 26 Gy/5 frs, daily d) 40.05 Gy/15 frs, daily, 3DCRT 43.5 Gy/15 frs, daily, 3DCRT 37.5 Gy/15 frs, daily, 3DCRT
	USA (Ling et al., 2020)	✓		40 Gy / 15 frs	a) Partial breast b) Whole breast	a) 30 Gy / 5 frs b) 26 Gy / 5 frs
	Poland (Łacko et al., 2020)	✓		50 Gy / 25 frs	a) APBI: -Age > 50 yrs; tumor ≤2 cm T1, negative margin width min. 2 mm without LVI, ER+, BRCA negative. -DCIS of low and medium differentiation level, detected using screening MMG, size ≤ 2 cm with negative margins ≥3 mm, located mainly on the left side. b) WBI: -Resignation from BOOST: patients T 1-2 N0 (≤50 yrs) with negative margins ≥2 mm, without unfavorable prognostic factors (G3, DCIS component) -Resignation from the radiation of patients T1, ER+, HER–, G 1-2, lymph nodes: Post-menopausal SLND up to 2 lymph nodes affected. c) WBI + BOOST ± RNI d) WBI + RNI e) Patients after mastectomy with breast reconstruction	a) 30 Gy/ 5 frs every 2nd day or IMRT technique - FAST Forward: 26 Gy/ 5 frs within a week b) UK FAST: 28.5 Gy /5 frs each once a week - FAST Forward: 26 Gy / 5 frs within a week c) SIB: 40 Gy/15 frs per breast (2.66 Gy) + 3.2 Gy per boost (total dose of 48 Gy) - SIB: 42.56 Gy/16 frs per breast + 3 Gy per boost (total dose of 48 Gy) d) 40 Gy / 15 frs e) 40 Gy 15 frs or 45 Gy / 20 frs
Lung	USA (Wu et al., 2020)	✓	✓	a) NSCLS 1,2,3) 18 Gy/ 3frs, 12 Gy/ 4frs, or 10 Gy/5frs 4) 60-70 Gy/ 30-35 frs 5) 54-60 Gy/ 27-30frs for margin-positiveor 50-54 Gy/ 25-30 frs for margin negative b) SCLC: 1) 45 Gy in twice-daily 1·5Gy or 66-70 Gy/ 33-35frs 2) 25 Gy/ 10frs 3,4,5) 20 Gy/5frs - consolidative thoracic RT: 30 Gy/10 frs	a) NSCLS 1) Peripheral T 1-2 N0 2) Central T 1-2 N0 3) Ultra-central T 1-2 N0 4) Locally advanced NSCLC 5) Postoperative radiation for NSCLC b) SCLC: 1) Limited-stage SCLC (thoracic RT) 2) Limited-stage SCLC (prophylactic cranial RT) 3) Extensive-stage SCLC (thoracic RT) 4) Extensive-stage SCLC (prophylactic cranial RT) 5) Palliative lung RT	a) NSCLS 1) 34 Gy/1 fr 2) 50 Gy/5 frs 3) 60 Gy/8 frs 4) 55 Gy/20 frs or 45-60 Gy/15 frs 5) 50 Gy/25 frs b) SCLC: 1) 45 Gy/30 twice-daily frs 2) 25 Gy/10 frs vs. MRI surveillance 3) 30 Gy/10 frs vs. observation 4) MRI surveillance 5) 20 Gy/5 frs, 17 Gy/2frs or 10 Gy/1 fr
	Canada (Rathod et al., 2020)	✓		a) NSCLC: 60 Gy / 30 frs or 66 Gy / 33 frs	a) NSCLC: 1) peripheral 2) central 3) concurrent CTRT	a) NSCLC: 1) SBRT: 54 Gy / 3 frs 2) SBRT: 50 Gy / 5 frs 3) 60 Gy / 30 frs

(*continued on next page*)

Table 3 (*continued*)

Cancer type		Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
						4) sequential CTRT	4) 40 Gy / 15 frs or 50 Gy / 20 frs
					b) SCLC: 45 Gy / 30 frs or 66 Gy / 33 frs PCI: 25 Gy / 10 frs	b) SCLC: 1) Limited stage: Radical 2) Limited stage: PCI 3) Extensive stage: Consolidation RT 4) Extensive stage: PCI	b) SCLC: b) SCLC: 1) 40 Gy / 15 frs 2) 25 Gy / 10 frs 3) 25 Gy / 5frs 4) 25 Gy / 10 frs
		USA (Kumar et al., 2020)	✓		LA-NSCLS: Hypo-F RT or standard schedules	When concurrent chemotherapy is not necessary	Hypo-F IMRT (with SIB were needed): a) 60 Gy/ 15 frs b) 60 Gy / 20 frs c) 55 Gy / 20 frs
		USA, France, China, Spain, the UK (Liao et al., 2020)	✓			a) NSCLC b) SCLC Early-stage: For the limited stage standard of care is concurrent chemoradiation with 45 Gy / 30 frs twice daily Extensive stage c) PCI - 25 Gy / 10 frs	a) NSCLC: 1) SABR IN 1-3 frs for stages I-II 2) 30-34 Gy / 1 fr for tumors < 2 cm and ≥ 1 cm from the chest wall 3) 48-54 Gy / 3 frs for peripheral lesions 4) 45 – 60 Gy / 4-8 frs for central and ultra-central lesions 5) 55 Gy / 20 frs for stage II-III 6) 45 Gy / 15 frs for poor performance patients b) SCLC: 1) SABR in 3-5 frs, 60 Gy / 3 frs, 48 Gy / 4 frs or 50 Gy / 5 frs for stage I-II of peripheral lesions 2) Early stage: 40-42 Gy / 15 frs daily or 50-55 / 20-25 frs daily 3) Extensive stage: 30 Gy / 10 frs c) PCI 1) Can be performed during radio(chemo) therapy 2) Can be omitted for p-stage I
		Canada (Kidane et al., 2020)	✓			a) Early-stage (T1-T2N0M0) NSCLC (non-central tumors) b) Pulmonary oligometastases (central tumors)	SABR: a) 30–34 Gy / 1 fr; 45–55 Gy /3–5 frs (e.g., 54/3,48/4, and 55/5); 60 Gy / 8 frs b) bronchial tree (central or ultra-central tumors: 60 Gy /8 frs or 50 Gy / 5 frs)
		USA (Ng et al., 2020b)	✓			Peripheral early-stage NSCLC	Single-fraction SBRT: 30 - 34 Gy
		UK (Jones et al., 2020a)	✓	✓	dCRT: 2 Gy / fr	- dCRT as the most appropriate curative option for both OSCC and OAC - High-risk patients for readmission, such as those with high-grade dysphagia, may not be appropriate for dCRT - Where dCRT is unavailable or inappropriate, consider Hypo-F-dRT	Definitive treatment: - dCRT (2 Gy / fr) Where dCRT is unavailable or inappropriate: - Hypo-F RT: 50 Gy / 16 frs tumors of up to 5 cm in length 55 Gy / 10 frs for tumors up to 10 cm in lengthNeoadjuvant: Hypo-F dCRT with 40 Gy/ 15 frs
Gastrointestinal	**Esophageal**	Brazil (Riechelmann et al., 2020)	✓			Early-stage 1) cT2-T4 and/or clinically lymph-node positive (cN+) SCC cases 2) Patients with obstructive symptoms or hemorrhage	1) Neoadjuvant chemoradiation with reduced dose (41·4 Gy) 2) Ultra- Hypo-F RT
			✓	✓		a) Operable patients	

(*continued on next page*)

Table 3 (*continued*)

Cancer type		Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
		India (Talapatra et al., 2020)				b) Inoperable patient	a) 41.4 Gy/23 frs or 40 Gy/15 frs (cCRT) b) Moderate Hypo-F RT (definitive CRT): 50 Gy/25 frs
						c) Palliation of symptoms such as bleeding and dysphagia	c)20 Gy/5 frs or single fraction schedule (avoid protracted fractionation)
		Italy (Barcellini et al., 2020)	✓		Conventional RT or SBRT	Essential	CIRT
	Pancreatic	USA (Ng et al., 2020b)	✓			Locally advanced pancreatic cancer	Single-fraction SBRT: 25 Gy
		UK (Jones et al., 2020b)	✓		Conventional- or Hypo-F RT	Where surgery is unlikely to be available for the resectable and borderline disease	Hypo-F RT: 25–35 Gy/5 frs (RT alone) or 36 Gy/15 frs CRT with concurrent capecitabine
		UK (Aitken et al., 2020)	✓	✓	Standard techniques		SABR: 24 – 60 Gy /1-5 frs radiofrequency ablation or stereotactic RT
	Liver	Brazil (Riechelmann et al., 2020)	✓			Localized BCLC stage A	
		India (Talapatra et al., 2020)	✓	✓		SBRT: a) Hepatocellular carcinoma b) Oligometastases in liver	a) 48–60 Gy/3–5 frs b) 16–45 Gy/1–5 frs
		Italy (De Felice and Petrucciani, 2020b)	✓		SCRT: 25 Gy / 5 frs LCCRT: 50·4-54 Gy / 28-30 frs	Locally advanced	SCRT
		USA (Romesser et al., 2020)	✓		LCCRT (25-28 frs)	Locally advanced	SCRT
		UK (Higgins et al., 2020)	✓				SCRT: 25 Gy / 5 frs
		France (Beddok et al., 2020)	✓				SCRT: 25 Gy / 5 frs
		Switzerland (Achard et al., 2020)	✓				SCRT (neoadjuvant)
		USA (Skowron et al., 2020)	✓			a) Stage I: high-risk feature patients b) Stage II or III	a) Chemoradiation as an alternative to TME b) Neoadjuvant SCRT: 25 Gy / 5 frs
	Rectal	Brazil (Riechelmann et al., 2020)	✓			a) For cT3b/c or cN+ (middle or low rectum) with clear circumferential margins cases b) If a major response is needed for sphincter preservation c) For cT4, or threatened/involved CRM, or lateral pelvic lymph nodes, or suspected cN2/bulky LN involvement	a) SCRT b) LCCRT c) neoadjuvant therapy with long-course chemoradiation or short-course radiotherapy followed by four to six cycles of chemotherapy
		USA (Ling et al., 2020)	✓		SCRT: 25 Gy / 5 frs LCCRT: 45-50.4 Gy / 25-28 frs	All localized rectal cancers	SCRT: 25 Gy / 5 frs
		Italy (Barra et al., 2020)	✓		standard fractionation (i.e., 74–81 Gy in 37–45 frs) or Hypo-F RT (dose per fraction 2·75-3 in 20–28 frs)	Early prostate cancer	SBRT (ultra- Hypo-F RT): 36·25 Gy in 5 frs (twice a week)
Genitourinary	**Prostate**	The USA, UK (Zaorsky et al., 2020)				a) Localized, oligometastatic, and low volume M1 b) Post-prostatectomy and clinical node positive disease. c) Adjuvant radiation	a) Ultra- Hypo-F RT (1-6 frs) b) Moderate Hypo-F RT (5-20 frs) c) Salvage (20 frs)
		Iran (Aghili et al., 2020)	✓		Standard techniques	Radiation of the whole pelvis is not intended	- SBRT - Abbreviated radiotherapy - A single 19 Gy /1 fr HDR brachytherapy
		Singapore (Tan et al., 2020)	✓		Standard techniques	localized prostate cancer (pT1b–T3aN0M0)	CHHiP: 60 Gy / 20 frs over four weeks or 57 Gy / 19 frs over 3·8 weeks (Dearnaley et al., 2016)

