Review

The Effects of COVID-19 on Cancer Care Provision: A Systematic Review

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Abstract

This systematic review aims to gather primary data from cancer institutions that have implemented changes to cancer service provision amid the COVID-19 outbreak to inform future intervention and health care facility response strategies. A comprehensive literature search was done on Global Health Medline and EMBASE using pertinent key words and MeSH terms relating to COVID-19 and Cancer service provision. A total of 72 articles were selected for inclusion in this systematic review. Following the narrative synthesis that was conducted of the literature, 6 core themes that encompassed common cancer service intervention adopted by institutions were identified: (1) Testing and Tracking, (2) Outreach and Communication, (3) Protection, (4) Social Distancing (5) Treatment Management, (6) Service Restructuring. Since cancer patients are a high-risk population amid the COVID-19 pandemic, these areas of targeted intervention can be used to inform necessary actions in institutions facing similar risks, based on previous learning from numerous cancer centers globally.

Keywords

COVID-19, SARS-CoV-2, cancer, service provision, care organization

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Introduction

In December 2019, COVID-19 / Coronavirus / SARS-CoV-2 emerged in Wuhan, China, and has subsequently infected over 53.7 million people and caused over 1.3 million deaths globally (as of 15 November 2020).[1] As these numbers are continually increasing, healthcare services worldwide have been subject to immense strain to cater to influx and demands of patients.[2] To combat this, service provision in healthcare institutions have subsequently been reorganized in order to cope with COVID-19 related challenges.[3]

The impacts of the COVID-19 outbreak have been particularly evident for cancer services, with many patients experiencing delays in cancer diagnosis and treatment.[4] For example, in the United Kingdom national cancer screening programs have been suspended and patients who are referred may be subject triage before being able to receive treatment.[5] Common stressors on healthcare facilities have been due to the shortage of intensive care beds, as well as the inability to protect healthcare staff due to shortages of personal protective equipment (PPE).[5]

To combat the disruptions, cancer care facilities have had to adopt drastic service configurations in order to maintain timely

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Table 1. Search Strategy.

Category	
COVID-19	"Coronavirus," OR "nCoV*," OR "2019-nCoV,"
AND	OR "COVID*" OR "SARS-CoV*"
Cancer	"Cancer" OR "carcinoma" OR "malignancy" OR
AND	"metastasis" OR "Neoplasm"
Service Provision	"Service" OR "service provision" OR "Care provision" OR "Care" OR "Care organisation" OR "Healthcare provision"

Table 2. Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Exposure: challenges to routine service provision due to COVID-19 pandemic	Published before Jan 2020
Outcome: Mitigating measures being undertaken	Does not contain primary Data
Date range: Papers from Jan 2020 to September 2020	Other Languages
In the English language	

and effective care.[3] These changes have been vital as cancer patients are at high risk of complications from viral infections and are likely to experience adverse outcomes. A Chinese cohort study reported that cancer patients with COVID-19 are at higher risk of severe events, including intensive care unit admission, invasive ventilation and death, compared to patients without cancer (39% vs 8%, $p = 0.0003$).[6] In light of this, the disproportionate vulnerability highlights the need for implementation of effective strategies that safeguard and protect oncology patients during this time.

In summary, the continual fluctuation of caseloads and the evolving nature of the pandemic require flexible and adaptive care to ensure the safety of patients and staff. As a result, there is a need to study and evaluate whether current adaptations to cancer care have been yielding consistent and positive outcomes for health systems worldwide. This systematic literature review aims to gather primary data from cancer institutions that have implemented changes to cancer service provision amid the COVID-19 outbreak to inform future intervention and health care facility response strategies.

Methods and Materials

Search Strategy

A comprehensive literature search was done on Medline, Global Health and EMBASE to identify articles relating to cancer service provision during the COVID-19 pandemic. This was done in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA). Grey literature was also included and obtained through snowballing. The search was deconstructed into 3 categories that comprised relevant keywords and MeSH headings relating to (1) COVID-19, (2) Cancer and (3) Service Provision (Table 1). All the relevant articles were identified and screened by 3 authors.

Inclusion and Exclusion Criteria:

The inclusion and exclusion criteria are outlined in Table 2. Studies were included if they contained primary data on cancer service provision amid the COVID-19 pandemic (Table 2).

Quality Assessment

A quality assessment for the included articles was carried out using the NIH quality assessment tool for the appropriate studies. No articles were excluded based on their quality score.

Data Extraction

All the relevant articles were screened and selected for inclusion by 3 authors and any disagreements were resolved through consensus and vote. Data extracted from the included articles were tabulated and then a narrative synthesis was undertaken to identify key themes in the literature.

Results

A total of 72 articles were selected for inclusion in this review following screening and duplicate removal (Figure 1). A narrative synthesis was conducted following the analysis of the data to identify recurrent and common themes of intervention that were frequently mentioned. Following this, we categorized the data into 6 themes of core cancer service interventions: (1) Testing and Tracking, (2) Outreach and Communication, (3) Protection, (4) Social Distancing, (5) Treatment Management, (6) Service Restructuring (Table 3). These themes encompass the comprehensive interventions adopted by various cancer departments/institutions during the pandemic. The characteristics of the included articles are summarized in Table 4 and have been explored in a narrative manner in the main text. A large proportion of the studies were conducted in China, Italy, Singapore, United Kingdom (UK) and the United States (US) and included various oncological sub-specialisms.

Discussion

The literature highlighted 6 common key areas for focused intervention that were adopted by many cancer institutions. A detailed summary of each theme is described below so that we can better apprehend how such measures enabled cancer care continuity, while also mitigating viral spread and protecting staff and patients.

(1) Testing and Tracking

Testing played a huge role in various studies, with many hospitals enabling patient screening for COVID-19 symptoms upon hospital entry or pre-operatively.[3,7-38] This involved recording body temperature, checking respiratory symptoms, and taking blood tests and nasal swabs.[3,10,11,22,33,34,36,39] If the

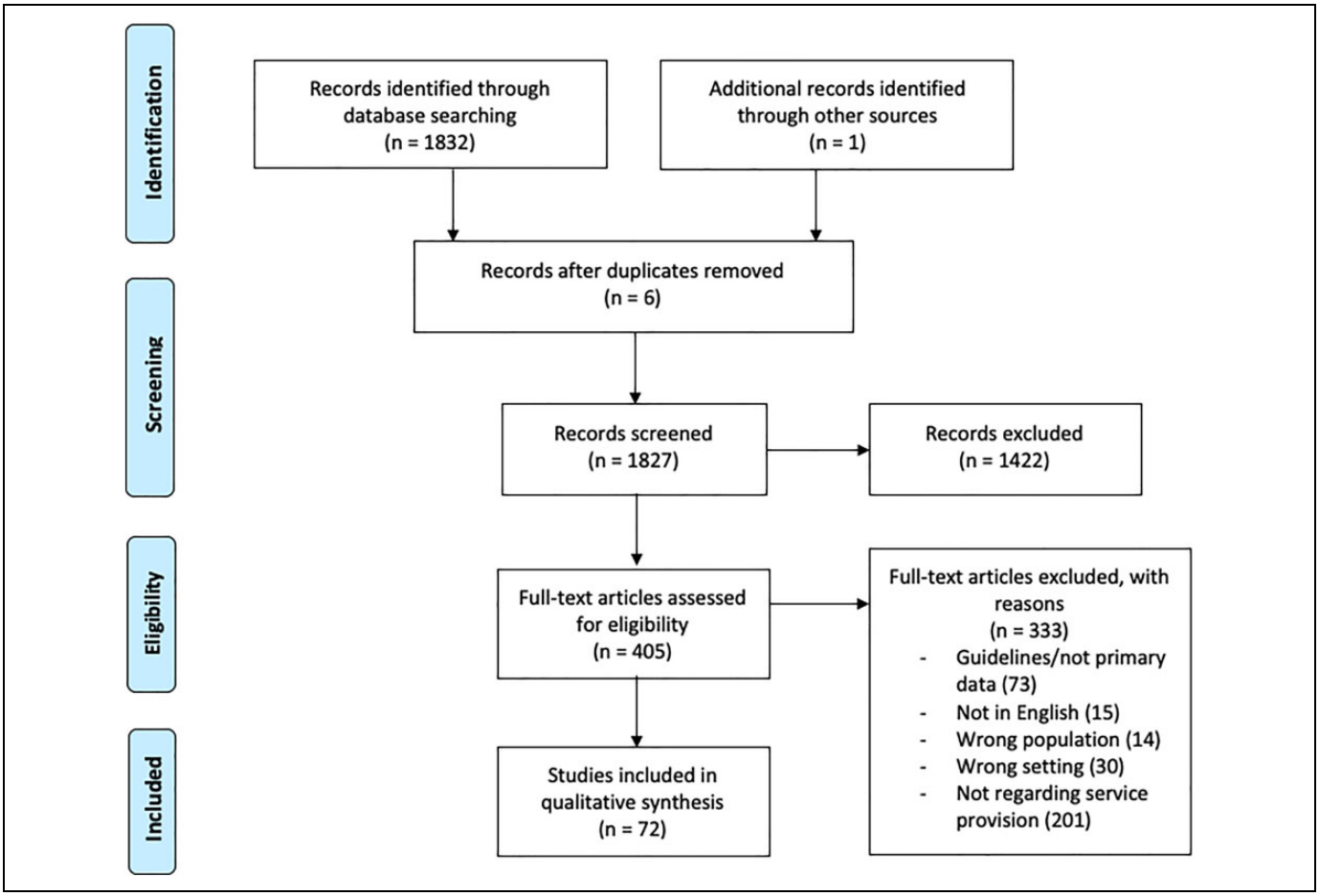

Figure 1. Prisma Flow Diagram.

tests results were positive, patients were either disallowed treatment, asked to isolate/quarantine or were directed to COVID-19 outpatient clinics/admitted in to dedicated COVID-19 wards.[33,36,40] These interventions helped to prevent the on-site transmission of the virus. In addition, Ngoi et al describes the use of 2 checkpoints within the hospital, where patients and their accompanying visitors had to fill out a health questionnaire and were screened via a thermal scanner for their body temperature (Singapore). This intervention was deemed effective, as results showed that within a 1-month period of adopting this screening method, only 1 person within the hospital was found to be COVID-19 positive out of 70 people tested.[41] As part of patient triaging pathway in some cancer centers, symptomatic patients would have to attend fever clinics before their appointments with their oncologists (UK and China).[21,42,43]

Staff testing was also mentioned in some articles, with Tan et al and Tey et al reporting that all staff temperature readings were taken twice daily to reduce healthcare worker-patient transmission and safeguard patients and staff.[7,10,23,42,44,45] A dedicated tracer team that monitored all patients under investigation allowed for active tracing of all clinical staff that were at potential exposure risk, through using a patient points-of-contact framework. This allowed for staff to be notified of infection risk immediately and enabled rapid instruction regarding the need for quarantine.[46]

In addition, contact tracing was highlighted as a tracking method to identify potentially infected patients worldwide.[34,42,43,45-47] Wang et al demonstrated that the use of documentation of all contact and travel histories was imperative for permitting visitors into the facility (China).[34] Similar contact tracing tactics were deployed in Korea which required mandatory quarantining of COVID-19 patients and any identified personnel who were in close contact with them.[47] A nation-wide program was implemented in China where health QR codes were issued to track case numbers in residential and high-risk areas. This large-scale surveillance system was informative for high-risk patients as they could make the decision to shield themselves if residing in a high-risk area.[43] The benefits of tracking were also evident in a study conducted by Ning et al who reported that active tracking reduced adverse effects that can occur from treatment delay and workforce incapacitation[46]

(2) Outreach and Communication

One of the most prominent strategies to ensure the maintenance of care continuity was regular communication between

Table 3. Articles Categorized by Theme.