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
	Canada (Kokorovic et al., 2020) - Node-positive without evidence of further metastases - Oligometastatic HSPC	✓			-UIR, HR, and VHR prostate cancer patients for whom RT should begin NADT - High-risk features post-RP (early salvage RT)	Hypo-F RT
	Zambia, USA (Lombe et al., 2020)	✓		74 Gy / 37 frs	High risk	60 Gy/ 20 frs
	Canada (Patrick et al., 2020)	✓		60 Gy / 30 frs		36.25 Gy in 5 frs
USA (Ling et al., 2020)		✓	All risk groups of localized prostate cancer	-SBRT with Ultra Hypo-F RT in 5-7 frs		
USA (Ng et al., 2020b)		✓	Localized prostate cancer	Single-fraction SBRT: 24 Gy		
	Morocco (Ismaili, 2020a)	✓			The same as before	Not changed
	Zambia, USA (Lombe et al., 2020)	✓		EBRT: 50 Gy/ 25 frs Brachytherapy: 7 Gy /4 frs	a) Cervix stage III bulky b) Cervix	a) 41·25 Gy / 15 frs b) 8 Gy / 3 frs 9 Gy / 2 frs one week apart; 9·4 Gy / 2 frs one week apart
Gynecological					Cervix	HEROICC-trial -PTV_{LD} = 40 Gy / 15 frs -PTV_{HD} = 48 Gy / 15 frs (SIB) -Brachytherapy as a boost to the CTVHR in early cancers
	UK, Canada (Mendez et al., 2020)	✓		Standard dose/fr	All but for the patients that may need elective radiotherapy to the paraaortic drainage, or if significant downstaging is necessary, like for the cases with FIGO stage IIIA–IVA.	
	France (Belkacemi et al., 2020a)	✓		50 Gy / 25 frs + boost: 10 Gy / 5 frs		TB: 50 Gy / 20 frs, 4 frs/ week +boost: 10 Gy/4 frs
Sarcoma	Poland (Spalek and Rutkowski, 2020)	✓		Preoperative Soft tissue sarcoma: 50 Gy / 25 frs		Hypo-F RT (e.g., 28 Gy / 8 frs or 25 Gy / 5 frs)
	Canada (Patrick et al., 2020)	✓		Preoperative Soft tissue sarcoma: 50 Gy / 25 frs		Hypo-F RT (35 Gy / 5 frs)
Lymphoma	France (Belkacemi et al., 2020a)	✓		High-grade: 40 Gy / 20 frs		36 Gy / 12 frs, 4 frs / week
	UK (Rembielak et al., 2020)	✓		a) 35 Gy / 5 frs b) 45 Gy / 10 frs c) 55 Gy / 20 frs	cSCC, MCC, and rare skin pathologies for which definitive RT should be considered	Hypo-F RT: a) 32·5 Gy / 4 frs b) 40 Gy / 8 frs c) 50 Gy / 15 frs
	France (Belkacemi et al., 2020a)	✓		45 Gy / 15 frs, 3 frs/week		30 Gy / 5 frs, 1 fr/week
Skin	Australia (Veness, 2020)	✓		Non-Melanoma (NMSC): 50–55 Gy (2-2·5 Gy / fr)	1)BCC 1a) Definitive 1b) Adjuvant 1c) Adjuvant high-risk site (perioral/ orbital) 2) SCC 2a) Definitive 2b) Definitive high-risk site (perioral/ orbital) 2c) Adjuvant 2d) Adjuvant high-risk site (perioral/ orbital)	<70 years ECOG 0/1: 1a) 30–45 Gy / 5–15 frs 1b) 30–45 Gy / 5–15 frs 1c) 45–50 Gy /15–20 frs 2a) 30–45 Gy /5–15 frs 2b) 45–50 Gy /15–20 frs 2c) 30–40 Gy /5–10 frs 2d) 45–50 Gy /15–20 frs ≥80 years or ECOG 2/ 3 1a) 15–28 Gy / 1–4 frs 1b) 15–28 Gy /1–4 frs 1c) 30–36 Gy / 5–6 frs 2a) 15–28 Gy /1–4 frs 2b) 15–28 Gy /1–4 frs 2c) 15–28 Gy /1–4 frs 2d) 30–36 Gy / 5–6 frs ECOG 3/4

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
						70–80 years ECOG 0/1: 1a) 30–40 Gy / 5–10 frs 1b) 30–40 Gy /5–10 frs 1c) 40–45 Gy /10–15 frs 2a) 30–40 Gy /5–10 frs 2b) 40–45 Gy /10–15 frs 2c) 30–40 Gy /5–10 frs 2d) 40–45 Gy /5–10 frs 1a) 15–18 Gy single frs 1b) no RT 1c) no RT 2a) 15–18 Gy / single frs 2b) 15–18 Gy / single frs 2c) no RT 2d) no RT
	Italy (van der Linden et al., 2020)		✓	SFRT or MFRT	If Unavoidable	SFRT: bone metastasis
	France, Switzerland, Belgium (GEMO) (Thureau et al., 2020)		✓	SFRT or MFRT	If Unavoidable	- SFRT: almost all - MFRT: adjuvant case or highly suspicious for fracture
	USA (Yerramilli et al., 2020b)		✓	a) 30 Gy /10frs b) 8 Gy / 1 fr c) 10 Gy /1 fr or 3·7 Gy / 4 frs twice daily d) 8·5 Gy / 2 weekly fractions or 4 Gy / 5 daily fractions	a) Brain met. For patients with urgent indications[¥] b) Spinal cord compression and bone met. c) Tumor bleeding d) SVCO or airway obstruction	a) Brain: 20 Gy / 5 frs b) Spinal cord and bone met.: 8 Gy/ 1 fr c) 3·7 Gy / 4 twice daily fractions or 4 Gy / 5 daily fractions d) 8·5 Gy / 2 weekly fractions or 4 Gy / 5 daily fractions
	Canada (Hahn et al., 2020)		✓		a) Tumor bleeding b) Other Palliative RT regimen	a) 8 Gy / 1 fr b) 8 Gy in 0-7-21 (3 days) regimen (ensuring the final fraction is off-cord and brainstem)
	Iran (Aghili et al., 2020)		✓			- 8 Gy/ 1 fr - 20 Gy/ 4 frs
	France (Belkacemi et al., 2020a)		✓	20 Gy / 5 frs		20 Gy / 4 frs
Palliative	Canada (Rathod et al., 2020)		✓	20 Gy / 5 frs 30 Gy / 10 frs	a) Stage IV NSCLC b) Extensive stage (III-IV) SCLC	a) 8-10 Gy / 1 fr b) 8 Gy / 1 fr
	Singapore (Tan et al., 2020)		✓	20 Gy / 5 frs 30 Gy / 10 frs		8 Gy / 1 fr
	USA (Chaves et al., 2020)		✓		Locally advanced HNSCC	- 24 Gy / 3 frs (D0-D70D21) - 25 Gy / 5 frs - QUAD SHOT technique: 3·7 Gy bid given over two consecutive days, a total dose of 14·8 Gy per cycle, each cycle every four weeks
	Italy, Switzerland (Banna et al., 2020)		✓		Lung	- 8-10 Gy / 1 fr - 17 Gy / 2 frs
	USA, France, China, Spain, the UK (Liao et al., 2020)		✓		a) Brain b) Lung (stage IV)	a) Brain - SRS: 1-3 frs - WBI: 20 Gy / 5 frs b) Lung: 8 Gy / 1 fr
	Argentina (Ismael et al., 2020)		✓		- patients with spinal cord compression, - superior vena cava syndrome - bleeding identified by a specialist	8 Gy or 18 Gy in 3 frs
	Zambia, USA (Lombe et al., 2020)		✓	20 Gy/5 frs 41·25/15 frs 30 Gy/ 10 frs	a) Breast b) Cervix EBRT Stage IVA (VVF, RVF) c) Head and Neck	a) 8 Gy/1 fr b) 10 Gy / 2 frs four weeks apart c) 20 Gy/ 5 frs

(*continued on next page*)

Table 3 (*continued*)

Cancer type	Country	Radical	Palliative	Pre-pandemic EBRT technique	Indication of EBRT during the pandemic	Suggested EBRT technique during the pandemic
				20 Gy/ 5 frs or 30 Gy/ 5 frs	d) Spinal Cord Compression	d) 8 Gy/ 1 fr
	Brazil (Riechelmann et al., 2020)			✓		Metastatic esophagus single fraction or Hypo-F RT
	UK (Jones et al., 2020a)				High risk esophageal cases	- 8 Gy / 1 fr
	Egypt, Morocco, Saudi Arabia, USA, Jordan (Elghazawy et al., 2020)		✓		a) Brain metastasis	a) SRS: 15 Gy/1 fr for 1–3 metastases, good KPS, no extracranial disease. −3D whole-brain RT:20 Gy/5 frs
					b) Bone metastasis	b) With or without cord compression: 8 Gy/1 fr Pathological fracture: 20 Gy/5frs
				30 Gy/10 frs	Treatment guidelines where LRC is important:	
					- Metastatic HNC in need of local therapy	- Metastatic HNC in need of local therapy:
					a) Prior RT	a) Quad Shot (3.7 Gy/frs twice daily × 2 consecutive days = 1cycle; may repeat cycle every 3-4 weeks for up to 4 total cycles)
	USA (Kang et al., 2020)		✓	20 Gy/5 frs	b) No prior RT	b) Quad Shot (3.7 Gy/frs twice daily × 2 consecutive days = 1 cycle; may repeat cycle every 3-4 weeks for up to 4 total cycles)
					- Other primary cancer metastatic to H&N	- Other primary cancer metastatic to H&N: Quad Shot (3.7 Gy/frs twice daily × 2 consecutive days = 1 cycle; may repeat cycle every 3-4 wk for up to 4 total cycles) Other palliative regimens: 30 Gy/10 frs, 20 Gy/5 frs, 8 Gy/1 frs
	USA (Ng et al., 2020b)		✓		Oligometastatic disease: a) Lung metastasis b) Bone, lymph node, or both c) Liver metastasis d) Adrenal metastasis	- Single-fraction SBRT: a) 30 Gy b) 20 Gy c) 18-30 Gy; 35-40 Gy d) 14-18 Gy

frs: fractions, fr: fraction, Bone-Met: bone metastases, Hypo-F RT: hypo-fractionated RT, SFRT: single fraction radiotherapy, MFRT: multiple fraction radiotherapy, GEMO: European study group of bone metastases, KPS: karnofsky performance status, dCRT :definitive chemoradiotherapy, OSCC: oesophageal squamous cell carcinoma, OAC: oesophageal adenocarcinoma, SIB: simultaneous integrated boost, SABR: stereotactic ablative radiotherapy, SVCO: superior vena cava syndrome, CIRT: carbon ion radiotherapy, SBRT: Stereotactic body radiotherapy, SCRT: Short-course radiotherapy, LCCRT: long course chemoradiotherapy, cSCC: cutaneous squamous cell carcinoma, MCC: Merkel cell carcinoma, HNSCC: head and neck squamous cell carcinoma, HPV: human papillomavirus–positive, WBI: whole breast irradiation, PBI: partial breast irradiation, LA-NSCLS: locally-advanced non-small cell lung cancer, SRS: stereotactic radiosurgery, UIR: unfavorable-intermediate-risk, HR: high-risk, VHR: very high-risk, NATD: neoadjuvant androgen-deprivation therapy, HSPC: hormone-sensitive prostate cancer, BCLC: Barcelona Clinic Liver Cancer, PTVLD: Low risk PTV, PTVHR: High risk PTV. NSCLC: non-small cell lung cancer, SCLC: small cell lung cancer, PCI: prophylactic cranial irradiation, VVF: vesicovaginal fistula; RVF: rectovaginal fistula. ¥: progressive neurologic symptom from multiple brain metastases or leptomeningeal disease, LRC: Locoregional control.

stable positioning during treatment, which requires a higher number of caregivers with a higher risk of infection (Hinduja et al., 2020). For the other cases, prioritization was performed to ease patient selection for palliative RT. As mentioned, patients with neurological or airway compromise or tumor bleeding belong to the highest priority (Tables 1 and 2). Using Hypo-F RT with a short number of fractions reaches desirable outcomes for patients requiring palliation for oncologic emergencies without compromising care. For example, 20 Gy / 5 frs for brain metastasis (urgent indications), 8 Gy/ 1 fr for spinal cord compression and bone metastasis, 14.8 Gy / 4 frs twice daily or 20 Gy / 5 frs tumor bleeding, and 17 Gy / 2 weekly fractions of 20 Gy / 5 daily fractions for SVC or airway obstruction (Table 3) (Yerramilli et al., 2020a). Using SBRT or frameless SRS was also suggested for these patients where these radiotherapy techniques are feasible. Avoiding palliative BT was proposed to minimize coronavirus infection risk (Barthwal et al., 2020).

4.2.13. Benign

For the benign disease, delay of radiotherapy was proposed. BT has reasonable local control for keloid cases. However, during the pandemic setting, the risk-benefit analysis leads to BT omission and switching to EBRT, such as treatment with the electron beam.

4.3. Patient's preparation guidelines for radiotherapy during COVID-19 pandemic

Selecting the best techniques to reduce the organs at risk (OARs) doses of each patient relies highly on the center's available equipment, staff's experience, patient's anatomy, and disease site. However, another aspect added to the previous criteria by selecting the best technique for patient positioning and monitoring the simulation and RT delivery during the pandemic. By considering all these aspects and patient benefits, the radiotherapy can be performed by some delivery techniques for better patient management and positioning. Table 4 summarized some of these techniques recently addressed by radiotherapy professionals in the pre/post-pandemic era.

For instance, in breast cancer, RT delivery techniques such as deep inspiration breath-hold (DIBH) can be performed voluntarily, with moderate or active breathing control/coordinator (ABC) equipment. ABC's utility is clinically necessary to control the dose of lung and heart (for left breast cases). It is also applied for gastrointestinal, thoracic, or pediatric patients if using abdominal compression or free-breathing leads to severe and unacceptable toxicity without reaching the normal tissue safety objectives (Wright et al., 2020). CBCT or prone positioning can also be used, mostly in case of reducing the delivered dose of lung and heart, and suggested as an alternative to reduce the infection risk during the pandemic situation by the majority of departments based on Table 4 (Desai et al., 2019; Joseph et al., 2017). However, daily CBCT can prolong treatment time and increase staff and exposure risk in other points of view. Therefore, it is also recommended to pay attention to this note-getting weekly CBCT or even the use of orthogonal films (Parashar et al., 2020).

It can be more useful to apply BBD (Belly Board device) for pelvic malignancies whenever the small bowel dose could be a restrictive factor for target dose escalation in clinical routine (Estabrook et al., 2016). For lung cancer, the supine position is superior to prone orientation by mitigating the target margins (Guy et al., 2020). Nevertheless, using spirometry analysis for respiratory gating of lung cancers was also abandoned and replaced by 4D scanners usage to high-risk components management; it avoids the risk of contamination spread from breathing filters and droplet precautions (Table 4) (Beddok et al., 2020).

It was also suggested to apply a chin rest for a slit lamp exam or chin strap, rather than the bite block during the proton therapy of uveal melanoma by the Particle Therapy Co-Operative Group (PTCOG). It can decrease the salivary fluid and maintain the positioning and reproducibility accuracy in parallel to care about the cleaning condition (Mishra et al., 2020). However, it is more time consuming to use prone positioning than routines supine or acquire daily CBCT rather than using ABC for each case. However, getting daily CBCT of patients can help detect COVID-19 cases caused lung infection in asymptomatic or mildly symptomatic (Table 4) (Sepulcri et al., 2020). It is essential to distinguish between radiation-related pneumonitis and ground-glass opacity from pulmonary symptoms of COVID-19 on chest CT images of patients undergoing chest radiotherapy (Shaverdian et al., 2020).

Eventually, besides choosing the best alternative procedures, shortening treatment time is dramatically crucial to alleviate droplet transmission risk among patients during the pandemic.

Upper airway procedures should be performed using personal protective equipment (PPE) such as wearing an N95 facemask, eye shield, and gloves based on the American Academy of Otolaryngology recommendation. On the other hand, all head and neck cancer cases need a thermoplastic mask during the simulation and treatment steps. Some of these cases also require a tongue blade, individualized mouth prosthesis, or bite blocks. Using these additional setup helpers caused controversy by having PPEs during the RT steps. Therefore, the centers suggested their novel approaches for making and forming the masks and tongue depressors facing this challenge during the pandemic (Yanagihara et al., 2020; Portaluri et al., 2020).

4.4. General consideration in radiotherapy during COVID-19 pandemic

For patients with an indication of definitive CRT (dCRT), robust processes should be obeyed to ensure that their radiotherapy can uninterruptedly continue their treatment even with approved COVID-19 infection (Table 1) (Clinical guide for the management of cancer-patientsduring the coronavirus pandemic [Online], 2021). Patients with spinal cord compression, bleeding, or SVCO syndrome are such cases to follow the routines.

It was suggested to dedicate a treatment machine to these cases or treating them at the end of the day by obeying post-treatment cleaning protocols (Jones et al., 2020a). It was suggested to postpone RT for head and neck, lung, gynecological cancer cases for a few weeks until resolving symptoms and subsiding inflammation. Using prone positioning instead of the supine one with the DIBH technique was also a reported consensus for COVID-19 positive breast cancer cases (Beddok et al., 2020). Switching to EBRT (with standard or hypo-fractionated regimen) was proposed as an alternative for continuing the treatment of COVD-19 positive cancer patients with BT indication such as GYN or rectal cases (Mohindra et al., 2020).

Hypofractionation is the most reported consensus of RT departments during the COVID-19 pandemic to minimize the risk of cancer patients' contagion without reducing their treatments' effectiveness (Tables 1 and 3) (Larrea et al., 2020). However, there are some doubts about the long-term results and toxicity of the proposed treatment schedule during this pandemic crisis due to the absence of long-term randomized trials in some suggested regimes. Using SCRT for rectal cancer can be named an example, especially for those who suffered from low rectal tumors and bulky ones with a close or positive circumferential residual margin (Romesser et al., 2020). Definitive Hypo-F RT of inoperable esophageal cancer patients is another example of debate due to the increasing probability of late toxicities (Tchelebi et al., 2020; Jones et al., 2019). However, the centers accept these risks and mandate Hypo-F short--course radiotherapy to reduce patient infection likelihood with the coronavirus in the pandemic setting (Romesser et al., 2020). However, in some cases, de-escalation of treatment intensity, such as advanced head and neck cancers, is not as curable as standard care. Consequently, these patients should be discussed and informed about the risk and benefit of choosing Hypo-F and standard fractionated regimens, their frequency of hospital visits, the potential of immunosuppression, and the risk of exposure to coronavirus infection (Iqbal et al., 2020).

Furthermore, based on Table 1 and the previous published papers data, there has been a significant omission or reduction and less intensive prescribing of RT strategies for elderly patients during the pandemic (Koch et al., 2020; Zaniboni et al., 2020). Reducing hospital admission frequency and following the isolation procedures was highly recommended for fragile and low-performance patients. Based on the recent adaptive recommendations for the older cancer patients, some similar protocols such as breast cancer Hypo-F RT or IORT and avoiding boost for the early stages, rectal cancer SCRT, single-fraction RT for palliative purposes, SRS technique for early non-small cell lung cancer (NSCLC), or central nervous system (CNS) metastases (Battisti et al., 2020). However, RT omission can be justified for frail or older patients due to the reported comorbidity and poor outcome of age and COVID-19 infection (Meattini et al., 2020).

The relationship between previous suggested OARs dose constraints and the risk of mortality and morbidity was also addressed during the COVID-19 emergency of cancer patients (Kabarriti et al., 2020). These

Table 4
Summary of national consensus for applying different patient's preparation strategies of radiotherapy departments during COVID-19 pandemic.

Cancer	Country	Routine EBRT/BT Technique	EBRT/BT Technique during the pandemic
External beam radiotherapy			
Head and neck	USA (Yanagihara et al., 2020)	Thermoplastic mask with/ without an intraoral device	- Mask-on policy by fitting the thermoplastic mask to the patient after wearing a personal protective mask and cutting the end of a tongue depressor - to use an open-faced thermoplastic mask and place a nonstick barrier between it and a surgical mask The patient was asked to wear one surgical mask (or a second mask if the patient has tracheostomy) during the positioning steps. The thermoplastic mask was used after the setup confirmation. - All treatment was done by VMAT technique and image-guidance.
	Italy (Alterio et al., 2020)	Mouthpiece-assisted head and shoulder thermoplastics masks during all positioning and setup process	
	USA (Pannullo et al., 2020)	SRS with frame-based immobilization	SRS with mask-based treatment
	USA (Song et al., 2020)	ABC (DIBH)	- Voluntary DIBH - Prone positioning - Supine position with further plan optimization
	Canada (Barnett et al., 2020)	ABC (DIBH)	A visually monitored voluntary breath-hold technique - ABC with a new single-use mouthpiece and filter kit must be used per treatment per patient. (in a case with cardiac mean dose >4 Gy or lung V20 > 40 %) - IMRT/VMAT to meet dose objectives CBCT with a prompt review of the lung windows is recommended - 4D scanner imaging and daily CBCT-based positioning - Prone position using free-breathing VMAT technique (for COVID + patients) - Prone positioning - Voluntary deep inspiration breath-hold -Avoid active breathing control due to the risk of aerosol contamination
	USA (Wright et al., 2020)	ABC	
Breast	Italy (Youssef et al., 2020)	CBCT	
	France (Beddok et al., 2020)	Supine positioning, DIBH, isocentric lateral decubitus irradiation	
	Slovenia (Orazem and Ratosa, 2020)	ABC	
	Egypt, Morocco, Saudi Arabia, USA, Jordan (Elghazawy et al., 2020)	DIBH	
Uveal melanoma	PTCOG (Mishra et al., 2020)	Bite block	-Voluntary breath-holding techniques Using chin rest or chin strap
Gastrointestinal **Lymphoma** **Thoracic** **Sarcoma** **Pediatric**	USA (Wright et al., 2020)	ABC	- Free-breathing or abdominal compression - 4DCT - ABC with a new single-use mouthpiece and filter kit must be used per treatment per patient - IMRT/VMAT to meet dose objectives
Lung	USA (Kumar et al., 2020)	CBCT	- Daily image guidance using CBCT to help assess the development of infiltrates in asymptomatic patients
	USA, France, China, Spain, the UK (Liao et al., 2020)	CBCT	IGRT (CT on rail, or CBCT) before the first fraction of the treatment
	France (Beddok et al., 2020)	Spirometry for respiratory gating	- 4D scanner imaging and daily CBCT-based positioning
	Italy (Sepulcri et al., 2020)	CBCT	- Daily image guidance using CBCT
All cases with EBRT indication	USA (Parashar et al., 2020)	Daily CBCT imaging	- Weekly CBCT imaging or orthogonal films, especially when motion is minimal (brain lesions).
Brachytherapy		Brachytherapy:	
Breast, prostate, gynecologic	USA (Williams et al., 2020)	a) General anesthesia for implantations	a) Procedural sedation and analgesia (PSA): - neuraxial analgesia (epidural, spinal, or combined spinal-epidural anesthesia; CSE) - pudendal nerve block - moderate sedation (midazolam and fentanyl) - local analgesia (with topical/mucosal lidocaine and/or tissue infiltration) b) Confined MR-based planning: - Just CT-based planning for local cervical cancer patients with limited vaginal involvement (T1b-2a stages) - MRI-based planning for the extra-cervical spread of malignancies (T2b-T4a stages) and choose one of these strategies: 1) Inpatient strategy: MRI-based BT with the applicator in situ
		b) MRI guidance for IGBT of gynecologic malignancies	

(continued on next page)

Table 4 (*continued*)

Cancer	Country	Routine EBRT/BT Technique	EBRT/BT Technique during the pandemic
			for two treatment fractions 2) Outpatient strategy: have a pre-BT MRI and incorporated it with CT performed at implantation time 3) Using a smit sleeve placed at first implant time for CT-based planning with subsequent MR fusion 4) Using 'cognitive fusion' and contouring on a CT with the applicator in place referring to a pre- BT MRI - Give priority to local or spinal anesthesia for applicator insertion - Balloon or catheter-based APBI is preferred to be inserted intraoperatively - Consider using MRI for just the first GYN BT fraction (especially if 1 st MRI shows a minimal residual tumor) - Consider spinal/ epidural anesthesia, oral analgesia, or intravenous conscious sedation - Avoid placement of gold seeds and consider CT for confirming vaginal applicator placement
Breast, prostate, gynecologic, head and neck, skin	Iran ()	General anesthesia for implantations	
	USA (Mohindra et al., 2020)	- General anesthesia for implantations	
All cases with BT indication	India (Barthwal et al., 2020; Kumar and Dey, 2020)	- Vaginal cuff gold seeds placement for postoperative vaginal cuff BT	

ABC (DIBH): active breathing control/coordinator (deep inspiration breath-hold), PTCOG: particle therapy co-operative group, IMRT: intensity-modulated radiotherapy, VMAT: volumetric modulated arc therapy, CBCT: cone-beam computed tomography, LA-NSCLC: locally advanced non-small cell lung cancer, IGBT: image-guided brachytherapy, APBI: accelerated partial breast irradiation, BT: brachytherapy, GYN: gynecological, SRS: stereotactic radiosurgery.

researchers performed a retrospective analysis to determine if the extent of prior lung irradiation can be a risk factor for death due to COVID-19 infection. They concluded that a mean lung dose of 7 Gy and 15 Gy yields a predicted COVID mortality rate of approximately 50 % and 75 %, respectively (Kabarriti et al., 2020). This result can be included in the previous radiobiological consideration in defining the organ at risk dose constraints and revising them, especially during pandemic conditions.

Multiple authors highlighted some issues in anticipating the pandemic's termination in their busy RT departments to incorporate new treatment techniques and management using the crisis experiences. These techniques include Hypo-F RT scheduling, real-time data monitoring by new visualization tools, telemedicine utilization, and remote working (Beddok et al., 2020; Orazem and Ratosa, 2020).