Author	Themes					
	Tracking and Triage	Outreach and Communication	Protection	Social Distancing	Treatment Management	Service Restructuring
Agyapong et al[52]		✓				
Ardizzone et al[75]					✓	
Baabdullah et al[67]		✓				
Batt et al[76]					✓	
Blot et al[77]						✓
Brody et al[38]	✓				✓	
Butler et al[19]	✓	✓	✓	✓	✓	✓
Casella et al[11]	✓	✓	✓	✓	✓	✓
Chiang et al[14]	✓	✓	✓	✓	✓	✓
Cinelli et al[53]		✓				✓
Civantos et al[9]	✓				✓	
Civantos et al[49]		✓	✓		✓	
Collins et al[17]	✓	✓		✓		✓
Curigliano et al[55]		✓	✓		✓	
Czernin et al[36]	✓	✓	✓	✓	✓	
de Marinis et al[39]	✓	✓			✓	✓
Dharmarajan et al[51]		✓				
Elkaddoum et al[59]		✓		✓		✓
Elkin et al[31]	✓					
Flannigan et al[57]		✓				✓
Fosker[26]				✓	✓	
Frey et al[66]						✓
Giuliani et al[58]		✓				
Gupta et al[48]		✓	✓		✓	
Grenda et al[54]		✓				✓
Guven et al[12]	✓	✓		✓		✓
Harky et al[61]	✓	✓				✓
Indini et al[33]	✓	✓	✓	✓	✓	✓
Jiang et al[60]		✓				✓
Lee et al[15]	✓	✓	✓	✓		✓
Lee et al[27]	✓	✓				
Lee et al[47]				✓	✓	✓
Lobascio et al[56]		✓				✓
Lombe et al[68]	✓		✓	✓		
Mei et al[21]	✓	✓	✓	✓	✓	✓
Mendoza et al[23]	✓		✓	✓		
Millar et al[65]		✓				
Mirnezami et al[73]		✓			✓	
Morrison et al[69]			✓			✓
Moss et al[32]	✓					
Mulvey et al[62]		✓			✓	
Ngoi et al[41]	✓	✓	✓	✓	✓	✓
Ning et al[46]	✓	✓	✓	✓		✓
Onesti et al[24]	✓	✓	✓		✓	✓
Ong et al[72]						✓
Oualla et al[22]	✓	✓	✓	✓		✓
Patel et al[16]	✓	✓	✓	✓	✓	
Peeters et al[63]		✓				
Peng et al[43]	✓	✓	✓	✓	✓	
Poggio et al[74]					✓	
Porzio et al[29]	✓	✓				✓
Press et al[18]	✓	✓	✓	✓	✓	
Quarto et al[70]	✓		✓		✓	✓
Rathod et al[50]		✓			✓	
Rodler et al[45]	✓	✓	✓	✓	✓	✓

(continued)

Table 3. (continued)

Author	Themes					
	Tracking and Triage	Outreach and Communication	Protection	Social Distancing	Treatment Management	Service Restructuring
Silvestris et al[35]	✓	✓	✓	✓	✓	
Tagliamento et al[25]	✓				✓	
Tan et al[7]	✓	✓	✓	✓		✓
Tey et al[10]	✓		✓	✓	✓	
Valenza et al[37]	✓	✓	✓	✓		
Van de Haar et al[3]	✓	✓		✓	✓	✓
van der Lee et al[64]		✓				
Vanderpuye et al[40]	✓	✓		✓	✓	✓
Wahed et a[28]	✓		✓			✓
Wang et al[34]	✓	✓	✓	✓	✓	
Wakefield et al[20]	✓	✓	✓	✓		
Wei et al[71]			✓			
Weisel et al[8]	✓	✓	✓	✓	✓	
Wilkinson[42]	✓	✓		✓	✓	✓
Wilson[30]	✓	✓	✓		✓	✓
Wu et al[44]	✓	✓	✓	✓		
Yusuf[13]	✓	✓	✓		✓	✓

healthcare providers and patients. While use of telehealth and mobile phone technologies has grown in recent years, it has shown to be particularly useful amid the COVID-19 pandemic.

Many studies reported the use of telehealth through videoconferencing, telephone, email, mobile phone apps and text message as a means to monitor and counsel patients.[3,7-8,11-12, 15-19,20-22,24,29,30,33-37,39-41,43,45,46,48-65,78] This included screening, symptom checking and side effect monitoring and outpatient care.[8,22,29,39,45,52-54] These modalities of communication were significant in enabling better evaluation and follow-up of patients, as well as facilitating patient triaging and contact tracing. This was demonstrated in an Italian paper, where a "Double Triage Protocol" was put into place involving 2 separate telephone interviews for palliative care patients that require home care. The first interview assessed if COVID-19 symptoms were present in the patient, while the second assessed the severity of their symptoms in order to guide the frequency of home visits.[29] Additionally, de Marinis et al showed that telehealth can be utilized for clinical application and diagnostics, whereby telematic evaluation was utilized for CT scans.[39] The main disadvantage of telehealth for care provision, however, was reduced efficiency as it made appointments longer by an average of 10 minutes.[15] Lobascio et al and Peeters et al also highlighted the use of mobile phone apps to help monitor and manage patient treatment toxicity and nutritional status.[56,63]

In terms of patient acceptability, Van der Lee et al reported interesting patient feedback, with patients showing a preference for virtual consultation due to the ease of accessibility and increased convenience as it reduced the need to travel.[64] Conversely, patients also reported feeling psychologically distant with the doctor as there was reduced non-verbal communication and felt that there was less time for reflection following their call.[64,65,78] A Canadian cancer center tried to mitigate this through running a trial to provide patients with daily, self-subscribed supportive text messages for extra psychological support.[11] In light of this, healthcare providers must be astute of the risks posed on the weakened doctor-patient interactions which could have significant impacts on patients' quality of life,[66,67] Consequently, the psychological impacts of drastic transitioning to tele-oncology should not be overlooked, especially within oncology where adjunctive emotional and holistic care is crucial.

Other forms of patient outreach and education included the dissemination of educational materials through virtual means or via patient information leaflets.[18,44,55-57] In Canada, the Princess Margaret cancer center released core education tools. These tools aided cancer patients with low health literacy to find reliable cancer-related patient education materials and a website (pmcancerclasses.ca) was recommended for online cancer classes for patients and families.[58] These strategies may be an effective way to improve patient compliance with protective measures and inform them of potential risks.

Effective communication of COVID-19-related risks was emphasized in the literature prior to consenting patients for treatments.[19] In West Africa, patients were educated about the possible additional risks of chemotherapy during the pandemic, including the complications associated with contracting COVID-19 and the possibility of experiencing poorer treatment outcomes.[40] Similar practice has been adopted in the UK, where doctors have openly educated patients on COVID-19 related risks before and during surgical treatment.[19]

Videoconferencing was also frequently utilized between healthcare staff and multidisciplinary teams in order to streamline healthcare provision, continue staff training and maintain timely diagnosis and treatment.[7,11,17,19,30,33,35,36,40,41,45,49,51]

Table 4. Summary of Included Articles.

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Agyapong et al[52]	Report	Canada	1. Trailed providing self-subscribed supportive message to reduce anxiety and depression in cancer patients
Ardizzone et al[75]	Report	USA	1. Only cancer patients that were not able to wait 2-3 months without a detrimental effect on their health received surgery 2. If a comparable non-surgical option was available, then this was conducted instead of surgery
Baabdullah et al[67]	Survey	Saudi Arabia	1. Adopted telephone consultations in Oncology Departments with patients being able to access patient-accessible electronic records *Outcome: Survey reveals that transition to telemedicine is well accepted by cancer patients*
Batt et al[76]	Prospective cohort study	UK	1. Treatment adaptation—switched to local anesthesia from general anesthesia in selected patients with breast cancer.
Blot et al[77]	Article	France	Highlighted role of ethical committee board during COVID-19 1. Offered reflective support to physicians facing difficult dilemmas. 2. Assisted decision making through ethical monitoring, promoted the supportive and palliative dimension of care in a holistic approach
Brody et al[38]	Cross-sectional (Multi-center survey)	USA & Canada (North America)	1. Surgeons had to triage which patients should be operated on urgently vs those which could be delayed indefinitely 2. Surgeons were willing to change their standard practice and recommend radiotherapy instead of surgery 3. Most surgeons were not willing to delay treatment beyond 4-6 weeks (Due to known risk of mortality/morbidity resulting from treatment delays)
Butler et al[19]	Article	UK	1. COVID-19 protected hospital focused on cancer services. 2. 2-weekly internal scheduling meeting was held to ensure efficient and safe patient scheduling for surgery 3. A designated form was created to document all change/deferment in treatment, due to the COVID-19 pandemic 4. Limited number of personnel allowed to attend MDT meetings physically with other members of the team joining via teleconferencing 5. MDT outcome communicated to patients via teleconferencing and patients would be advised to self-isolate for 14 days at the earliest if the MDT outcome was to offer surgical treatments 6. Streamlined peri-operative assessment to reduce patient's travel to hospitals. COVID-19 swab test pre-surgery and CT chest surveillance for patients receiving category 2-3 surgeries 7. Patients were provided information on increased risk from COVID-19 infection when being consented for surgery 8. Full PPE was worn by staff intra-operatively 9. Intubation involved only a limited number of anesthetic team 10. Surgical staff were instructed to be screened for temperature and change clean scrubs after entering hospital
Casella et al[11]	Editorial	Italy	1. Rearranged space to reconfigure workflow in radiology departments 2. Multidisciplinary meetings replaced by teleconferencing 3. Outpatient appointment partially taken over by telecare 4. Telematic consultations with psycho-oncology specialists for patients with high-grade psychological distress 5. Protection: widely distributed alcohol-based hand gel 6. Reduction of surgical lists from 4 days to 2 days per week 7. Staff segregation: 3 teams of physicians who were not in contact with each other 8. Implemented Patient triaging and body temperature surveillance at hospital entrance 9. Treatment adaptation: Adjusted the indications to access neoadjuvant therapy

(continued)

Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Chiang et al[14]	Article	Singapore	1. Screening clinics to triage patients 2. Swab-and-Send-Home (SASH) program for suspected cases of COVID-19 or vulnerable patients at increased risk. E.g. Cancer patients undergoing chemotherapy with COVID-19 symptoms 3. 1 accompanied visitor was allowed for outpatients 4. Deferred non-urgent appointments and scans 5. New patients with suspected cancer will receive biopsy or imaging on the same day as their clinic appointment if possible 6. Capped number of patients per session 7. Electronic billing and prescription 8. Home delivery of medications 9. Dedicated ward was established for cancer patients with COVID-19 10. Centralized coordination of surgical volume to ensure sufficient ITU beds is available 11. Pre-op questionnaire to triage patients for risk of contracting COVID-19 12. Enhanced surgical recovery program to reduce hospital stay post-operation 13. Full PPE required for surgical procedures that are aerosol generating, surgical masks with eye shield for other lower risk procedures 14. Delayed non-urgent or surveillance imaging to improve turnaround time for urgent investigations
Cinelli et al[53]	Letter	Italy	1. Used teleoncology to monitor skin toxicity from cancer treatment via telephones or email 2. Department set up a specific outpatient clinic dedicated to dealing with chemo-, immune-, and radiotherapy-related cutaneous and mucosal adverse events.
Civantos et al[9]	Report	USA	1. An otolaryngologic triage committee was set up to correctly allocate resources to patients 2. Patients with tumors were screened for non-surgical choices of treatment 3. Patients were tested twice for COVID-19 before operation. 4. Questions regarding triage needing multidisciplinary action were asked virtually to a Head and Neck Tumour Board 5. Patients going through chemotherapy and radiation were tested for COVID-19 before starting the treatment
Civantos et al[49]	Report	USA	1. Cordectomy was carried out using a sharp technique, replacing a laser to lessen aerosolization 2. Surgical interventions were delayed, especially in immunocompromised patients 3. Telemedicine communication between patients and doctors was enforced 4. PPE was mandatory for surgery
Collins et al[17]	Editorial	USA	Urology department in USA: 1. Segregation of staff: 2 teams of staff taking alternating between emergency operations and outpatient activities weekly 2. Testing for patients with symptoms and patients who were due to receive surgical treatments 3. Outpatient appointments conducted by telephone calls 4. Outsourced urgent elective cases to non-COVID private hospitals temporarily. Surgeries to be performed by the same consultant. 5. Where possible, emergency surgeries were delayed until COVID test was negative. 6. Limited attendance to MDT meetings with additional participants joining via teleconferencing *Outcome:* 1. 5 out of 101 inpatients at COVID hospitals contracted COVID-19. No outsourced patients were infected 2. Decreased outpatient referrals with 66% decrease in new cancer diagnosis 3. Telemedicine led to reduced costs and savings

(continued)

Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Curigliano et al[55]	Opinions	Italy	1. Gave periodic updates on infected cases, adjusted level of risk alerts 2. Mandatory provision of PPE to healthcare workers 3. Patient education: used phone calls or social media messages to deliver key advice in prevention of COVID-19 4. Treatment adaptation: Cancer designated hubs were put in place to deliver necessary curative treatments in Lombardy region 5. Patients on oral treatments were monitored remotely and higher volume of drug supply was provided to patients at each hospital visit 6. Blood monitoring was performed at local labs
Czernin et al[36]	Report	International	1. All patients on hospital sites had temperatures recorded and positive patients were told to isolate 2. Patients were screened upon arriving at hospital where they filled out a questionnaire on symptoms and their body temperature was taken. 3. Oncology staff were put into 2 separate teams, switching between working from home and in the clinics 4. Telehealth consultations instated 5. Virtual MDT meetings 6. Screening spots were outside hospitals with people who have respiratory symptoms.
de Marinis et al[39]	Retrospective	Italy	1. Patients received emails with recommendations to follow for protection from COVID-19 as well as telephone triage to check for symptoms and personal contacts with people suspected to have COVID-19 2. Patients were screened by telephone triage on day 1 of each clinical visit for symptoms 3. *Day of visit/treatment:* clinical triage was done at the cancer center upon admission (fever and respiratory tract check) 4. Patients with symptoms 19 underwent nasal swab testing. 5. Access to the premises was forbidden to all people except patients and staff 6. Patient evaluation of the risk/benefit ratio for delaying anticancer treatment was undertaken 7. Visits/treatment were delayed for patients with recent respiratory symptoms 8. Deliveries of oral cancer treatments were made to pharmacies near the patient's home. 9. Follow up visits were replaced with email, phone calls, telematics evaluation of CT scan imaging. Telemedicine evaluation was adopted. 10. Treatment for progressive tumors was not delayed. 11. (neo)adjuvant therapies, chemo-radiotherapy, first line therapies for metastatic disease, chemotherapy for high grade tumors, and clinical trial treatments were continued. 12. Referrals to cancer centers closer to patients' homes were considered. *Outcome: In 5 weeks of multilevel measure—only 6/325 of patients evaluated in the study with lung cancer tested positive for COVID-19 and only 1 patient required oxygen support due to severe COVID-19. No deaths occurred*
Dharmarajan et al[51]	Cross-sectional (survey)	USA	1. A multidisciplinary team of specialists used a virtual multidisciplinary conferencing (MDC) approach which was accessible at all locations in order to streamline head and neck oncologic care for patients for timely diagnosis and organisation of treatment plans *Outcomes: Use of virtual MDC improved referral coordination, decreased delay in diagnosis and treatment, had a higher frequency of MDT evaluation and reduced patients and provider travel burden.* *Challenges in implementing the MDC: reliable technical setup, increased length of virtual case presentations, delays in receiving supporting information such as imaging and pathology slides and cost of virtual informatics infrastructure. It appeared that virtual MDC participants had positive experiences and found it compatible to in-person meetings*

(continued)

Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Elkaddoum et al[59]	Article	Lebanon	MDT meetings were carried out virtually using Microsoft Teams *Outcomes* 1. Virtual MDT appears to be able to accommodate more participants than face-to-face meetings 2. Having patient data gathered on a single electronic system was an advantage to ensure efficiency of virtual meetings
Elkin et al[31]	Review	USA	1. A telephone triage was developed by Oncology nurse educators to screen incoming patients for symptoms and potential exposure to COVID-19 2. The triage system was incorporated into electronic health record documentation and easier identification of high-risk patients in clinical settings with appropriate prognostic algorithms
Flannigan et al[57]	Editorial	Canada	1. Clinic appointments were done virtually 2. Patient education sessions were given on exercising, nutritional and psychological support. Extra attention was given to identity those who demonstrate signs of depression from isolation 3. Intracavernosal injection therapies were suspended
Fosker[26]	Editorial	Bermuda	1. The outpatient department and chemotherapy suite were relocated to free up physical space 2. Treatment time was lengthened in order to allow more time for safety checks 3. During treatment reviews, clinicians picked up individual patients from the car park
Frey et al[66]	Prospective cohort study	USA	1. Ovarian cancer survivors were experiencing delays in cancer-directed treatment during the COVID-19 crisis and reported high levels of cancer worry, anxiety, and depression
Giuliani et al[58]	Editorial	Canada	1. Quick transition to telemedicine was made since the beginning of the pandemic to reduce in-person care 2. Gave Digital Information Prescription: Online classes, easy access to database of health information 3. Developed core online education systems by multidisciplinary team ○ Designated search engine is created to help patients locate reliable cancer-related patient education materials ○ Online multimedia classes about cancer were provided to patients and families
Gupta et al[48]	Cohort study/ report	India	1. 11 cancer institutions stopped all elective surgeries and outpatient clinics—only urgent cases were admitted and only crucial surgeries were performed 2. 5 institutes still provided Head and Neck Cancer treatments 3. 4 cancer centers still performed all types of surgeries, even with limited access to PPE ○ Many centers liaised with patients via telephone consultations or in clinic
Grenda et al[54]	Article	USA	1. New patient evaluation shifted to telemedicine 2. In lung cancer clinics, patients requiring multidisciplinary intervention saw different members of the MDT team in a single visit 3. Telemedicine used in triaging post-operative patients with acute issues and subsequent follow up scheduled at 48 hours postoperatively
Guven et al[12]	Short Report	Turkey	1. Floors were marked for enforcement of social distancing while in hospital 2. Follow up appointments were performed over telephone 3. Patient triaging with temperature measurements was done at hospital entrance 4. Only 1 companion allowed per patient 5. Patients were informed to go to palliative care outpatient, rather than emergency department, for treatment-related symptoms 6. All new patients were given same day appointments to avoid delay in diagnosis

(continued)

Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Harky et al.[61]	Letter	UK	1. Telemedicine has been widely adopted into current practice 2. Out-of-hours operations have been a viable coping strategy adopted 3. Patients triaged on respiratory symptoms and contact histories
Indini et al[33]	Cross-sectional (multi-center survey)	Italy	COVID-19 diffusion containment measures: 1. Triage of patients (vital sign monitoring at entrance of hospital) 2. Patients questioned on symptoms during 15 days before visit and possible contacts with COVID-19) 3. Triage procedures sometimes resulted in preventative isolation and diagnostic work up of symptomatic patients (nasal swab/ chest x-ray) 4. Non-urgent visits delayed (mainly follow up visits) 5. MDT video conferencing for meetings 6. Patients underwent telephone interviews/counseling 7. Access to oncological hubs was limited/denied for visitors/caregivers (outpatient visits, day hospital and ward admissions 8. Family doctors delegated to conduct follow-ups/carry out home visits 9. Telephone line was set up for emergencies Diffusion of COVID-19 in oncology units: 1. One third of oncological hubs had to employ their oncologists for guard duties in the internal medicine ward/emergency dept. 2. Patients' treatments were redistributed homogeneously throughout the week 3. Doctors on COVID wards waived from oncologic activities to reduce the risk of infection. *Outcomes:Twenty-four percent of Italian oncology departments had at least 1 patient diagnosed with COVID-19. 23% of patients accessed the emergency room with symptoms, 18% diagnosed after triage procedure and/or a medical interview regarding possible contacts with COVID-19*
Jiang et al[60]	Review	USA	1. Remote care was established to facilitate anti-cancer medication deliveries 2. 92.8% reported very satisfied with the experience with using clinical video telehealth (CVT)
Lee et al[15]	Perspective	Hong Kong	1. Routine clinic appointments were postponed (only urgent conditions to be seen or reschedules 2. Number of doctors seeing consultations was reduced performing aerosol generating procedures. 3. Reduction of caseload (doctor saw only 10-15 patients per session) allowing time needed for infection control compliance 4. All doctors were given PPE 5. Drug refill clinic was set up to allow stable patients to get repeat prescription without consultation 6. Extra clinic sessions on weekends and evenings were considered to deal with accumulation of rescheduled appointments 7. Telemedicine appointments were implemented (took 10 minutes longer than face-to-face appointment) 8. Preoperative personnel for procedures was kept to a minimum . 9. Video laryngoscopes with a plastic drape to form a barrier between them and the patient's airway to decrease aerosol spread were used by Anaesthetists 10. Only experienced surgeons were selected for airway operations in order to reduce contact time and risk. 11. Reduction of operation theater service (only emergency and priority elective operations go ahead)
Lee et al[47]	Editorial	Korea	1. Aggressive contact tracing and quarantining of COVID-19 positive patients and any personnel in close contact 2. Patient triaging by telephones a day before appointments were done 3. COVID-19 testing was offered to patients attending chemotherapy infusion

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Lee et al[27]	Prospective cohort study	UK	1. Patient segregation: hospital visits were minimized by favoring replacement of intravenous agent with oral agents 2. Staff segregation: COVID-19 negative and COVID-19 positive dedicated teams were formed *Outcomes: Retrospective data shows no increase in mortality from COVID-19 after chemotherapy, suggesting that curative treatments, such as chemotherapy or ITU admission should not be delayed in cancer patients.*
Lobascio et al[56]	Opinion	Italy	1. Patient education: Upon patient discharge, patient information leaflet on nutritional advice during COVID-19 was delivered to patients 2. Nutritional follow-up was done by telephone consultations 3. Monitoring and management of patient's nutritional status was completed remotely by using mobile phone apps
Lombe et al[68]	Article	Zambia	1. Staff training was provided to improve understanding of the disease and key preventative measures. Emphasis was placed on how to respond if faced with patients undergoing treatment who were COVID-19 positive. 2. Outpatients were screened for symptoms and temperatures. High risk patients were transferred to an isolation room for further review 3. Visitation of inpatients was suspended 4. Testing of all inpatients was made mandatory 5. Tiered PPE protocol was implemented depending on patient type 6. Mental health team was involved in supporting medical staff via both grouped and individual care interventions. Staff were encouraged to report any concerns
Mei et al[21]	Reportage	China	1. Patients and healthcare workers in the hospitals were screened (via nucleic acid and antibody tests in combination with CT scans) 2. An isolation ward was created with an increased prevention level compared to the rest of the hospital 3. Telemedicine was used to follow up on discharged patients and medicine was mailed to patients 4. Confirmed patients were isolated and visits were prohibited 5. Wearing of masks and hand sanitization by staff and patients were made mandatory 6. To combat shortage of staff, 50 doctors and nurses were redeployed and temporarily relocated from other not-in-service departments to oncology departments (which also consisted of specialists in serious infections and management of respiratory tract diseases 7. COVID-19 confirmed and suspected cases were redirected to other hospitals 8. Careful evaluation of cancer patients was undertaken before admission with an emergency department for serious care 9. Elective patient admissions were postponed 10. Chemotherapy-free alternatives were given when possible. 11. Chemotherapy protocol was adjusted/postponed 12. Free-of charge online fever clinic was set up
Mendoza et al[23]	Editorial	Philippines	1. Pre-scheduling and pre-screening of all patients was done for outpatient consultations and admissions 2. Referrals were coordinated to local oncologists for patients with travel restrictions 3. Patients receiving systemic cancer treatment were prioritized 4. The outpatient clinic was restructured physically and procedurally 5. hand hygiene and social distancing was observed in hospital Personnel working in COVID-19 areas were segregated 6. Medical supplies were secured by working with non-governmental organizations 7. Centralized inventory system for medical consumables was made

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Millar et al[65]	Survey	UK	1. Psycho-oncology service was transitioned to remote care with regular "check-ins" arranged on an individual basis *Outcome: Some cancer patients report concerns over limitations of remote care on the widened physical distance between therapists and patients, lack of opportunity to reflect during the travel and that resources on remote care might not be utilized to fulfil cancer-related goals*
Mirnezami et al[73]	Letter	UK	1. Treatment adaptation: short term radiotherapy was favored for locally advanced colorectal cancer rather than long term radiotherapy
Morrison et al[69]	Article	USA	1. Elective cases were postponed. Each scheduled case was approved by the Department Chair. 2. Surgery was only performed after negative COVID testing and sufficient PPE is available 3. Tiered PPE protocol according to case type was implemented to conserve PPE 4. N95 respirator was reprocessed with UV light for repeated use 5. Clinic availability was limited to patients with a new diagnosis, worsening symptoms and post-operative follow-up. 6. Residents were protected from COVID-status unknown patients 7. Guest visits to hospitals were limited
Moss et al[32]	Prospective cohort studies	UK	1. Routine testing of patients was done prior to admission to hospital
Mulvey et al[62]	Opinions	USA	1. Almost 2/3 of follow-up cancer care was conducted virtually 2. Difficult conversations usually reserved for in-person visit were shifted to video or phone consultations. 3. Low-risk drugs that require subcutaneous or intramuscular administration were safely administered at home. 4. Fixed-dose chemotherapy or immunotherapy was given to patients who remain stable over long periods.
Ngoi et al[41]	Editorial	Singapore	1. All staff belonging to the National University Cancer Institute, Singapore (NCIS), with clinical and non-clinical roles, were separated into 2 teams to prevent full departments from being quarantined in the case of COVID-19 2. Each outpatient part was segregated from the others, with their own registration desks and triage systems to help enable contact tracing 3. Cancer services running within the community were canceled, such as home chemotherapy 4. All face-to-face meetings were canceled, and all departmental meetings were conducted via video calling 5. Telemedicine consultations were conducted 6. Home delivery of prescribed medications was used 7. All patients and visitors to outpatient clinics were screened at 2 points in the hospital via a thermal scanner and health questionnaire. *Outcomes: During the 1-month period in which this team segregation method was carried out, 70 COVID-19 testing kits were utilized in the outpatient and inpatient clinics. There was only 1 case of COVID-19 found in the entire unit*
Ning et al[46]	Prospective cohort study	USA	1. Routine appointments were deferred by 2 months 2. Transitioning to telemedicine as implemented 3. Patients were outsourced to local oncology providers 4. Designated contact tracing team were formed to identify staff who are exposed to patients who was tested positive for SARS-CoV-2, which subsequently leads to quarantining of staff 5. Staff were screened for fever and respiratory symptoms and offer staff testing if symptomatic 6. Dual PPE policy was implemented—Patients and clinicians had to wear surgical masks while on site

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Onesti et al[24]	Survey	International	1. Patients were triaged for signs of infection are observed in more than 90% of centers. Triage was the preferred method in most centers 2. Patients were educated on precautions to avoid contracting COVID-19 is delivered in more than 90% of cancer centers 3. Clinical areas were frequently sterilized in 85% of centers 4. Telemedicine was adopted in 76% of centers 5. 65% of centers required COVID-19 swab tests before admission 6. 50% reduced palliative care admission
Ong et al[72]	Letter	Singapore	1. Team segregation was used to ensure continuity of care 2. Outpatient load was decreased and non-urgent cases were deferred to ensure sustainability 3. High patient load was maintained through efficient deployment of manpower within the SPRinT team.
Oualla et al[22]	Article	Morocco	1. Crisis management team was formed 2. Training was given to all staff in the Oncology department 3. Patients were tested before admission and only those who were COVID-19 negative were admitted 4. Face mask-wearing was mandatory for patients and staff 5. Temperature monitoring of patients and staff was implemented 6. Alcohol hand rubs were provided in hospital 7. Reception area and clinical rooms were disinfected 8. The number of accompanying family members was limited 9. All clinical follow-ups were postponed 10. Transition to web-based consultations was implemented 11. Stopping or changing treatment was considered if absolute benefit of treatment regimen is low; Reduce invasive procedures that requires ICU admission 12. For patients with metastatic disease were discussed on case-by-case basis. Discussions considered patients age and comorbidities, considered treatment breaks/oral treatment for indolent and stable disease 13. Palliative care was managed with telephone consultations with home services in patients with high palliative care needs
Patel et al[16]	Perspectives	USA	1. Preoperative COVID-19 testing was offered in 79% of institutions 2. Telemedicine was implemented in most head and neck cancer units implemented 3. Clinical visits were limited through triaging of patients 4. Resident involvement in surgery was limited 5. N95 masks were used for all high-risk procedures in patients who tested negative 6. Treatment decisions were reviewed by multidisciplinary committee
Peeters et al[63]	Editorial	Belgium	1. Mobile phone apps were developed to monitor treatment toxicity in patients and identify individuals who are at risk of COVID-19 infections
Peng et al[43]	Comment	China	2. Nation-wide program issued each personnel a health QR code showing a 2 tier contagion risks, which was determined by the number of cases in the area of residency. Medical isolation is required for "high-risk" patients, unless in an emergency 3. Face coverings were required in hospitals 4. Temperature monitoring of patients and staff was implemented 5. Visitors were prohibited in the wards 6. Fever clinics were used to screen patients with suspected COVID-19 symptoms. If cancer patients presented to the hospital with fever, they were attended by an infectious disease specialist before they were seen by oncologists 7. Online consultations were performed Home drug deliveries were done 8. Special programming model was used to aid scheduling of radiotherapy to minimize patients' waiting time at hospital

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Poggio et al[74]	Survey	Italy	1. Physicians had good awareness of reasonable treatment adaptations without excessively worrying about the negative impact 2. Concerns over potential undertreatment of cancer patients (due to treatment changes) 3. For chemotherapy administration in patients with metastatic disease, oral treatments were considered the preferred choice compared with intravenous agent
Porzio et al[29]	Perspectives	Italy	Transitioned oncological services to home care under a double triage protocol 1. First telephone interview: Screened for symptoms of COVID-19 the day before scheduled home visit 2. Second telephone interview: Assessed symptom severity (Pain, Eating, Rehabilitation, Sleep, Oxygen, Nausea and Vomiting, Suffering) to determine frequency of home visits needed *9. Outcomes: Good level of patients' acceptability for telephone interviews*
Press et al[18]	Technical Report	USA	1. Patient educational materials were provided 2. Daily symptom screening of patients and close contacts was implemented 3. Sanitization measures were put in place 4. Telemedicine appointments/virtual meetings 5. Visitors were restricted 6. Treatment of indolent diseases was deferred 7. Treatment times were spaced out and waiting rooms were closed 8. Patients in subacute care/nursing facilities were not eligible for treatment until discharged 9. Hypofractionation was used to shorten treatment schedules when feasible. 10. Patients were prospectively monitored on treatment for new symptoms, date of onset, ill contacts COVID-19 test results 11. Treatments for COVID-10 positive patients were deferred and negative test result was needed before treatment could resume. 12. Patients with high-risk exposure were quarantined *Outcomes:* *11% monitored for symptoms/high-risk exposure* *8% of patients had an alteration in treatment plans* *Out of 11 affected patients, 7 were cleared and rescheduled for treatment (median delay of 7 days), 4 patients were indefinitely delayed (including 3 COVID-19 cases, 1 of which died)* *Majority of patients who required monitoring had not yet started treatment (60%), all except one were cleared and rescheduled (median delay of 4.5 days)* *Out of 6 patients on-treatment requiring evaluation (40%), 5 had treatment interruptions and were rescheduled (median delay of 4 days)*
Quarto et al[70]	Opinion	USA	1. Patients were triaged before hospitalization with rapid blood testing for IgG and IgM. COVID-19 positive patients will be quarantined 2. PPE use was made mandatory 3. Robotic surgery was adopted to minimize hospital stay 4. The healthcare system was restructured to manage cancer patients in COVID free hospitals whenever possible
Rathod et al[50]	Short Communication	Canada	New guidelines were issued based on principles of 4R's for radiation oncology 1. Vi**R**tual care (reduce in-person appointments) 2. **R**ation radiation (offer radiation wisely and avoid when minimal benefit) 3. Defe**R** radiation (as appropriate) 4. Hypof**R**actionate radiation (where applicable)