As mentioned previously, choosing shorter fractionation schedules for palliation and cure is critical to adapt to the regional health system. This technique necessarily needs the use of advanced RT skills and high-tech equipment for imaging, planning, immobilization, and treatment delivery to avoid the increasing of normal tissue toxicity; it also mandates to maintain the equivalent benefit as in conventionally fractionated radiotherapy (Kochbati et al., 2020)

Therefore, there is still a long way to reach optimum cancer treatment all over the world. It is necessary to renew some emergency national/ international protocols parallel to different aspects of RT developments. Overall survival and disease-free survival of various cancer stages have been updating through the newly published references influenced by the improvements in screening culture, follow-ups, and the mentioned treatment progresses. Hence, it should be frequently renewed the patient prioritizing to receive RT according to anticipated outcomes.

The COVID-19 pandemic challenged healthcare resources by creating an extraordinary struggle. The oncology community has been suddenly required to protect a group of cancer patients. They are assumed to be susceptible to a potentially fatal infection without threatening cancer treatments. Risk-to-benefit ratios should be considered dealing with quarantine laws, shortages, lockdowns situations, and cancer treatment priorities (Poortmans et al., 2020). At the early of the pandemic, every cancerous patient was assumed to be at higher risk of mortality from COVID-19. This assumption originated from the rapid primary publications, which caused abandonment or delay of some anticancer treatments, particularly for those who were the candidate to receive systemic treatments (Poortmans et al., 2020). Some multi-central studies find no meaningful associations between the COVID-19 mortality with any cancer type and anticancer therapies such as their current radiotherapy, cytotoxic chemotherapy, hormone therapy, or targeted therapy. On the other hand, some recommended treatment protocols or RT fractionation for which the phase III trials were not done or ongoing (Simcock et al., 2020).

In conclusion, it should be acknowledged that a recent meta-analysis shows cancer patients have higher mortality, although some studies did not show a strong link (Garassino et al., 2020; Zhang et al., 2020). Therefore, it is imperative to reconsider and rethink suggested cancer care protocols during the COVID-19 outbreak. It should be discussed to consider the oncological care, individualized risk factor assessment to choose the pre-pandemic standard approach and avoiding definitive and effective treatment strategies or switching to the new therapeutic options based on the pandemic situations.

Role of the funding source

There was no funding source for this study.

Data statement

The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

CRediT authorship contribution statement

Zahra Siavashpour: Conceptualization, Data curation, Writing - original draft, Supervision. **Neda Goharpey:** Data curation, Writing - review & editing. **Mosayyeb Mobasheri:** Data curation, Resources.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

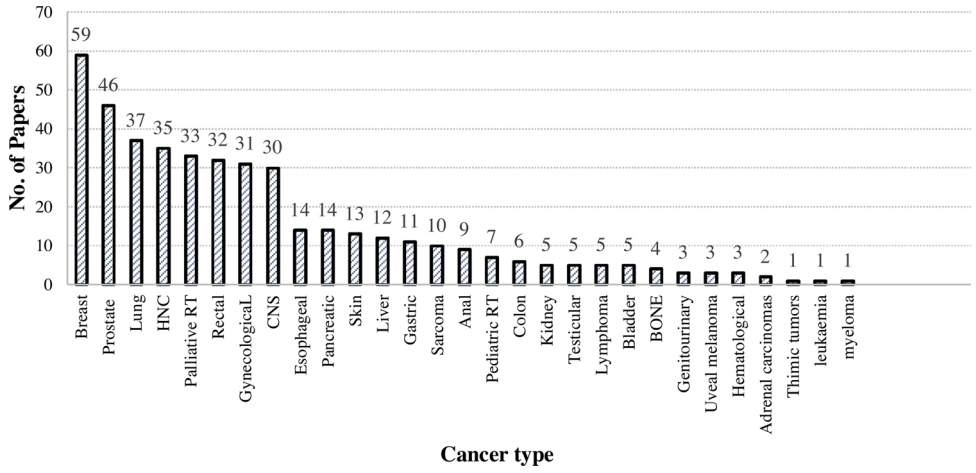

Fig. 2. Distribution of papers concerning studied cancer type.

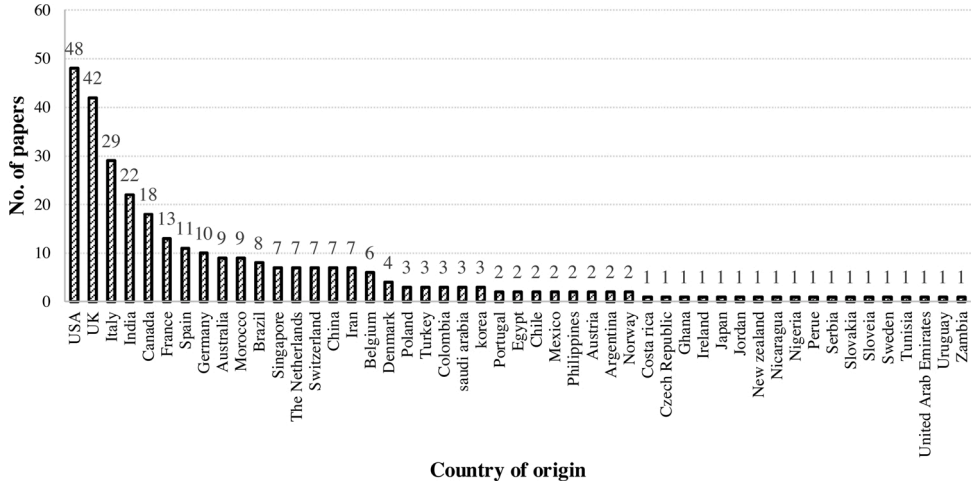

Fig. 3. Distribution of papers concerning the origin of presented consensus or guideline.

Acknowledgments

The authors would like to thank physicians, medical physicists, radiotherapy technicians, and all the nursing team of Shohada-e Tajrish educational hospital, for staying on the front line during this crisis. The authors would like to acknowledge and express their gratitude to numerous radio-oncologist colleagues for their valuable contributions to distribute this survey. We are also grateful to all physicians and care-givers worldwide who are doing their best to treat cancer patients during the COVID-19 pandemic.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.critrevonc.2021.103402.

References

Achard, V., Aebersold, D.M., Said Allal, A., Andratschke, N., Baumert, B.G., Thomas Beer, K., et al., 2020. A national survey onradiation oncology patterns of practice in Switzerland during the COVID-19 pandemic: present changes and future perspectives. Radiother. Oncol. (June).

Aghili, M., Ghalehtaki, R., Mousavi Darzikolaee, N., Jafari, F., Moshtaghian, M., 2020a. Radiotherapy and COVID-19: practical recommendations from iran. Radiother. Oncol. 149 (May), 70–71.

Aghili, M., Jafari, F., Vand Rajabpoor, M., 2020b. Brachytherapy during the COVID-19-lessons from Iran. Brachytherapy (May).

Aitken, K., Good, J., Hawkins, M., Grose, D., Mukherjee, S., Harrison, M., et al., 2020. Liver stereotactic ablative radiotherapy: an effective and feasible alternative to surgery during the COVID-19 pandemic. Clin. Oncol. (R Coll Radiol) 32 (July), p. 477.

Alkatout, I., Karimi-Zarchi, M., Allahqoli, L., 2020. Gynecological cancers and the global COVID-19 pandemic. J. Turk. Ger. Gynecol. Assoc. 21 (December), 272–278.

Alonzi, R., Antoniou, G., Anyamene, N., Hoskin, P., Hughes, R., Ostler, P., et al., 2021. Guidance for Treatment of Uro-oncology Patients During COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/prostate-cancer-treatment-covid19.pdf.

Al-Rashdan, A., Roumeliotis, M., Quirk, S., Grendarova, P., Phan, T., Cao, J., et al., 2020. Adapting radiation therapy treatments for patients with breast cancer during the COVID-19 pandemic: hypo-fractionation and accelerated partial breast irradiation to address world health organization recommendations. Adv. Radiat. Oncol. (April).

Alterio, D., Volpe, S., Marvaso, G., Turturici, I., Ferrari, A., Leonardi, M.C., et al., 2020. Head and neck cancer radiotherapy amid COVID-19 pandemic: report from Milan, Italy. Head Neck (June).

Amaoui, B., Semghouli, S., Benjaafar, N., 2020. Organization of a radiotherapy service during the COVID-19 epidemic: experience of regional center of oncology of agadir, Morocco. Radiography (Lond) (June).

Arrieta, O., Cardona, A.F., Lara-Mejia, L., Heredia, D., Barron, F., Zatarain-Barron, Z.L., et al., 2020. Recommendations for detection, prioritization, and treatment of thoracic oncology patients during the COVID-19 pandemic: the THOCOoP cooperative group. Crit. Rev. Oncol. Hematol. 153 (September), p. 103033.

Bakhribah, H., Zeitouni, M., Daghistani, R.A., Almaghraby, H.Q., Khankan, A.A., Alkattan, K.M., et al., 2020. Implications of COVID-19 pandemic on lung cancer management: a multidisciplinary perspective. Crit. Rev. Oncol. Hematol. 156 (December), p. 103120.

Balakrishnan, R., Sebastian, P., Rajkrishna, B., Venkatasai, J.P., Backianathan, S., 2020. Radiotherapeutic management of brain tumours during the COVID-19 pandemic. J. Radiother. Pract. 1–4.