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Rodler et al[45]	Perspective	Germany	1. Urologists who tested negative resumed oncological cancer service on a biweekly rotation 2. Patients who were exposed to infected personnel were found by extensive contact tracing and subjected to strict quarantine. These patients were advised to monitor their symptoms with a symptom diary 3. Symptom checking and side effects monitoring was done through telemedicine; multidisciplinary team meetings were conducted using teleconferences 4. Enrolment in clinical trials was suspended; Study follow-ups were done under virtual care 5. Treatment de-escalation: Immunotherapies were given at prolonged intervals; chemotherapy was subjected to dose reductions 6. Patients were triaged prior to hospital visits; patient companions during visits were prohibited 5. Patients visiting the hospital for systemic treatment were advised to wear surgical masks and were taken to a single room on arrival.
Silvestris et al[35]	Report	Italy	1. Cancer surgery: partial home recovery was encouraged with early discharge 2. Patient testing was conducted before surgery; FFP2 masks were worn during surgery 3. Medical therapy: Subcutaneous and oral medications were favored 4. All common areas were closed promptly 5. Patient triage was done in an out-of-hospital tent 6. r multidisciplinary meetings were done by Teleconferencing 7. A cross-departmental commission was established to regularly review hospitalization proposals on a case-by-case basis 8. COVID-19 free hospitals were designated
Tagliamento et al[25]	Survey	Italy	1. Testing: 53.8% of healthcare professionals supported testing patients with cancer for SARS-CoV-2 to identify and isolate also asymptomatic carriers before starting treatment with immune checkpoint inhibitors. 2. 97.1% of respondents would not deny ICIs as a treatment option at the time of COVID-19 outbreak 3. ICI given to reduce frequency of hospital visits: 55.8% of respondents (physicians) chose to implement a higher flat-dosing regimen of immune checkpoint inhibitors 31.7% of respondents did not modify the choice of the treatment regimen and the schedule of administration in order to decrease the number of hospital visits 4. Treatment modifications: overall results did not demonstrate a significant change in the attitudes of Italian physicians toward the prescription of immune checkpoint inhibitors during COVID-19 outbreak.
Tan et al[7]	Editorial	Singapore	1. Staff underwent refresher course on PPE & PAPR and were required to wear a surgical mask or wear full PPE for aerosol generating procedures 2. The number of patients in clinics was reduced and appointment times were spaced out 3. Cross-covering of satellite clinics in cluster hospitals was suspended 4. Multi-disciplinary meetings were conducted via email/teleconferencing 5. Teams were divided to service each treatment site when full segregation of services activated 6. Temperature was checked and logged twice/day on database (staff) 7. Only one person was allowed to accompany patients 8. Declaration form for patients had to be signed at hospital entrances before triage 9. Thermal Scanners were placed at hospital entrance 10. Visitors had to wear surgical masks 11. Non-essential appointments were postponed

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Tey et al[10]	Perspective	Singapore	5. Strict visitor screening was implemented 6. Patient triaging with questionnaire and temperature measurement was implemented 7. Universal masking of all visitors was implemented 8. Twice daily temperature monitoring of working staff was done 9. Weekly reviews of availability of medical supplies was conducted 10. Radiotherapy was continued if it has already been started, but new elective new referrals were reduced to high maintenance services (E.g. Brachytherapy) 11. Staff segregation—movement between hospitals was restricted 12. Care teams were formed so 1 team could ensure continuity of service if 1 team requires quarantine 13. Workplace segregation was adopted—2-meter distance between work desks 12. Separate areas for meals were allocated for different clusters of staff
Valenza et al[37]	Observational	Italy	1. Filters were applied to and within the hospital, the institution of a surveillance zone to serve both in-hospital and out-of-hospital individuals suspected of having COVID-19, and filters for patients about to undergo surgery. 2. Text messages were sent to those with appointments to contact their doctor if influenza-like symptoms displayed 3. Text messages were sent to those with hospital appointments, asking them to contact their doctor upon experiencing symptoms 4. Those at hospital entrance were filtered out by symptoms and temperature measurements. 5. Surgical masks were distributed 6. Surveillance zones (serve both in-hospital and out-of-hospital patients suspected of having COVID-19 or in need of a differential diagnosis to continue with cancer treatment) was chosen according to – Logistics: Room isolation was considered based on transfer time and distance within the hospital to access CT scanner). Closed-circuit video cameras installed in high care and triage rooms to limit number of nurse visits – Pathways of diagnosis and treatment: pathways and treatment were designed for categories of patients (admitted and at home (under active treatment)). Prerequisite for triage was COVID-19-like symptoms Admission to surveillance area based on decision to start triage, clinical data (vital signs & lung function, scanning) and a multidisciplinary final decision) – Dedicated manpower: rules were set for those taking care of patients. Surveillance team of clinical staff frequented the area to observe the escalation of illness. – Filters were put in place for surgical activity (surgery was verified by cancer board, triage conducted and then tested (if positive, patients are sent home and restaged for symptoms in the following week). However, if the surgery was urgent and the patient had COVID-19, the surgery took place in a dedicated COVID-19 theater *Outcome: Overall 33 patients tested positive for COVID-19 (31% of those tested and 11% of those included in the filtering activity report*
Van de Haar et al[3]	Perspective	European countries	Inpatient: 1. Patient triaging was done on the day before hospital admission over phone and at hospital entrance 2. Video consultations were carried out for physicians who had to self-isolate Outpatient: 3. Blood tests were done outside the hospital 4. Interventions were outsourced to private clinics

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
			5. Intravenous treatment was converted to oral treatment or subcutaneous treatments Medication was home delivered 6. Considerations were made to postpone surgeries/alternative treatments without compromising clinical outcomes e.g. radiotherapy 7. Cancer patients were transferred from general hospitals treating COVID-19 patients to cancer centers
Van der Lee et al[64]	Correspondence	Netherlands	1. Cognitive behavioral therapy and psychotherapy was continued with video consultations *Outcome: Patient feedback: No travel time means there are less time for reflection after video consultation,* *Felt distance due to less non-verbal communication*
Vanderpuye et al[40]	Editorial	Ghana	West Africa 1. Elective procedures and face to face meetings were suspended 2. Patients were educated on the possible additional risks of COVID-19 infection from chemotherapy 3. Patients with fever were rapidly isolated and were referred to the emergency room for assessment 4. Prescriptions were remotely filled 5. Primary radiotherapy treatments were continued, and patients on concurrent chemoradiotherapy only received radiotherapy. 6. New referrals, including emergencies, were triaged based on the effect of treatment delays on outcomes. South Africa 1. Volume of outpatient follow-ups was reduced 2. Use of adjuvant therapy was reduced as long as risk outweighs the benefits 3. Primary therapy was shortened Sudan 1. All new cases were deferred except for emergency cases 2. Elective surgery, non-urgent chemotherapy and follow up visits were suspended for 2 weeks 3. inpatient visits were limited to 1 visitor per day 4. MDT meetings were done via teleconferencing 5. Medical staff were trained on COVID-19
Wahed et al[28]	Article	UK	1. Aerosol generating procedures (e.g. Endoscopy, exercise tolerance tests) were selectively reduced with decisions made by MDT. 2. Patients were isolated for 14 days and offered testing for COVID-19 before surgeries
Wang et al[34]	Report	China	1. Body temperature was measured at hospital entrance, wards and outpatient clinics. 2. Contact and travel histories of all visitors and patients were documented 3. An online booking system was used to book appointments to limit number of patients waiting on-site 4. Admitted patients wore masks and were subject to sanitization 5. Cancer patient had online consultations, directing them to take prescribed drugs on time and helping to manage any symptoms Patients: 6. Potential COVID-19 symptoms were registered regularly 7. Patients were required to have blood tests and CT scans of the lungs are taken. If patients were thought to have pneumonia from the scans, then COVID-19 nucleic acid tests were done 8. Anticancer drugs normally administered intravenously were switched to an oral version of the drug, if available *Outcomes:2944 were monitored in total from Feb 12-March 2, 2020. 27 patients showed possible changes in the lungs due to pneumonia and 8 of these patients were suspected of being COVID-19 positive. All of these patients were tested with nucleic acid testing and all patient results came back negative. As of March 3, no patient or member of staff tested positive for COVID-19.*

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
Wakefield et al[20]	Report	USA	Management strategies undertaken in radiation oncology in US: 1. Telecare was quickly adopted 2. 97% of department increased their infection control measures by sanitizing treatment tables (91%), increasing the cleaning of immobilization devices (88%), and requiring patients and staff to wash their hands when entering and exiting treatment vaults (65%) 3. Patients were triaged at the entrance of the facility in 98% of practices. 4. Social distancing was required in majority of clinics (98%), 5. Mask wearing was required (82%) 6. 98% of practices reported increased measures for the protection of staff, including requiring all staff to wear masks (99%) 7. Increased cleaning (95%) 8. Screening staff at the beginning of each shift (91%), and testing symptomatic staff (93%). 9. Some practices required gloves (72%), face shields (50%), and gowns (22%) during treatments and procedures, as well as staggered shifts of limited staff (50%).
Wei et al[71]	Letter/Survey	China	A survey was conducted to assess the radiotherapy implementation status in 74 Chinese hospitals: 1. 88% of surveyed hospitals provided radiation treatment for COVID-19 negative patients 2. 39% of hospitals would not treat COVID-19 patients even if they have been cured. 3. Hospitals recommended that patients took the stairs, sterilizing handrails 4. 50% disinfected treatment bed and surrounding accessories during treatment intervals
Weisel et al[8]	Perspectives	Germany	1. A multidisciplinary leadership task force was established to discuss treatment plans on a case-by-case basis 2. Outpatient care was replaced with telemedicine 3. Staff and patients were trained to practice social distancing at outpatient departments 4. Elective surgeries were reduced to make way for necessary cancer surgery 5. Frequent staff testing was provided for those with suspected contact with COVID-19 patients 6. Physicians were assigned a designated replacement staff in case of quarantine *Outcome:Reduction in outpatient visitors by 40-50% per week* *6 cancer patients and 5 staff members were tested COVID-19 positive*
Wilkinson[42]	Editorial	UK	1. COVID-19 free cancer center was established 1. Patients were quarantined and tested before surgery 2. Clear guidance was issued on patient prioritization (3 tier system arranged according to urgency of treatment) 3. Phlebotomy service allowed patients to wait in their cars for their turns 4. Treatment adaptation: immunosuppressive treatments were reduced 5. Regular weekly staff testing was implemented 6. Phone calls prior to appointments were made for patient reassurance 7. Rapid diagnostic clinics were held virtually to deal with new referrals
Wilson[30]	Report (gray literature)	UK	1. Single point entry to the hospital was instated, where all patients and visitors were screened 2. Oncology and hematology wards on separate levels were repurposed into a clean ward for patients who had tested negative and a second ward for patients awaiting test results 3. face to face outpatient clinic appointments were almost entirely replaced by to telephone-based consultations almost entirely 4. All intravenous anti-cancer treatments were moved off-site

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Table 4. (continued)

Author	Study Type	Country	Key Adaptations/Intervention service delivery *Outcome (in Italic)*
			Treatment adaptations 5. Standard prescription length for some oral medications was increased to reduce appointments 6. Medications including oral anti-chemotherapy were sent to patients' home addresses 7. Patients established on immunotherapy were switched to longer regimens Team restructuring: 8. Separate staffing was adopted for clean, potential positive and confirmed positive areas 9. Separate consultants provided inpatient cover to clean and positive areas 10. Junior doctors covered all inpatient areas onsite 24 hours a day 11. Shadow rota was implemented to cover sickness or self-isolation 12. Task groups were set up between registrars, consultants, senior nursing staff and management to facilitate rapid decisions and communication
Wu et al[44]	Perspectives	China	1. Patient and healthcare worker screening was undertaken 2. Health education for patients: patients signed a consent form before therapy and were informed of the risk of cross-contamination during treatments and the zoning design of center. 3. Staff were trained on personal hygiene, prevention and protection. 4. Staff learned about the appropriate personal protection for the role 5. Special radiotherapy workflow was adopted to avoid patient-patient contact and minimize patient-staff interaction time. 6. Departments were divided into zones according to different contamination levels
Yusuf[13]	Editorial	Pakistan	1. Well-developed textile companies were enlisted to help speed up the production of protection gowns and N95 masks 2. Only essential imaging studies were performed. Elective imaging and endoscopy surveillance were stopped 3. All hospital visitors were triaged to quickly screen for respiratory symptoms at hospital entrance. High-risk patients were transferred to temporary triage areas 4. Outpatient services were continued virtually 5. Treatment adaptation: Oral medication was preferred over ablative procedures for hepatocellular carcinoma to minimize hospital visits

Dharmarajan et al reported that instating virtual multidisciplinary conferencing facilitated MDT evaluation, referral coordination and reduced diagnosis, treatment delays and travel burdens on patients and staff.[38] Utilization of this modality was also well accepted among the users as many found it comparable to in-person meetings.[51] In Lebanon, virtual MDT also allowed for patient data to become centralized on a single electronic system, which facilitated efficient virtual meetings and allowed for more participants to be included than in normal face-to-face meetings.[59] However, one study reported that the duration of MDT case presentations had also increased and there were greater delays in receiving supporting information such as imaging and pathology slides.[78] Although speed and efficiency were marginally hindered compared to "business as usual," videoconferencing should be considered by institutions as a method to reduce unnecessary physical contact between managing team members. In summary, the adoption of telemedicine into modern practice has been well received by both healthcare professionals and patients.[26,44]

(3) Protection

This theme encompasses measures that aim to mitigate the spread of the virus to protect both staff and patients. Use of PPE by staff was adopted by almost all institutions.[7,11,15-17, 19-21,24,30,35,37,40,43,44,46-49,55,68-70] For example, in a head and neck cancer center in the UK, staff were required to wear full PPE intra-operatively and surgical staff were instructed to change clean scrubs after entering hospital.[19] Patients and visitors were also sometimes asked to wear masks, especially if they displayed symptoms.[7,10,20,21,24,34,36,37,43,45,46,70]

While PPE was endorsed as a necessity within many healthcare institutions, some studies reported shortages. For example, in the US, a 35% shortage in protective gear was reported.[16,21] Tey et al, however, stated that their institution in Singapore undertook weekly reviews for the medical supplies, a potential way to ensure PPE shortages can be mitigated.[10] Similarly, at the National University Cancer Institute of Singapore, to further reduce the use of N95 masks and gowns in cancer wards,

all COVID-19 positive patients were admitted to a designated COVID-19 ward.[41] Another approach taken in Zambia was the tiering of PPE protocol, which reserved various types of PPE depending on patient type and status.[68] Interestingly, Morrison et al from the USA reported extending the use of N95 respirators through reprocessing under UV light radiation and vaporized hydrogen peroxide.[69] On the other hand, Philippines and Pakistan ensured that demands were met through increasing the supply of PPE through working with manufacturers and external charities.[13,23] To ensure correct use, one study also conducted a refresher course on PPE and Powered Air Purifying Respirator (PAPR) so that staff knew how to use their PPE properly.[7]

Disinfection was also an important priority for some healthcare centers with hand sanitizers being widely distributed and hand sanitation/washing being made compulsory.[11,18,20-22,34,71] Clinical environments and equipment were also frequently sterilized, such as the disinfection treatment of beds and surrounding areas during treatment intervals.[18,20,22,24,44,71] Anesthetists also undertook protective measures whereby intubation procedures were conducted via the use of video laryngoscopes with a plastic drape in order to reduce aerosol spread (Head and Neck Cancer Services, Hong Kong).[15]

(4) Social Distancing

Social distancing measures were put in place to enforce physical distance to help limit contamination and spread. To minimize contact among patients, some facilities enforced limits on the number of patients who were permitted onsite at a given time for clinical visits.[16,33] Stringent restrictions on visitation for visitors/caregivers were applied and waiting rooms were closed in centers to reduce unnecessary congregation of people within a confined space.[12,14,16,18,20,22,35,40] In some cases, visitors were able to accompany patients, given that health checks were enacted upon arrival.[7,10,34,41] To ameliorate the social impacts of this, cancer care providers from Singapore tried to establish communication with family members through conducting remote meetings.[14] Another social-distancing measure to avoid physical proximity was adopted in a cancer center in Bermuda, where patients were asked to wait at car-parks until they were collected for their appointment.[26] Similarly, in the UK, phlebotomy services adopted similar approach where patients were asked to wait in their cars until their turn.[42] Peng et al also described the use of a special programming model in China which aided the scheduling of radiotherapy, in an attempt to minimize waiting time and hence cross-infection risk for patients requiring in-hospital treatment. Similarly, an online booking system was utilized in Wang et al to improve efficiency and limit the number of patients on-site.[34]

Clinical space reconfiguration was also undertaken, as some centers attempted to modify their physical environment to better facilitate social distancing through freeing up physical space or marking floors and/or seating.[11,12,23,26,68] For example, a breast cancer center in Italy reorganized working spaces and schedules in radiology and outpatient clinics to minimize patient flow and increase physical distance.[21] Another study also ensured that work desks had a 2-meter separation between them to ensure adequate spacing.[10]

Staff and healthcare workers were also subject to intervention to minimize staff-staff/patient-staff contact.[7,10,14-17,19,20,23,24,36,41,44,47,72] In Singapore, staff-to-staff transmission was avoided by separating areas for mealtimes for different clusters of staff.[10] Additionally, in surgical settings, the presence of staff during high-risk procedures was minimized when possible in order to reduce staff-staff contact and protect them from aerosol generating procedures.[19] For example, in head and neck surgery, intubation was performed with only essential members of the anesthetic team, while in Hong Kong the number of staff required to be present was reduced preoperatively and intraoperatively.[15] In the USA, Patel et al also noted that several Head and Neck cancer centers limited resident participation in high-risk surgeries.[16]

Staff-to-patient transmission was mitigated through implementing "staff segregation systems," in which oncological staff were often separated into 2 teams or had back-up staff to ensure care continuity in the case of staff infection and subsequent need for quarantine.[7,10,13,17,23,27,30,36,41,72] In Singapore, Ngoi et al discussed the utilization of a "Team-Segregation Pandemic Strategy" where departmental teams were restricted to one ward and cross-transfer of staff between hospital facilities was forbidden to avoid cross-contamination. The outcome for these measures were favorable as within a month of employing staff segregation, only 1 confirmed case of COVID-19 was reported among staff and patients.[41] Wu et al also instated the zoning of departments according to different levels of contamination in a center in China.[44]

Social distancing was additionally enforced through physical isolation of COVID-19 wards and closure of common areas to prevent viral spread (Italy).[35] Rodler et al reported the isolation of new patients in a single room upon arrival (Uro-oncology, Germany), while in Mei et al, an isolation ward was created and had an increased prevention level compared to the rest of the hospital so that patients who tested positive could not be visited (Wuhan, China).[21,45] Valenza et al similarly described the creation of a surveillance zone to house COVID-19 patients, whereby isolation rooms were selected based on transfer time and distance from the hospital CT scanner and contained installed video cameras to limit the number of nurse visits (Italy).[37] In addition, COVID-19 patients in need of urgent surgery were operated on when no regular cases were underway in a dedicated COVID-19 theater.[37]

Attempts were also made to instate COVID-19 free cancer-dedicated centers/hospitals, in order to segregate them from institutions treating COVID-19 cases to prevent viral spread.[10,19,35,42,44,70] In Van der Haar et al, cancer patients were transferred from general hospitals dealing with COVID-19 patients to dedicated cancer centers aiming to stay COVID-19 free.[3] However, this study also noted that complete segregation is difficult for cancer centers built within general hospitals as they still ended up treating COVID-19 positive patients.[3] It should be noted that factors such as widespread

use of PPE and good ventilation are key factors that should be considered in order to mitigate aerosol transmission when segregation measures have been implemented within one building.[79]

Finally, training staff and patients on social-distancing practice proved to be beneficial in improving behaviors conducive to maintaining physical separation.[8] Education on good social-distancing practice may be beneficial in ingraining habits that are essential for staff and patients who have high exposure to the virus due to their clinical surroundings.