Banna, G., Curioni-Fontecedro, A., Friedlaender, A., Addeo, A., 2020. How we treat patients with lung cancer during the SARS-CoV-2 pandemic: primum non nocere. ESMO Open 5 (April).
Barcellini, A., Vitolo, V., Cobianchi, L., Valvo, F., Vischioni, B., Bonora, M., et al., 2020. Pancreatic cancer: does a short course of carbon ion radiotherapy worth during COVID-19 outbreak? Pancreatology (May).
Barnett, E., Comsa, D., Zhang, B., Pestill, T., Bradley, C., Proctor, L., et al., 2020. A rapid transition to voluntary breath hold from device-assisted moderate deep inspiration breath hold for patients receiving breast radiotherapy during the COVID-19 pandemic. Adv. Radiat. Oncol. (April).
Barra, S., Guarnieri, A., di Monale, E.B.M.B., Marcenaro, M., Tornari, E., Belgioia, L., et al., 2020. Short fractionation radiotherapy for early prostate cancer in the time of COVID-19: long-term excellent outcomes from a multicenter Italian trial suggest a larger adoption in clinical practice. Radiol. Med. (May).
Barry, A., Apisarnthanarax, S., O'Kane, G.M., Sapisochin, G., Beecroft, R., Salem, R., et al., 2020. Management of primary hepatic malignancies during the COVID-19 pandemic: recommendations for risk mitigation from a multidisciplinary perspective. Lancet Gastroenterol. Hepatol. 5 (August), 765–775.
Barthwal, M., Pareek, V., Mallick, S., Sharma, D.N., 2020. Brachytherapy practice during the COVID-19 pandemic: a review on the practice changes. J. Contemp. Brachytherapy 12 (August), 393–396.
Battisti, N.M.L., Mislang, A.R., Cooper, L., O'Donovan, A., Audisio, R.A., Cheung, K.L., et al., 2020. Adapting care for older cancer patients during the COVID-19 pandemic: recommendations from the International Society of Geriatric Oncology (SIOG) COVID-19 Working Group. J. Geriatr. Oncol. 11 (November), 1190–1198.
Baumann, B.C., MacArthur, K.M., Brewer, J.D., Mendenhall, W.M., Barker, C.A., Etzkorn, J.R., et al., 2020. Management of primary skin cancer during a pandemic: multidisciplinary recommendations. Cancer (June).
Beddok, A., Calugaru, V., Minsat, M., Dendale, R., De Oliveira, A., Costa, E., et al., 2020. Post-lockdown management of oncological priorities and postponed radiation therapy following the COVID-19 pandemic: experience of the institut curie. Radiother. Oncol. (June).
Belkacemi, Y., Krichenane, G.L., Grellier, N., Fonteneau, G., Zaoui, G., Coraggio, G., et al., 2020a. 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. Adv. Radiat. Oncol.
Belkacemi, Y., Grellier, N., Ghith, S., Debbi, K., Coraggio, G., Bounedjar, A., et al., 2020b. A review of the international early recommendations for departments organization and cancer management priorities during the global COVID-19 pandemic: applicability in low- and middle-income countries. Eur. J. Cancer 135 (August), 130–146.
Birtle, A.J., Varughese, M., James, N., Huddart, R., Hoskin, P., Choudhury, A., 2021. Guidance for Management of Urothelial Cancer during COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/urothelial-cancer-covid19.pdf.
Breast Cancer in the COVID-19 Era [Online], 2021. Available: https://www.esmo.org/guidelines/breast-cancer/breast-cancer-in-the-covid-19-era.
Brunt, M., Chakraborty, S., Chatterjee, S., Cleator, S., Coles, C., Kirby, A., et al., 2021. Emergency Guidelines for Pre-operative Breast Radiotherapy During the COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/pre-operative-breast-radiotherapy-covid-19.pdf.
Caicedo-Martínez, M., González-Motta, A., Gil-Quiñones, S.R., Galvis, J.C., 2020. Prostate cancer management challenges due to COVID-19 in countries with low-to-middle-income economies: a radiation oncology perspective. Rev. Mex. Urol. 80, 1–14.
Cameron, J., 2020. Malignant spinal cord compression (MSCC) presentation before and during Covid-19. J. Radiother. Pract. 1–3.
Carvalho, H.A., Vasconcelos, K., Gomes, H.C., Salvajoli, J.V., 2020. Impact of COVID-19 pandemic on a daily-based outpatient treatment routine: experience of a radiotherapy department of a tertiary public/university hospital in Brazil. Clinics (Sao Paulo) 75, e2298.
Chakraborty, M., Pandey, M., 2020. Caring for cancer patients in the Covid pandemic: choosing between the devil and deep sea. World J. Surg. Oncol. 18 (August), 220.
Chan, J.J., Sim, Y., Ow, S.G.W., Lim, J.S.J., Kusumawidjaja, G., Zhuang, Q., et al., 2020. The impact of COVID-19 on and recommendations for breast cancer care: the Singapore experience. Endocr. Relat. Cancer 27 (September), R307–R327.
Chaves, A.L.F., Castro, A.F., Marta, G.N., Junior, G.C., Ferris, R.L., Giglio, R.E., et al., 2020. Emergency changes in international guidelines on treatment for head and neck cancer patients during the COVID-19 pandemic. Oral Oncol. 107 (April), p. 104734.
Clinical Guide for the Management of Cancerpatientsduring the Coronavirus Pandemic [Online], 2021. Available: https://www.uhb.nhs.uk/coronavirus-staff/downloads/pdf/CoronavirusCancerManagement.pdf.
Coles, C.E., Aristei, C., Bliss, J., Boersma, L., Brunt, A.M., Chatterjee, S., et al., 2020. International guidelines on radiation therapy for breast cancer during the COVID-19 pandemic. Clin. Oncol. (R. Coll. Radiol.) 32 (May), 279–281.
Colombo, I., Zaccarelli, E., Del Grande, M., Tomao, F., Multinu, F., Betella, I., et al., 2020. ESMO management and treatment adapted recommendations in the COVID-19 era: gynaecological malignancies. ESMO Open 5 (July).
Combs, S.E., Belka, C., Niyazi, M., Corradini, S., Pigorsch, S., Wilkens, J., et al., 2020. First statement on preparation for the COVID-19 pandemic in large German Speaking University-based radiation oncology departments. Radiat. Oncol. 15 (April), p. 74.
Counago, F., Navarro-Martin, A., Luna, J., Rodriguez de Dios, N., Rodriguez, A., Casas, F., et al., 2020. GOECP/SEOR clinical recommendations for lung cancer radiotherapy during the COVID-19 pandemic. World J. Clin. Oncol. 11 (August), 510–527.
Cruz, M.C., Flores, J.A.S., Paule, J.R., Macalalad, J.M., Lacuesta, A.V.A., Francisco, M.C., et al., 2020. Adapting to the contemporary normal in cancer management and workflow during COVID-19 situation in the Philippines: multi-cancer center collaborative approach. Radiother. Oncol. 150 (September), 70–72.
Chargari, Cyrus, Chopra, Supriya, Viswanathan, Akila N., Deutsch, Eric, 2020. Brachytherapy issues and priorities in the context of COVID-19 outbreak. Adv. Radiat. Oncol.
De Felice, F., Petrucciani, N., 2020a. Treatment approach in locally advanced rectal cancer during coronavirus (COVID-19) pandemic: long course or short course? Colorectal Dis. 22 (June), 642–643.
De Felice, F., Petrucciani, N., 2020b. Treatment approach in locally advanced rectal cancer during coronavirus (COVID-19) pandemic: long course or short course? Colorectal Dis. (April).
De Felice, F., Polimeni, A., Tombolini, V., 2020. The impact of Coronavirus (COVID-19) on head and neck cancer patients' care. Radiother. Oncol. 147 (Mar ch), 84–85.
Dearnaley, D., Syndikus, I., Mossop, H., Khoo, V., Birtle, A., Bloomfield, D., et al., 2016. Conventional versus hypofractionated high-dose intensity-modulated radiotherapy for prostate cancer: 5-year outcomes of the randomised, non-inferiority, phase 3 CHHiP trial. Lancet Oncol. 17 (August), 1047–1060.
Desai, N., Currey, A., Kelly, T., Bergom, C., 2019. Nationwide trends in heart-sparing techniques utilized in radiation therapy for breast cancer. Adv. Radiat. Oncol. 4 (Apr-Jun), 246–252.
Dewan, A., Mitra, S., Aggarwal, S., Barik, S., Kaur, I., Umesh, P., et al., 2021. Management of cervical cancer during the corona virus disease-19 (COVID-19) era. Br. J. Radiol. 94 (January), p.20200686.
Di Ciaccio, P., McCaughan, G., Trotman, J., Ho, P.J., Cheah, C.Y., Gangatharan, S., et al., 2020. Australian and New Zealand consensus statement on the management of lymphoma, chronic lymphocytic leukaemia and myeloma during the COVID-19 pandemic. Intern. Med. J. 50 (June), 667–679.
Di Franco, R., Borzillo, V., D'Ippolito, E., Scipilliti, E., Petito, A., Facchini, G., et al., 2020. COVID-19 and radiotherapy: potential new strategies for patients management with hypofractionation and telemedicine. Eur. Rev. Med. Pharmacol. Sci. 24 (December), 12480–12489.
Dietz, J.R., Moran, M.S., Isakoff, S.J., Kurtzman, S.H., Willey, S.C., Burstein, H.J., et al., 2020. Recommendations for prioritization, treatment, and triage of breast cancer patients during the COVID-19 pandemic. The COVID-19 pandemic breast cancer consortium. Breast Cancer Res. Treat. 181 (June), 487–497.
Dingemans, A.C., Soo, R.A., Jazieh, A.R., Rice, S.J., Kim, Y.T., Teo, L.L.S., et al., 2020. Treatment guidance for patients with lung cancer during the coronavirus 2019 pandemic. J. Thorac. Oncol. 15 (July), 1119–1136.
Dong, S., Luo, C., Hu, X., Zhang, J., Cai, Q., Qian, Y., et al., 2020. Expert consensus for treating cancer patients during the pandemic of SARS-CoV-2. Front. Oncol. 10, p. 1555.
Elghazawy, H., Bakkach, J., Zaghloul, M.S., Abusanad, A., Hussein, M.M., Alorabi, M., et al., 2020. Implementation of breast cancer continuum of care in low- and middle-income countries during the COVID-19 pandemic. Future Oncol. 16 (November), 2551–2567.
Elkhouly, E.A., Salem, R.H., Haggag, M., 2020. Should cancer treatment be continued during the COVID-19 pandemic? A single Egyptian institution experience. Ecancermedicalscience 14, 1077.
Elledge, Christen R., Beriwal, Sushil, Chargari, Cyrus, Chopra, Supriya, Erickson, Beth A., Gaffney, David K., Jhingran, Anuja, Klopp, Ann H., Small Jr, William, Yashar, Catheryn M., Viswanathan, Akila N., Christen, S.B., Elledge, R., Chargari, Cyrus, Choprad, Supriya, Erickson e, Beth A., Gaffney, David K., 2020. Radiation therapy for gynecologic malignancies during the COVID-19 pandemic: international expert consensus recommendations. Gynecol. Oncol.
ElMajjaoui, S., Ismaili, N., Benjaafar, N., 2020. COVID-19, brachytherapy, and gynecologic cancers: a moroccan experience. SN Compr. Clin. Med. (July), 1–4.
Estabrook, N.C., Bartlett, G.K., Compton, J.J., Cardenes, H.R., Das, I.J., 2016. Role of belly board device in the age of intensity modulated radiotherapy for pelvic irradiation. Med. Dosim. 41, 300–304. Winter.
Faivre-Finn, C., Fenwick, J.D., Franks, K.N., Harrow, S., Hatton, M.Q.F., Hiley, C., et al., 2020. Reduced fractionation in lung Cancer patients treated with curative-intent radiotherapy during the COVID-19 pandemic. Clin. Oncol. (R. Coll. Radiol.) (May).
Garassino, M.C., Whisenant, J.G., Huang, L.C., Trama, A., Torri, V., Agustoni, F., et al., 2020. COVID-19 in patients with thoracic malignancies (TERAVOLT): first results of an international, registry-based, cohort study. Lancet Oncol. 21 (July), 914–922.
Garganese, G., Tagliaferri, L., Fragomeni, S.M., Lancellotta, V., Colloca, G., Corrado, G., et al., 2020. Personalizing vulvar cancer workflow in COVID-19 era: a proposal from Vul.CAn MDT. J. Cancer Res. Clin. Oncol. 146 (October), 2535–2545.
Griffiths, W., Frew, J.A., Chandler, R., Jiang, X.Y., Pedley, I.D., Pearson, R.A., 2021. Prostate ultrahypofractionation - rising to challenges presents opportunities in the COVID-19 era. Clin. Oncol. (R Coll Radiol) 33 (January), p. e90.
Guidance for Radiotherapy for Gynaecological Cancer and COVID-19 [Online], 2021. Available: https://www.rcr.ac.uk/sites/default/files/gynae-cancer-treatment-covid19.pdf.
Gulia, A., Arora, R.S., Panda, P.K., Raja, A., Tiwari, A., Bakhshi, S., et al., 2020. Adapting management of sarcomas in COVID-19: an evidence-based review. Indian J. Orthop. (May), 1–13.
Gundavda, M.K., Gundavda, K.K., 2020. Cancer or COVID-19? A review of guidelines for safe cancer care in the wake of the pandemic. SN Compr. Clin. Med. (November), 1–11.