(5) Treatment Management

With aims to minimize non-essential hospital visits and additional risks of treatment-induced complications, many health care providers adapted individual treatment plans during the COVID-19 pandemic.[8,21] Careful assessment before treatment continuation/initiation and reviewing of hospitalization proposals were conducted to priorities patients requiring necessary and urgent intervention.[19,35]

De-escalation of treatment regimens was commonly adopted by many institutions, with some making changes to treatment type, intervals or dosage.[11,13,16,24,25,30,33,36,40-42,73,74] Several healthcare providers routinely considered replacing intravenous regimens with oral or subcutaneous agents and prolonging treatment intervals for intravenous treatment.[8,10,34,35,62,73,74] Interestingly, in Germany, this was accompanied by dosage increase in immunotherapy but reduction in chemotherapy to minimize risk of leukopenia.[45] In the UK, some patients with hematological cancers were denied stem cell transplantation and received radiotherapy instead, while patients with locally advanced colorectal cancer, were offered a short course of radiotherapy prior to radical surgery rather than the standard long-term chemotherapy prior to radical surgery.[42,73] In Italy, oncologists adopted regimens that deviated from orthodox first line therapy for breast cancer in the metastatic setting. Preferred adaptions included switching of oral treatment in patients eligible for chemotherapy administration (n = 139; 84.2%) compared to the standard intravenous agents (n = 26; 15.8%). A significant deviation of treatment therapeutics was also observed, whereby the administration of CDK4/6 inhibitors to endocrine therapy for luminal tumors with less-aggressive characteristics was reduced during the pandemic than before the emergency (n = 92; 55.8% vs n = 132; 80.0%).[74]

In Tagliamento et al, concerns over the potential interference with immune checkpoint inhibitors (ICI) and SARS-COV-2 was highlighted. Despite this, 97.1% of Italian physicians in the survey reported that they would not deny ICI's as a treatment option, while 31.7% of the respondents did not modify the choice of the ICI and the schedule of administration in order to reduce the number of hospital visits.[25] With the ambiguity surrounding the interaction between ICIs and the pathogenesis of the virus worsening hyperinflammation with cytokine release syndrome, is it essential that parallel efforts are made to reduce the risk of contracting COVID-19 among patients taking this medication.[25] Delivery of this drug should be evaluated on a case-by-case basis and should take both efficacy and safety into consideration.[25]

Similarly, treatment de-escalation was made in radiation oncology and nuclear medicine, in compliance with a proposed the 4R's system by a Canadian group, including (1) viRtual care, (2) Ration radiation, (3) deFer radiation and (4) hypofRactionate radiation.[10,18,36,41,50] Hypofractionating radiation in selected patients (i.e. escalation in dose of radiation, but reduced treatment frequencies) was thought to be a viable strategy to shorten treatment schedules in radiotherapy.[18] Interestingly, a retrospective cohort study following 800 cancer patients with symptomatic COVID-19 infection found no significant association between mortality and the receipt of cytotoxic chemotherapy, radiotherapy and immunotherapy. This suggests curative treatment should not be delayed in cancer patients while trying to shield cancer patients from exposure to the virus.[27]

Curative cancer surgeries were also subject to change, delays or cancelation due to safety concerns or lack of resources.[9,38,40,48,66] Surgical oncologists often considered referral to non-surgical options such as radiotherapy or switching to a less risky surgical technique.[3,9,15,75] For instance, one study reported that cordectomies were performed for vocal cord malignancy using a sharp technique, instead of the laser technique to prevent aerosolization of viruses.[49] In addition, attempts to switch from general anesthesia to local or regional anesthesia were observed during sentinel lymph node biopsies and breast cancer surgery in some UK centers.[42,76] In the US, robotic technique was preferred over open surgery when managing urological cancers, while some others reported use of enhanced recovery programs after surgery protocols to minimize hospital stay.[14,70] Patients who were also candidates for supportive therapy alone or eligible for alternate non-surgical treatment were excluded from hospitalization.[35]

In summary, many centers judiciously considered risks and benefits for treatment continuation or initiation for patients, such as treatment-related complications and intensive care availability.[3] Although downscaling treatment plans in cancer patients was a significant intervention in this review, Poggio et al expressed their concern over potential undertreatment of cancer patients as a result of these treatment changes.[74] The general consensus was that each patient should be assessed on a case-by-case basis by multidisciplinary teams and that delaying treatments for curable cancer was not recommended. Tumor stage, histology, age, treatment type, comorbidities, patients' general well-being and history of recent pneumonitis were taken into account when assessing the risks and benefits of cancer treatments.[39] Documentation of treatment variation into trust databases and regular auditing of clinical activity was also deemed crucial in maintaining standard of care during COVID-19 pandemic (Head and Neck Surgery, UK).[19]

(6) Service Restructuring

Due to resource scarcity, staff shortages and interruptions to care continuity and accessibility, service provision was often

adapted to combat the pressures inflicted on healthcare institutions. Service restructuring through role allocation, outsourcing and patient transfers were common methods used to help mitigate the strain. For example, healthcare providers outsourced investigations (blood tests) or transferred patients externally to private sectors/local providers to help alleviate burdens.[3,17,46] Some studies made referrals to family doctors and centers closer to the patient's home in order to maintain care continuity and conduct follow-ups, while also minimizing patient travel.[33,39]

Good organization and role allocation of healthcare staff proved to be pivotal in streamlining cancer care.[11] A case from the epicenter of the outbreak in Wuhan outlined the redeployment of 50 doctors and nurses to oncology departments who were part of departments that were not in service when cases of COVID-19 started exponentially rising.[21] Ong et al also ensured that there was efficient deployment of manpower to maintain high patient loads.[72] The importance of COVID-19 dedicated teams in Europe was also highlighted, whereby Valenza et al also described how setting up a "surveillance team" (including one nurse specializing in respiratory care) meant that COVID-19 patients could continuously be monitored (Italy).[37] In addition, in the UK, junior doctors also provided effective 24-hours cover for all inpatient areas onsite. This was made possible via an implemented shadow rota to cover sickness or self-isolation absence.[30] In the context of surgery, the importance of surgeon selection was also mentioned, with one study reported using only highly experienced surgeons who were selected for airway operations as a means to reduce contact time and risk as they were able to carry out surgeries at a quicker pace.[15] These examples demonstrate how assembly of a team with dedicated responsibilities and selection of staff based on their skills and competencies can contribute to increased safety and better quality of care.

In addition, to improve drug delivery, drug-refill clinics were set up to fast-track repeat prescriptions for stable patients who did not require drug reviews in Hong Kong.[15] In other countries, home delivery of medications was introduced to minimize patient travel to pharmacies.[14,21,41,43,60] One study also reported that patients received a higher volume of drugs at each hospital visit so that patients did not have to keep on returning to replenish their supply.[55]

Another significant determiner for service restructuring was the need to accommodate demand, maintain care continuity, and address the accumulation of delayed and canceled appointments.[22,28,66,69] Service restructuring proved to be essential in mitigating these strains. In Italy, a specific outpatient clinic was set up to resolve treatment-related cutaneous and mucosal adverse events53. This allowed for dedicated care for specific issues, while reducing appointment backlogging. Italian cancer designated hubs were also created to deliver necessary curative treatments in regions significantly hit by the virus (Lombardy) to ensure patients in high-risk areas were also able to access adequate care.[55] In Singapore, Ong et al reported that efforts were devoted to review patient lists for clinic sessions in order to decrease outpatient load and defer non-urgent cases.[70] Healthcare providers that limited caseloads to 10-15 patients per session and spaced out appointment times also implemented evening and weekend clinical sessions to reduce the backlogging of appointments.[7,15] Out-of-hour operations were also adopted to catch up on rescheduled lung cancer surgeries (UK).[75]

Finally, various institutions formed leadership teams and committees, who were pivotal in making crucial decisions in regard to various aspects of service restructuring in order to minimize patient contact.[30] For example, Blot et al highlighted the crucial role played by their ethical committee board in assisting physicians with decision making in clinical dilemmas.[77] Additionally, Civantos et al also set up an otolaryngologic triage committee in order to decide patient resource allocation, while in Germany a multidisciplinary leadership task force was created to assess treatment plans on a case-by-case basis.[8,9] These leadership teams were essential for service restructuring decisions and ensured that care provision could be prioritized and maintained in a safe and efficient way.[9]

The Utilization of Tele-oncology for Care Provision

Possible financial, social and ethical factors should also be considered as telehealth becomes more integrated into cancer care. In terms of ethics, adequate cybersecurity measures should be in place to ensure patient privacy is protected.[78] Financially, positive economic outcomes for telemedicine usage have been reported highlighting the potential cost-effectiveness for healthcare institutions.[17] Financial support has been demonstrated by some countries such as the USA, where reimbursement for telephone and video encounters has been allowed.[78] However, ambiguity remains in regards to how flow of funds and reimbursement pathways will continue post-pandemic and as well as what constitutes as "chargeable" care.[78] Thus, there is a need for financial regulation and renegotiation of funding models to ensure that the financial implications posed on cancer institutions and oncologists can be minimized.

Despite the numerous benefits of telehealth, the social and structural implications associated are numerous. Internet connectivity, possession of digital devices and technological literacy are factors that can lead to digital and socioeconomic divides. As aforementioned, the virtual pivot may also have significant effects on doctor-patient interactions and rapport building, as well as removing the "social, moral and ritual significance" of in-person communication.[78] Thus, in order to bridge the digital void, acquisition of communication and technological skills within tele-oncology settings are required.[78]

In summary, the COVID-19 pandemic has emphasized the benefits of the clinical application of tele-oncology for cancer patients.[80,81,82] As many cancer treatments often result in immunosuppression, cancer patients are a prominent risk group in the pandemic due to their increased susceptibility to contracting COVID-19. Thus, a significant benefit identified for tele-oncology is that it reduces the risk of infection through decreasing in-person contact, while maintaining care continuity. Additionally, since previous literature has reported that virtual oncology services are efficient, cost effective and result

in good patient satisfaction, the future of tele-oncology is a promising prospect and is likely to be continually adopted post-pandemic in routine clinical care.[75,83,84]

Broad Considerations for Cancer Care Provision

The COVID-19 pandemic has placed inevitable psychological implications on cancer patients. Ciążyńska et al found that cancer patients often felt stressed due the uncertainty regarding their cancer therapy and the risk of developing COVID-19 symptoms while undergoing treatment.[84] Furthermore, patient wellbeing was also affected due to social distancing restrictions, as patients who would have previously taken their family members to hospital appointments were asked to come alone.[84] While our review focuses on the operational and organizational adjustments to care provision, cancer institutions must also consider the importance of providing emotional support and addressing mental health issues that are prevalent among cancer patients at this time.

Learning from the pandemic has also highlighted the broad impacts of how governmental policies and societal needs have shaped oncological care. It has also emphasized the need for healthcare systems to be dynamic and flexible in order to mitigate the mid and long-term ripple effects that will be reflected in clinical practice and patient outcomes. Broad challenges on oncological care will include: the effects of unemployment and thus the inability to pay for cancer therapies, access to novel treatments and clinical trials as a result of structural impacts, disparities in patient experience due to wider socioeconomic disparities, and enhanced mental health consequences.[78] In light of this, we can foresee that future cancer patient care will be disproportionately affected by the consequences of the COVID-19 pandemic.[78]

Available Models of Care Delivery for COVID-19 Positive/Negative Patients

COVID-19 Positive Patients. As COVID-19 positive patients may still shed the virus for prolonged periods, care delivery was adjusted in order to maintain cancer care for those requiring it in the interim. For these patients, 2 priorities were prominent within the care models of each institution. Firstly, changes to models of care were made to ensure effective isolation (either at home or in a quarantined area onsite) to minimize viral spread to other patients and personnel while receiving care. While isolation requirements often resulted in the cancelation/delay of treatments, implementation of COVID-19 designated areas in institutions facilitated the continuation of treatment for patients in need of in-patient care. Additionally, since COVID-19 positive were deprived of visitors, models of care should include services that supplement the emotional support that is usually provided through visitation.