Gupta, T., Singh, V.P., Balasubramian, A., Menon, H., Kurkure, P.A., Kumar, S., et al., 2020a. ISNO position statement on treatment guidance in neuro-oncology during pandemics. Neurol. India 68 (July-August), 769–773.
Gupta, T., Ghosh-Laskar, S., Agarwal, J.P., 2020b. Resource-sparing curative-intent hypofractionated-accelerated radiotherapy in head and neck cancer: more relevant than ever before in the COVID era. Oral Oncol. 111 (December), 105045.
Gupta, T., Agarwal, J.P., Bentzen, S.M., 2020c. Comment on "Practice recommendations for risk-adapted head and neck cancer radiotherapy during the COVID-19 pandemic: an ASTRO-ESTRO consensus statement. Int. J. Radiat. Oncol. Biol. Phys. (May).
Guy, Christopher L., Weiss, Elisabeth, Rosu-Bubulac, Mihaela, 2020. Characterization of respiration-induced motion in prone versus supine patient positioning for thoracic radiation therapy. Adv. Radiat. Oncol. 5, 466–472.
Hahn, E., Livergant, J., Millar, B.A., Ringash, J., Wong, R., Dawson, L.A., et al., 2020. Comments on the publication by Yerramilli et al. titled "Palliative Radiotherapy for Oncologic emergencies in the setting of COVID-19: approaches to Balancing Risks and Benefits. Adv. Radiat. Oncol. (May).
Higgins, E., Walters, S., Powell, E., Staffurth, J., 2020. The impact of the acute phase of COVID-19 on radiotherapy demand in South East Wales. Clin. Oncol. (R. Coll. Radiol.) (May).
Hinduja, R.H., George, K., Barthwal, M., Pareek, V., 2020. Radiation oncology in times of COVID-2019: a review article for those in the eye of the storm - an Indian perspective. Semin. Oncol. 47 (October), 315–327.
Hosni, A., Chiu, K., Huang, S.H., Xu, W., Huang, J., Bayley, A., et al., 2020. Non-operative management for oral cavity carcinoma: definitive radiation therapy as a potential alternative treatment approach. Radiother. Oncol. 154 (August), 70–75.
Hosseiny, M., Kooraki, S., Gholamrezanezhad, A., Reddy, S., Myers, L., 2020. Radiology perspective of coronavirus disease 2019 (COVID-19): lessons from severe acute respiratory syndrome and middle east respiratory syndrome. AJR Am. J. Roentgenol. 214 (May), 1078–1082.
Huang, S.H., O'Sullivan, B., Su, J., Ringash, J., Bratman, S.V., Kim, J., et al., 2020. Hypofractionated radiotherapy alone with 2.4 Gy per fraction for head and neck cancer during the COVID-19 pandemic: the Princess Margaret experience and proposal. Cancer (June).
Hwang, E.S., Balch, C.M., Balch, G.C., Feldman, S.M., Golshan, M., Grobmyer, S.R., et al., 2020. Surgical oncologists and the COVID-19 pandemic: guiding cancer patients effectively through turbulence and change. Ann. Surg. Oncol. 27 (August), 2600–2613.
I. A. E. A. (IAEA), 2021. DIrectory of RAdiotherapy Centres (DIRAC) [Online]. Available: https://dirac.iaea.org/Data/CountriesLight.
Iqbal, M.S., Warner, L., Paleri, V., Kovarik, J., Kelly, C., 2020. De-intensification of treatment in human papilloma virus related oropharyngeal carcinoma: patient choice still matters for de-escalation and for the COVID era. Oral Oncol. 105 (June), 104768.
Ismael, J., Losco, F., Quildrian, S., Sanchez, P., Pincemin, I., Lastiri, J., et al., 2020. Multidisciplinary approach to COVID-19 and cancer: consensus from scientific societies in Argentina. Ecancermedicalscience 14, 1044.
Ismaili, N., 2020a. COVID-19 and gynecological cancers: a Moroccan point-of-view. Radiother. Oncol. 148 (April), 227–228.
Ismaili, N., 2020b. COVID-19 recommendations for patients with cancer: the post-COVID-19 era. SN Compr Clin Med (August), 1–6.
Ismaili, N., El Majjaoui, S., 2020. Management of breast cancer during COVID-19 pandemic in Morocco. Breast J. 26 (August), 1618–1619.
Ismaili, N., Elmajjaoui, S., 2020. COVID-19 and gynecological cancers: a summary of international recommendations. SN Compr Clin Med (August), 1–8.
Jalali, R., Goda, J.S., Patil, V., 2020. Coronavirus disease 2019 pandemic and its implications on triaging patients with brain tumors for surgery, radiotherapy, and chemotherapy. Cancer Res. Statistics Treat. 3, 49–53.
Janssens, G.O., Mandeville, H.C., Timmermann, B., Maduro, J.H., Alapetite, C., Padovani, L., et al., 2020. A rapid review of evidence and recommendations from the SIOPE radiation oncology working group to help mitigate for reduced paediatric radiotherapy capacity during the COVID-19 pandemic or other crises. Radiother. Oncol. 148 (April), 216–222.
Joiner, Michael C., van der Kogel, Albert J., Gordon Steel, G., 2019. Introduction: the significance of radiobiology and radiotherapy for cancer treatment. In: Joiner, M.C., Kogel, A.V.D. (Eds.), Basic Clinical Radiobiology, 5th ed. Taylor & Francis Group, LLC.
Jones, C., Crosby, T., 2021. Considerations for Treatment of Oesophagogastric Cancers Within the United Kingdom During the COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/upper-gi-cancer-treatment-covid19.pdf.
Jones, C.M., Spencer, K., Hitchen, C., Pelly, T., Wood, B., Hatfield, P., et al., 2019. Hypofractionated radiotherapy in oesophageal cancer for patients unfit for systemic therapy: a retrospective single-centre analysis. Clin. Oncol. (R. Coll. Radiol.) 31 (June), 356–364.
Jones, C.M., Hawkins, M., Mukherjee, S., Radhakrishna, G., Crosby, T., 2020a. Considerations for the treatment of oesophageal cancer with radiotherapy during the COVID-19 pandemic. Clin. Oncol. (R. Coll. Radiol.) 32 (June), 354–357.
Jones, C.M., Radhakrishna, G., Aitken, K., Bridgewater, J., Corrie, P., Eatock, M., et al., 2020b. Considerations for the treatment of pancreatic cancer during the COVID-19 pandemic: the UK consensus position. Br. J. Cancer 123 (September), 709–713.
Joseph, K., Warkentin, H., Ghosh, S., Polkosnik, L.A., Powell, K., Brennan, M., et al., 2017. Cardiac-sparing radiation therapy using positioning breast shell for patients with left-sided breast cancer who are ineligible for breath-hold techniques. Adv. Radiat. Oncol. 2 (October-December), 532–539.
Kabarriti, R., Brodin, N.P., Maron, M.I., Tomé, W.A., Halmos, B., Guha, C., et al., 2020. Extent of prior lung irradiation and mortality in COVID-19 patients with a cancer history. Adv. Radiat. Oncol.
Kang, J.J., Wong, R.J., Sherman, E.J., Rybkin, A., McBride, S.M., Riaz, N., et al., 2020. The 3 Bs of cancer care amid the COVID-19 pandemic crisis: "Be safe, be smart, be kind"-A multidisciplinary approach increasing the use of radiation and embracing telemedicine for head and neck cancer. Cancer 126 (September), 4092–4104.
Kidane, B., Spicer, J., Kim, J.O., Fiset, P.O., Abdulkarim, B., Malthaner, R., et al., 2020. SABR-BRIDGE: stereotactic ablative radiotherapy before resection to avoid delay for early-stage lung cancer or oligomets during the COVID-19 pandemic. Front. Oncol. 10, p. 580189.
Koch, C.A., Lee, C., Liu, Z.A., Liu, F.F., Fyles, A., Han, K., et al., 2020. Rapid adaptation of breast radiotherapy utilization during the COVID-19 pandemic at a large academic Cancer Centre in Canada. Adv. Radiat. Oncol.
Kochbati, L., Vanderpuye, V., Moujahed, R., Rejeb, M.B., Naimi, Z., Olasinde, T., 2020. Cancer care and COVID-19: tailoring recommendations for the African radiation oncology context. Ecancermedicalscience 14, 1144.
Kokorovic, A., So, A.I., Hotte, S.J., Black, P.C., Danielson, B., Emmenegger, U., et al., 2020. A Canadian framework for managing prostate cancer during the COVID-19 pandemic: recommendations from the Canadian Urologic Oncology Group and the Canadian Urological Association. Can. Urol. Assoc. J. 14 (June), 163–168.
Kuderer, N.M., Choueiri, T.K., Shah, D.P., Shyr, Y., Rubinstein, S.M., Rivera, D.R., et al., 2020. Clinical impact of COVID-19 on patients with cancer (CCC19): a cohort study. Lancet (May).
Kumar, D., Dey, T., 2020. Recapitulating intracavitary brachytherapy in cervical cancer patients during the COVID-19 pandemic: a viewpoint. Future Oncol. 16 (October), 2143–2146.
Kumar, S., Chmura, S., Robinson, C., Lin, S.H., Gadgeel, S.M., Donington, J., et al., 2020. Alternative multidisciplinary management options for locally advanced NSCLC during the coronavirus disease 2019 global pandemic. J. Thorac. Oncol. 28 (April).
Kwek, J.W., Chan, J.J., Kanesvaran, R., Wang, M.L.C., Neo, P.S.H., Chia, C.S., et al., 2021. Early outcomes of a national Cancer center's strategy against COVID-19 executed through a disease outbreak response taskforce. JCO oncology practice (January) p. OP2000535.
Łacko, A., Maciejczyk, A., Kasprzak, P., Dupla, D., Senkus, E., Wysocki, W., et al., 2020. Proposals for the modification of diagnostics and combination treatment of breast cancer during the COVID-19 pandemic. Nowotw. J. Oncol. 70, 77–84.
Lancia, A., Bonzano, E., Bottero, M., Camici, M., Catellani, F., Ingrosso, G., 2020. Radiotherapy in the era of COVID-19. Expert Rev. Anticancer Ther. (June).
Larrea, L., Lopez, E., Antonini, P., Gonzalez, V., Berenguer, M.A., Banos, M.C., et al., 2020. COVID-19: hypofractionation in the Radiation Oncology Department during the' state of alarm': first 100 patients in a private hospital in Spain. Ecancermedicalscience 14, p. 1052.
Lee, L.Y.W., Cazier, J.B., Starkey, T., Turnbull, C.D., U.K.C.C.M.P. Team, Kerr, R., et al., 2020a. COVID-19 mortality in patients with cancer on chemotherapy or other anticancer treatments: a prospective cohort study. Lancet (May).
Lee, S.J., Kim, T., Kim, M., Suh, D.H., Park, J.Y., Lim, M.C., et al., 2020b. Recommendations for gynecologic cancer care during the COVID-19 pandemic. J. Gynecol. Oncol. 31 (July), p. e69.
Lewis, S., Talapatra, K., 2020. Radiotherapy management of rectal cancer in the backdrop of the COVID pandemic. Cancer Rep (Hoboken) (December), p. e1320.
Liao, Z., Rivin del Campo, E., Salem, A., Pang, Q., Liu, H., Guerra, J.Ls.L., 2020. Optimizing lung cancer radiation treatment worldwide in COVID-19 outbreak. Lung Cancer.
Ling, D.C., Vargo, J.A., Beriwal, S., 2020. Breast, Prostate, and Rectal Cancer: Should 5-5-5 Be a New Standard of Care? Int. J. Radiat. Oncol. Biol. Phys. 108 (October), 390–393.
Lombe, D.C., Mwaba, C.K., Msadabwe, S.C., Banda, L., Mwale, M., Pupwe, G., et al., 2020. Zambia's National Cancer centre response to the COVID-19 pandemic-an opportunity for improved care. Ecancermedicalscience 14, p. 1051.
Luther, A., Agrawal, A., 2020. A practical approach to the management of breast cancer in the COVID-19 era and beyond. Ecancermedicalscience 14, 1059.
Machiels, M., Weytjens, R., Bauwens, W., Vingerhoed, W., Billiet, C., Huget, P., et al., 2020. Accelerated adaptation of ultrahypofractionated radiation therapy for breast Cancer at the time of the COVID-19 pandemic. Clin. Oncol. (R. Coll. Radiol.) (December).
Madan, A., Siglin, J., Khan, A., 2020. Comprehensive review of implications of COVID-19 on clinical outcomes of cancer patients and management of solid tumors during the pandemic. Cancer Med. 9 (December), 9205–9218.
Mahmoodzadeh, H., Hadjilooei, F., Omranipour, R., Esmati, E., Alipour, S., Shahi, F., 2020. Management policies of breast cancer surgery, chemotherapy and radiotherapy during COVID-19 outbreak in Iran. WCRJ 7, e1623.
Mandeville, H.C., 2021. Prioritisation of Paediatric and TYA Patients (with Paediatric-type Tumours) for Radiotherapy During the COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/paediatric-tya-patients-radiotherapy-covid19.pdf.
Manjandavida, F.P., Honavar, S.G., Kim, U., Singh, U., Menon, V., Das, S., et al., 2020. Ocular oncology practice guidelines during COVID-19 pandemic-An expert consensus. Indian J. Ophthalmol. 68 (July), 1281–1291.
Manoj Gowda, S., Kabeer, K.K., Jafferbhoy, S., Marla, S., Soumian, S., Misra, V., et al., 2020. Breast cancer management guidelines during COVID-19 pandemic. Indian J. Surg. (July), 1–8.
Marcus, S., Mahajan, R., 2020. The impact of COVID-19 on radiation oncology and cancer care: a perspective from the Cancer belt region of India. Asian J. Oncol.
Marshall, J.L., Yarden, R.I., Weinberg, B.A., 2020. Colorectal cancer care in the age of coronavirus: strategies to reduce risk and maintain benefit. Colorectal Cancer.
Martell, K., McGeachy, P., Quon, H., Quirk, S., Roumeliotis, M., Husain, S., et al., 2020. Rapid implementation of extreme hypofractionation protocols in prostate cancer

using RapidPlan(R) in response to COVID-19. Radiother. Oncol. 151 (October), 296–297.
Martin, M., Guerrero-Zotano, A., Montero, A., Jara, C., Filipovich, E., Rojo, F., et al., 2020. GEICAM guidelines for the management of patients with breast cancer during the COVID-19 pandemic in Spain. Oncologist 25 (September), e1339–e1345.
Meattini, I., Franco, P., Belgioia, L., Boldrini, L., Botticella, A., De Santis, M.C., et al., 2020. Radiation therapy during the coronavirus disease 2019 (covid-19) pandemic in Italy: a view of the nation's young oncologists. ESMO Open 5 (April).
Mendez, L.C., Raziee, H., Davidson, M., Velker, V., D'Souza, D., Barnes, E., et al., 2020. Should we embrace hypofractionated radiotherapy for cervical cancer? A technical note on management during the COVID-19 pandemic. Radiother. Oncol. 148 (May), 270–273.
Miriyala, R., Mahantshetty, U., 2020. Brachytherapy in cervical cancer radiotherapy during COVID-19 pandemic crisis: problems and prospects. J. Contemp. Brachytherapy 12 (June), 290–293.
Mishra, K.K., Afshar, A., Thariat, J., Shih, H.A., Scholey, J.E., Daftari, I.K., et al., 2020. Practice considerations for proton beam radiotherapy of uveal melanoma during the COVID-19 pandemic: PTCOG Ocular experience. Adv. Radiat. Oncol. (April).
Mohammadi, Reza, et al., 2019. Evaluation of deformable image registration algorithm for determination of accumulated dose for brachytherapy of cervical cancer patients. J. Contemp. Brachytherapy. https://doi.org/10.5114/jcb.2019.8876.
Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., P. Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J. Clin. Epidemiol. 62 (October), 1006–1012.
Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., et al., 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst. Rev. 4 (January), 1.
Mohindra, P., Beriwal, S., Kamrava, M., 2020. Proposed brachytherapy recommendations (practical implementation, indications, and dose fractionation) during COVID-19 pandemic. Brachytherapy (May).
Montesi, Giampaolo, et al., 2020a. Radiotherapy during COVID-19 pandemic. How to create a No fly zone: a Northern Italy experience. Radiol. Med. 125, 600–603.
Montesi, G., Di Biase, S., Chierchini, S., Pavanato, G., Virdis, G.E., Contato, E., et al., 2020b. Radiotherapy during COVID-19 pandemic. How to create a No fly zone: a Northern Italy experience. Radiol. Med. 125 (June), 600–603.
Muirhead, R., Jacobs, C., Weaver, A., Mukerjee, S., Owens, R., 2021. Lower GI Response to the COVID-19 Outbreak [Online]. Available: https://www.rcr.ac.uk/sites/default/files/lower-gi-cancer-treatment-covid19.pdf.
Mukherjee, S., Jones, C., 2021. Considerations for Treatment of Pancreatic Cancer within the United Kingdom During the COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/pancreatic-cancer-treatment-covid19.pdf.
Mummudi, N., Tibdewal, A., Gupta, T., Patil, V., Prabhash, K., Agarwal, J.P., 2020. Tackling brain metastases from lung cancer during the COVID-19 pandemic. Cancer Rep (Hoboken) (September), p. e1276.
Murakami, N., Nakamura, S., Kashihara, T., Inaba, K., Kaneda, T., Takahashi, K., et al., 2020. Increased number of prostate cancer patients selecting high dose-rate interstitial brachytherapy during the COVID-19 pandemic. Radiother. Oncol. 154 (November), 274–275.
Nahm, S.H., Rembielak, A., Peach, H., Lorigan, P.C., Contributing, C., 2021. Consensus guidelines for the management of melanoma during the COVID-19 pandemic: surgery, systemic anti-cancer therapy, radiotherapy and follow-up. Clin. Oncol. (R. Coll. Radiol.) 33 (January), e54–e57.
Neuro-oncology Treatment Guidance during COVID-19 Pandemic [Online], 2021. Available: https://www.rcr.ac.uk/sites/default/files/neuro-oncology-treatment-covid-19.pdf.
Ng, C.W.Q., Tseng, M., Lim, J.S.J., Chan, C.W., 2020a. Maintaining breast cancer care in the face of COVID-19. Br. J. Surg. 107 (September), 1245–1249.
Ng, S.S.W., Ning, M.S., Lee, P., McMahon, R.A., Siva, S., Chuong, M.D., 2020b. Single-fraction stereotactic body radiation therapy: a paradigm during the coronavirus disease 2019 (COVID-19) pandemic and beyond? Adv. Radiat. Oncol. 5 (July-August), 761–7612773.
Noticewala, S.S., Ludmir, E.B., Bishop, A.J., Chung, C., Ghia, A.J., Grosshans, D., et al., 2020a. Radiation for glioblastoma in the era of COVID-19: patient selection and hypofractionation to maximize benefit and minimize risk. Adv. Radiat. Oncol.
Noticewala, S.S., Ludmir, E.B., Bishop, A.J., Chung, C., Ghia, A.J., Grosshans, D., et al., 2020b. Radiation for glioblastoma in the era of coronavirus disease 2019 (COVID-19): patient selection and hypofractionation to maximize benefit and minimize risk. Adv. Radiat. Oncol. 5 (July-August), 743–745.
Novel Corona Virus Update [Online], 2021. Available: https://www.who.int/docs/default-source/maldives/novel-corona-virus-update-mav-30jan.pdf?sfvrsn=a10dfb7b_2.
O'Cathail, S.M., Gilbert, D.C., Sebag-Montefiore, D., Muirhead, R., 2020. Challenges and consequences of COVID-19 in the management of anorectal cancer: coming together through social distancing. Clin. Oncol. (R. Coll. Radiol.) 32 (July), 413–416.
Obek, C., Doganca, T., Argun, O.B., Kural, A.R., 2020. Management of prostate cancer patients during COVID-19 pandemic. Prostate Cancer Prostatic Dis. 23 (September), 398–406.
Oertel, M., Elsayad, K., Engenhart-Cabillic, R., Reinartz, G., Baues, C., Schmidberger, H., et al., 2020. Radiation treatment of hemato-oncological patients in times of the COVID-19 pandemic : expert recommendations from the radiation oncology panels of the German Hodgkin Study Group and the German Lymphoma Alliance. Strahlenther. Onkol. 196 (December), 1096–1102.
Omeroglu Simsek, G., 2020. Lung cancer management in COVID-19 pandemic. Turk. Thorac J. 21 (September), 340–344.
Orazem, M., Ratosa, I., 2020. COVID-19 pandemic as an opportunity for the radiotherapy department. Clin. Oncol. (R. Coll. Radiol.) (May).
Pannullo, S.C., Chidambaram, S., Brandmaier, A., Knisely, J., Adler, J.R., 2020. Clinical considerations in neurosurgical radiosurgery in the time of COVID-19. Cureus 12 (April), p. e7671.
Parashar, B., Chen, W.C., Herman, J.M., Potters, L., 2020. Disease site-specific guidelines for curative radiation treatment during 'Limited Surgery' and 'Hospital Avoidance': a radiation oncology perspective from the epicenter of COVID-19 pandemic. Cureus 12 (May), p. e8190.
Pardoa, R., Algarab, M., Montero-Fernándezc, M.A., Sanzb, X., Vernetd, M., Rodríguezb, N., et al., 2020. Diagnosis and locoregional treatment of patients with breast cancer during the COVID-19 pandemic. Revista de Senología y Patología Mamaria 3, 61–67.
Passaro, A., Addeo, A., Von Garnier, C., Blackhall, F., Planchard, D., Felip, E., et al., 2020. ESMO management and treatment adapted recommendations in the COVID-19 era: lung cancer. ESMO Open 5 (June).
Patrick, H.M., Hijal, T., Souhami, L., Freeman, C., Parker, W., Joly, L., et al., 2020. A canadian response to the coronavirus disease 2019 (COVID-19) pandemic: is there a silver lining for radiation oncology patients? Adv. Radiat. Oncol. 5 (July-August), 774–776.
Perini, Guilherme Fleury, 2020. How to manage lymphoid malignancies during novel 2019 coronavirus (CoVid-19) outbreak: a Brazilian task force recommendation. Hematol, Transfus, Cell Ther 42 (2), 103–110.
Poortmans, P.M., Guarneri, V., Cardoso, M.J., 2020. Cancer and COVID-19: what do we really know? Lancet (May).
Portaluri, M.S., Bambace, F., Tramacere, F., Errico, A., Carbone, S., Portaluri, T., 2020. Staff and patients' protection in radiation oncology departments during COVID-19 pandemic. Adv. Radiat. Oncol.
Radiation Protection in the Design of Radiotherapy Facilities, 2006. I. A. E. A. VIENNA Safety Reports Series No.47.
Raghavan, D., Tan, A.R., Story, E.S., Burgess, E.F., Musselwhite, L., Kim, E.S., et al., 2020. Management changes for patients with endocrine-related cancers in the COVID-19 pandemic. Endocr. Relat. Cancer 27 (September), R357–R374.
Ramirez, P.T., 2020. COVID-19 global pandemic: options for management of gynecologic cancers. Int. J. Gynecol. Cancer 1–3.
Rathod, S., Dubey, A., Bashir, B., Sivananthan, G., Leylek, A., Chowdhury, A., et al., 2020. Bracing for impact with new 4R's in the COVID-19 pandemic - A provincial thoracic radiation oncology consensus. Radiother. Oncol. 149 (April), 124–127.
Rembielak, A., Sykes, A.J., Fife, K., Challapalli, A., Nobes, J.P., 2020. Radiotherapy and systemic treatment for non-melanoma skin cancer in the COVID-19 pandemic. Clin. Oncol. (R. Coll. Radiol.) 32 (July), 417–419.
Rembielak, A., Sykes, A., Fife, K., Challapalli, A., Nobes, J., Lawton, P., 2021. Radiotherapy for Melanoma in COVID-19 Pandemic [Online]. Available: https://www.rcr.ac.uk/sites/default/files/radiotherapy-melanoma-covid19.pdf.
Riechelmann, R.P., Peixoto, R.D., Fernandes, G.D.S., Weschenfelder, R.F., Prolla, G., Filho, D.R., et al., 2020. Evidence-based recommendations for gastrointestinal cancers during the COVID-19 pandemic by the Brazilian Gastrointestinal Tumours Group. Ecancermedicalscience 14, p. 1048.
Romesser, P.B., Wu, A.J., Cercek, A., Smith, J.J., Weiser, M., Saltz, L., et al., 2020. Management of locally advanced rectal cancer during the COVID-19 pandemic: a necessary paradigm change at Memorial Sloan Kettering Cancer Center. Adv. Radiat. Oncol. (April).
Ronchi, S., Vischioni, B., Bonora, M., Barcellini, A., Locati, L.D., Castelnuovo, P., et al., 2020. Managing locally advanced adenoid cystic carcinoma of the head and neck during the COVID-19 pandemic crisis: is this the right time for particle therapy? Oral Oncol. 106 (July), 104803.
Roques, T., Prestwich, R., 2021. Head and Neck Cancer and COVID-19 [Online]. Available: https://www.rcr.ac.uk/sites/default/files/head-and-neck-cancer-treatment-covid19.pdf.
Saber Soltani, S., Zakeri, A.M., Karimi, M.R., Akhavan Rezayat, S., Zomorodi Anbaji, F., Tabibzadeh, A.R., et al., 2020. A systematic literature review of current therapeutic approaches for COVID-19 patients. J. Pharm. Res. Int. 32, 13–25.
Salari, A., Jalaeefar, A., Shirkhoda, M., 2020. What is the best treatment option for head and neck cancers in COVID-19 pandemic? A rapid review. Am. J. Otolaryngol. 41 (November-December), p. 102738.
Samiee, S., Hadjilooei, F., Alamolhoda, M., Akhlaghpoor, S., 2020. New policy and regulation for a Radiology-Oncology Center at the time of Covid-19 outbreak in Tehran-Iran. Adv. Radiat. Oncol. (April).
Sarkis, J., Samaha, R., Kattan, J., Sarkis, P., 2020. Bladder cancer during the COVID-19 pandemic: the calm before the storm? Future Sci. OA vol. 6 (August), p. FSO615.
Seddon, B., Zaidi, S., 2021. Updated neoadjuvant/adjuvant/definitive Radiotherapy Guidelines for the Management of Newly Diagnosed Soft-tissue and Bone Sarcoma [Online]. Available: https://www.rcr.ac.uk/sites/default/files/sarcoma-treatment-covid19.pdf.
Sepulcri, M., Paronetto, C., El Khouzai, B., Novo, A., Aldegheri, V., Scaggion, A., et al., 2020. Effectiveness of CBCT imaging during radiotherapy for the detection of initial COVID-19 lung disease. Adv. Radiat. Oncol. (May).
Shaverdian, N., Shepherd, A., Rimner, A., Wu, A.J., Simone 2nd, C.B., Gelblum, D.Y., et al., 2020. Need for caution in the diagnosis of radiation pneumonitis in the COVID-19 pandemic. Adv. Radiat. Oncol. (May).
Siavashpour, Zahra, et al., 2016. A comparison of organs at risk doses in GYN intracavitary brachytherapy for different tandem lengths and bladder volumes. J. Appl. Clin. Med. Phys. 17 (3) https://doi.org/10.1120/jacmp.v17i3.5584.
Siavashpour, Z., Taghizadeh-Hesary, F., Rakhsha, A., 2020. Recommendations on management of locally advanced rectal cancer during the COVID-19 pandemic: an Iranian consensus. J. Gastrointest. Cancer 51 (September), 800–804.

Simcock, R., Thomas, T.V., Estes, C., Filippi, A.R., Katz, M.A., Pereira, I.J., et al., 2020. COVID-19: global radiation oncology's targeted response for pandemic preparedness. Clin. Transl. Radiat. Oncol. 22 (May), 55–68.
Singh, A.P., Berman, A.T., Marmarelis, M.E., Haas, A.R., Feigenberg, S.J., Braun, J., et al., 2020. Management of lung cancer during the COVID-19 pandemic. JCO Oncol. Pract. 16 (September), 579–586.
Skowron, K.B., Hurst, R.D., Umanskiy, K., Hyman, N.H., Shogan, B.D., 2020. Caring for patients with rectal cancer during the COVID-19 pandemic. J. Gastrointest. Surg. (May).
Slotman, B.J., Lievens, Y., Poortmans, P., Cremades, V., Eichler, T., Wakefield, D.V., et al., 2020. Effect of COVID-19 pandemic on practice in European radiation oncology centers. Radiother. Oncol. (June).
Song, A., Manukian, G., Taylor, A., Anne, P.R., Simone, N.L., 2020. Concerns for activated breathing control (ABC) with breast cancer in the era of COVID-19: maximizing infection control while minimizing heart dose. Adv. Radiat. Oncol. (April).
Spalek, M.J., Rutkowski, P., 2020. Coronavirus disease (COVID-19) outbreak: hypofractionated radiotherapy in Soft tissue sarcomas as a valuable option in the environment of limited medical resources and demands for increased protection of patients. Front. Oncol. 10, p. 993.
Starling, M.T.M., Silva, A., Pereira, A.P.A., Ferreira Neto, D.R., Restini, F.C.F., Brito, L.H., et al., 1992. Recommendations for radiotherapy during the novel coronavirus pandemic. Rev. Assoc. Med. Bras. 66 (March), 359–365, 2020.
Stepanović, A., Nikitović, M., 2020. Radiotherapy and COVID-19 pandemic-a review of the current recommendations. Srpski arhiv za celokupno lekarstvo 148, 644–647.
Sullivan, M., Bouffet, E., Rodriguez-Galindo, C., Luna-Fineman, S., Khan, M.S., Kearns, P., et al., 2020. The COVID-19 pandemic: a rapid global response for children with cancer from SIOP, COG, SIOP-E, SIOP-PODC, IPSO, PROS, CCI, and St Jude Global. Pediatr. Blood Cancer 67 (July), p. e28409.
Svajdova, M., Sicak, M., Dubinsky, P., Slavik, M., Slampa, P., Kazda, T., 2020. Recurrent nasopharyngeal cancer: critical review of local treatment options including recommendations during the COVID-19 pandemic. Cancers (Basel) 12 (November).
Sylvia, M., Ng, S.W., Ning, Matthew S., Lee, Percy, McMahon, Ryan A., Siva, Shankar, Chuong, Michael D., 2020. Single-Fraction Stereotactic Body Radiotherapy: A Paradigm During the COVID-19 Pandemic and Beyond? Adv. Radiat. Oncol.
Tagliaferri, L., Di Stefani, A., Schinzari, G., Fionda, B., Rossi, E., Del Regno, L., et al., 2020. Skin cancer triage and management during COVID-19 pandemic. J. Eur. Acad. Dermatol. Venereol. 34 (June), 1136–1139.
Talapatra, K., Majumder, D., Laskar, S., 2020. COVID-19: an advisory for a radiation oncology department pertinent to the multidisciplinary team. Indian J. Med. Paediatr. Oncol. 41 (September), 629–633, 2020.
Tan, B.F., Tuan, J.K.L., Yap, S.P., Ho, S.Z., Wang, M.L.C., 2020. Managing the COVID-19 pandemic as a national radiation oncology centre in Singapore. Clin. Oncol. (R. Coll. Radiol.) 32 (July), e155–e159.
Tanderup, K., Fokdal, L.U., Sturdza, A., Haie-Meder, C., Mazeron, R., van Limbergen, E., et al., 2016. Effect of tumor dose, volume and overall treatment time on local control after radiochemotherapy including MRI guided brachytherapy of locally advanced cervical cancer. Radiother. Oncol. 120 (September), 441–446.
Tchelebi, L.T., Haustermans, K., Scorsetti, M., Hosni, A., Huguet, F., Hawkins, M.A., et al., 2020. Recommendations for the use of radiation therapy in managing patients with gastrointestinal malignancies in the era of COVID-19. Radiother. Oncol. 148 (April), 194–200.
Thomson, David J., et al., 2020a. Practice recommendations for risk-adapted head and neck cancer radiotherapy during the COVID-19 pandemic: an ASTRO-ESTRO consensus statement. Int. J. Radiat. Oncol. Biol. Phys.
Thomson, D.J., Palma, D., Guckenberger, M., Balermpas, P., Beitler, J.J., Blanchard, P., et al., 2020b. Practice recommendations for risk-adapted head and neck Cancer radiation therapy during the COVID-19 pandemic: an ASTRO-ESTRO consensus statement. Int. J. Radiat. Oncol. Biol. Phys. 107 (July), 618–627.
Thureau, S., Faivre, J.C., Assaker, R., Biver, E., Confavreux, C.B., Debiais, F., et al., 2020. Adapting palliative radiation therapy for bone metastases during the Covid-19 pandemic: GEMO position paper. J. Bone Oncol. (April), 100291.
Upadhyay, R., Shankar, A., 2020. Implementing continued radiation therapy for cancer management in low resource countries during and after the COVID-19 crisis. Expert Rev. Anticancer Ther. (December), 1–5.
Uwins, C., Bhandoria, G.P., Shylasree, T.S., Butler-Manuel, S., Ellis, P., Chatterjee, J., et al., 2020. COVID-19 and gynecological cancer: a review of the published guidelines. Int. J. Gynecol. Cancer 30 (September), 1424–1433.
Uzzo, R.G., Kutikov, A., Geynisman, D.M., 2021. Coronavirus Disease 2019 (COVID-19): Cancer care During the Pandemic [Online]. Available: https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19-cancer-care-during-the-pandemic.
van der Linden, Y.M., Westhoff, P.G., Stellato, R.K., van Baardwijk, A., de Vries, K., Ong, F., et al., 2020. Dexamethasone for the prevention of a pain flare after palliative radiotherapy for painful bone metastases: the multicenter double-blind placebo-controlled three-armed randomized Dutch DEXA study. Int. J. Radiat. Oncol. Biol. Phys. (May).
Veness, M.J., 2020. Hypofractionated radiotherapy in patients with non-melanoma skin cancer in the post COVID-19 era: time to reconsider its role for most patients. J. Med. Imaging Radiat. Oncol. (May).
Venkatesulu, B.P., Chandrasekar, V.T., Girdhar, P., Advani, P., Sharma, A., Elumalai, T., et al., 2020. A systematic review and meta-analysis of cancer patients affected by a novel coronavirus. medRxiv (May).
Vordermark, D., 2020a. Shift in indications for radiotherapy during the COVID-19 pandemic? A review of organ-specific cancer management recommendations from multidisciplinary and surgical expert groups. Radiat. Oncol. 15, 140.
Vordermark, D., 2020b. Shift in indications for radiotherapy during the COVID-19 pandemic? A review of organ-specific cancer management recommendations from multidisciplinary and surgical expert groups. Radiat. Oncol. 15 (June), p. 140.
Vreugdenhil, M., Fong, C., Sanghera, P., Hartley, A., Dunn, J., Mehanna, H., 2020. Hypofractionated chemoradiation for head and cancer: Data from the PET NECK trial. Oral Oncol. 113 (December), 105112.
Wallis, C.J.D., Novara, G., Marandino, L., Bex, A., Kamat, A.M., Karnes, R.J., et al., 2020. Risks from deferring treatment for genitourinary cancers: a collaborative review to aid triage and management during the COVID-19 pandemic. Eur. Urol. (May).
Wang, Y., Zhang, S., Wei, L., Lin, Z., Wang, X., Wang, J., et al., 2020. Recommendations on management of gynecological malignancies during the COVID-19 pandemic: perspectives from Chinese gynecological oncologists. J. Gynecol. Oncol. 31 (July), p. e68.
Wei, W., Zheng, D., Lei, Y., Wu, S., Verma, V., Liu, Y., et al., 2020. Radiotherapy workflow and protection procedures during the Coronavirus Disease 2019 (COVID-19) outbreak: experience of the Hubei Cancer hospital in Wuhan, China. Radiother. Oncol. 148 (March), 203–210.
Weisel, K.C., Morgner-Miehlke, A., Petersen, C., Fiedler, W., Block, A., Schafhausen, P., et al., 2020. Implications of SARS-CoV-2 infection and COVID-19 crisis on clinical Cancer care: report of the university cancer center hamburg. Oncol. Res. Treat. 43, 307–313.
Weller, M., Preusser, M., 2020. How we treat patients with brain tumour during the COVID-19 pandemic. ESMO Open 4 (May).
Williams, V.M., Kahn, J.M., Harkenrider, M.M., Chino, J., Chen, J., Fang, L.C., et al., 2020. COVID-19 impact on timing of brachytherapy treatment and strategies for risk mitigation. Brachytherapy (April).
Wright, J.L., Alcorn, S., McNutt, T., Han-Oh, S., Gonzalez, R., Lin, L., et al., 2020. An integrated program in a pandemic: johns hopkins radiation oncology department. Adv. Radiat. Oncol. (April).
Wu, A.J., Rimner, A., Shepherd, A.F., Gelblum, D.Y., Shaverdian, N., Yorke, E., et al., 2020. Thoracic radiation therapy during COVID-19: provisional guidelines from a comprehensive cancer center within a pandemic epicenter. Adv. Radiat. Oncol. (April).
Yahalom, J., Dabaja, B.S., Ricardi, U., Ng, A., Mikhaeel, N.G., Vogelius, I.R., et al., 2020. ILROG emergency guidelines for radiation therapy of hematological malignancies during the COVID-19 pandemic. Blood 135 (May), 1829–1832.
Yanagihara, T.K., Holland, R.E., Chera, B., 2020. Practical Challenges of mask-to-mask encounters with patients with head and neck cancers amid the coronavirus disease 2019 pandemic. Adv. Radiat. Oncol.
Yerramilli, D., Xu, A.J., Gillespie, E.F., Shepherd, A.F., Beal, K., Gomez, D., et al., 2020a. Palliative radiation therapy for oncologic emergencies in the setting of COVID-19: approaches to balancing risks and benefits. Adv. Radiat. Oncol. 5 (July-August), 589–594.
Yerramilli, D., Xu, A.J., Gillespie, E.F., Shepherd, A.F., Beal, K., Gomez, D., et al., 2020b. Palliative radiotherapy for oncologic emergencies in the setting of COVID-19: approaches to balancing risks and benefits. Adv. Radiat. Oncol. (April).
Youssef, I., Donahue, B., Flyer, M., Thompson, S., Huang, A., Gallant, F., 2020. Covert Covid-19: CBCT lung changes in an asymptomatic patient receiving radiotherapy. Adv. Radiat. Oncol.
Zaniboni, A., Ghidini, M., Grossi, F., Indini, A., Trevisan, F., Iaculli, A., et al., 2020. A review of clinical practice guidelines and treatment recommendations for Cancer care in the COVID-19 pandemic. Cancers (Basel) 12 (August).
Zaorsky, N.G., Yu, J.B., McBride, S.M., Dess, R.T., Jackson, W.C., Mahal, B.A., et al., 2020. Prostate Cancer radiotherapy recommendations in response to COVID-19. Adv. Radiat. Oncol. (April).
Zhang, H., Han, H., He, T., Labbe, K.E., Hernandez, A.V., Chen, H., et al., 2020. Clinical characteristics and outcomes of COVID-19-Infected Cancer patients: a systematic review and meta-analysis. J. Natl. Cancer Inst. (November).
Zhao, W., Qiu, H., Gong, Y., Han, C., Ruan, S., Wang, C., et al., 2020. Clinical considerations for the management of cancer patients in the mitigation stage of the COVID-19 pandemic. Am. J. Cancer Res. 10, 2282–2292.

Zahra Siavashpour: Ph.D. of Medical Radiation Engineering, Shahid Beheshti University, Tehran, Iran. Assistant professor of Shahid Beheshti University of Medical Sciences, Tehran, Iran, since 2018-present. Ten years of experience as a medical physicist in radiotherapy and brachytherapy departments and five years of health physicist officer experience. Three years of experience in eye plaque brachytherapy. Have been elected and member of the National Elite Foundation of Iran, 2018-Present. ORCID ID: https://orcid.org/0000-000 3-4 061-099X

Neda Goharpey: Master of Science, medical physics, Tarbiat Modares University, Tehran, Iran. The medical physicist of the radiation oncology department of Shohada-e Tajrish hospital, from September 2016 until the present. Responsible for developing and maintaining quality assurance (QA) and quality control (QC) programs of radiation therapy modalities; also preparing and validating computerized treatment plans (both 3D CRT and advanced techniques) and calculations of patient dose.

Mosayyeb Mobasheri: Ph.D. of medical physics, Tarbiat Modares University, Tehran, Iran.