Another significant consideration was the type, frequency, and continuation of treatment that was given based on their medical need and severity of cancer. Thus, the opportunity cost of maintaining cancer care in those infected was judiciously considered. The factorization of risks imposed by infection, such as developing severe pneumonia during the disease course and their weakened immune state were significant determinants for the proposed model of care delivery which were decided on an individual basis. The importance of conducting risk-benefit analyses has been particularly emphasised in the context of surgery, due to the substantial risk of mortality and developing postoperative complications in patients with COVID-19.[85]

COVID-19 Negative Patients. For COVID-19 negative patients, efforts were predominantly centered around reducing the risk of contracting the virus. As a result, models of care delivery and treatment were adjusted to safeguard and mitigate the possible negative health outcomes patients may experience should they get infected at a later time. To reduce this risk, segregation systems were often instated to ensure COVID-19 negative patient safety. For institutions providing care within the same building, staff segregation interventions were instated so that staff working in COVID-19 designated areas would not mix with staff in contact with non-infected patients. In addition, some institutions implemented transfer procedures to relocate patients from general hospitals dealing with COVID-19 cases to COVID-19 free centers so that treatment could resume in low infection risk settings. Similar to patients who tested positive, the risk of COVID-19 exposure was weighed against the risk of not receiving or de-escalating cancer treatments.

In summary, the literature emphasizes the great importance of multidisciplinary leadership teams studying treatment regimens on a case-by-case basis due to the varying cancer types, prognosis, and needs within the cancer patient population. Moreover, due to their vulnerability to infection, institutions should also priorities effective segregation and isolation measures within their care delivery procedures. Based on these priorities, there is a need for models of care to be catered and flexible to patients according to a detailed risk-benefit criterion.

Recommendations

The purpose of the narrative synthesis conducted in this review was to identify key areas that must be targeted in order to mitigate viral spread while maintaining cancer care provision. In doing so, the themes outlined in the literature can be considered by cancer centers or other institutions containing high-risk patient populations when planning and implementing their own interventions amid the viral outbreak. Table 5 and Figure 2 highlights recommendations based on the findings from this review.

The utilization of common quality improvement tools, such as logic models (to evaluate the effectiveness of interventions), process mapping (to map out staff workflows and patient journeys) and Plan, Do, Study, Act Cycles (to test interventions and incrementally improve them) are recommended for the planning and assessment of new strategies for cancer service

Table 5. Table of Recommendations.

Testing and Tracking	1. Pre-admission screening and testing outside hospital entrances 2. Mandatory health questionnaires for patients and visitors regarding symptoms 3. Testing for all patients before undergoing any medical procedures 4. Frequent staff testing 5. Strict and thorough contact tracing (e.g. documentation of contact and travel histories) 6. Dedicated tracer team to monitor patients progress, investigations, outcomes and staff exposure and quarantine
Outreach and Communication	1. Use of videoconferencing meetings for MDT and staff to coordinate care 2. Patient education on cross-contamination risks and safe practice 3. Use of telehealth to communicate with patients (treat, track and monitor) 4. Consider the ethical and financial challenges of transitioning to telehealth and the psychological impact on tele-oncology on patients 5. Consider and address the impact of tele-oncology on the doctor-patient relationship 6. Provision of cancer-related education materials online or through leaflets 7. Development of mobile phone apps for monitoring treatment and/or identifying those at risk of COVID-19 8. Education about and open discussion on the impact of COVID-19 or additional risks of COVID-19 infection with patients
Protection	1. Provide training on PPE and provide PPE to all staff 2. Perform weekly PPE stock checks to mitigate potential shortages 3. Implement a tiered PPE protocol based on patient type and status 4. Staff change into clean surgical scrubs when entering hospital 5. Provide visitors and patients with masks upon entering facility 6. Use of video laryngoscopes and plastic sheaths can be used as a barrier to reduce aerosol spread during intubation to protect anesthetists 7. Hand sanitization should be made compulsory 8. Disinfect surrounding environments and frequently contacted areas 9. Consider using UV light radiation and vaporized hydrogen peroxide to extend the use of N95 respirators 10. Maintain PPE supply through engaging with external stakeholders (e.g manufacturers and charities)
Social Distancing	Patients and Visitors 1. Visitors/caregivers should be given limited access to health facility 2. If accompanying visitors are allowed, health checks should be put in place 3. Limit number of patients on-site (prioritization of admission can be done through triaging) 4. Instate measures to reduce waiting room congregation and waiting time (e.g. online booking systems to reduce waiting time, ask patients to wait in car) 5. Use of videoconferencing for discussions with patient and family 6. Requiring patients to quarantining and test negative for COVID-19 before surgery 7. Immediate patient isolation in a single room upon arrival Staff 8. Ensure personnel and staff onsite are kept to a minimum (especially for surgical procedures) 9. Staff segregation systems put into place to reduce intermixing 10. Set up oncological teams focusing solely on COVID-19 patients with cancer, including a respiratory specialist 11. Movement restrictions should be put in place to contain staff/patients to one area to reduce interdepartmental/facility viral spread 12. Workspaces should be reconfigured to ensure adequate spacing 13. Plans to combat staff shortages if staff isolation is required (e.g. split teams into sub-teams) 14. Use of videoconferencing for multidisciplinary teams and healthcare workers 15. Perform aerosol generating procedures with the minimum number of members of the anesthetic team in the operating theater General 16. Segregation by area (allocate areas for COVID-19 and COVID-19 free rooms/zones) 17. Treatment rooms should utilize cameras to reduce healthcare worker-patient contact 18. Provide training on social distancing to staff and patients

(continued)

Table 5. (continued)

Treatment Managements	1. Carry out careful risk-benefit assessment before treatment initiation /continuation
	2. Consider de-escalation of treatment regimens/frequency:
	  1. Consider oral/subcutaneous treatments over intravenous treatments (as well as prolonged treatment intervals for intravenous treatment)
	  2. Consider defer radiotherapy for less aggressive tumors; Hypofractionating radiation for those who are on radiotherapy to shorten treatment schedules
	  3. Consider changing to less invasive/immunosuppressive treatments
	3. Consider postponing/canceling elective operations
	4. Employ surgical techniques with lower risks of aerosolization
	5. Minimize length of hospital stay using less invasive (e.g. robotic) surgery or enhanced recovery protocols after surgery
	6. Document treatment variation and regularly audit clinical activity to maintain standard of care
	7. Consider non-surgical interventions when possible

Service Restructuring	1. Consider outsourcing selected clinical investigations (e.g. blood tests) to non-academic centers or the private sector 2. Delegate and refer care provision to family doctors/local centers 3. Streamline drug delivery: set up dug-refill clinics, home delivery, and prescription of medication through telehealth. 4. Limit case load and space-out patient appointments 5. Instate out-of-hour operations to reduce accumulation of delayed appointments 6. Form leadership teams or committees to help advise and streamline care 7. Form shadow rotas to help cover sick or quarantining staff 8. Leadership roles should be given to senior staff members to delegate tasks effectively 9. Select experienced surgeons to perform airway operations to minimize contact time with patient. 10. Redeploy staff from hospital departments that are not in service to oncological wards

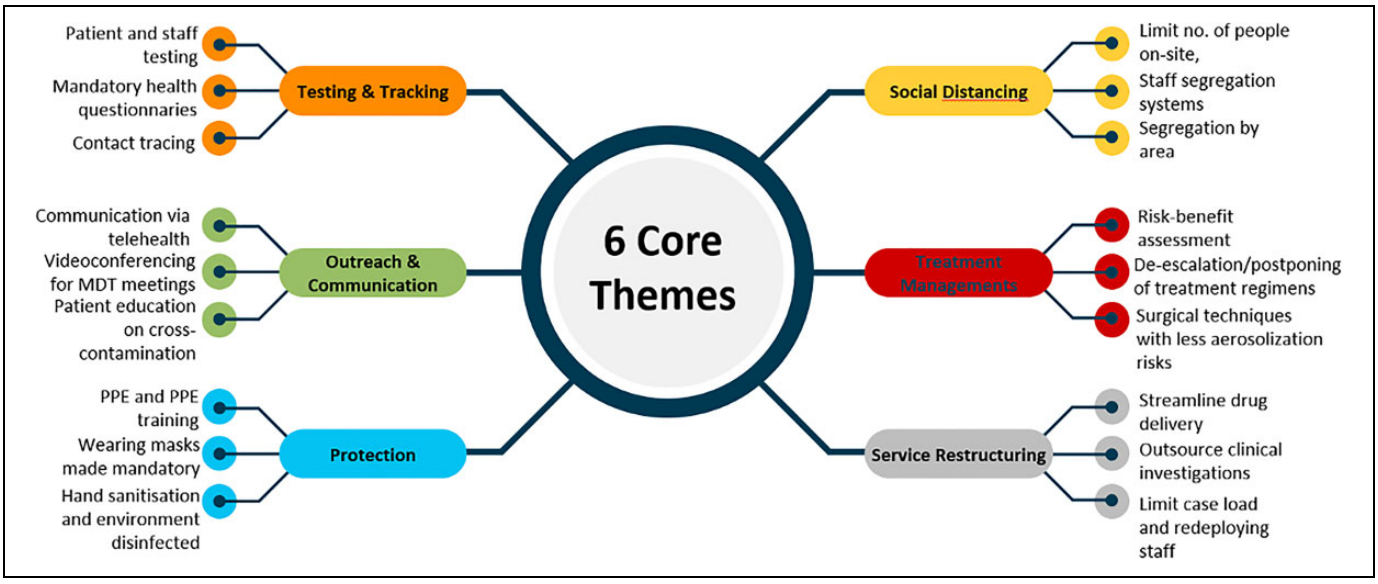

Figure 2. Summary of Themes.

provision. These tools will help ensure that any changes to cancer care are thorough, efficacious and efficient.

Future Research

In search of a better strategy to support cancer patients during the COVID-19 pandemic, research priorities should be directed to the following areas. Firstly, long-term clinical data is required to assess the impact of treatment de-escalation has on patients' outcomes. Secondly, psychological impacts on cancer patients should also be examined with both qualitative and quantitative methods to help guide evidence-based interventions aiming to provide adjunctive holistic and emotional care. Thirdly, though many healthcare institutions have shared their ideas on possible adjustments to be made on an organizational level, quality improvement data is still limited. Sharing of this information should be encouraged as it could provide a

point of reference for recommended intervention implementation when managing future health crises. Finally, as we anticipate further consequential impacts on cancer care post-pandemic, it is imperative that efforts are made to better understand the mid- and long-term implications imposed on clinicians and patients. In order to strengthen the evidence-base, qualitative methods should be employed to aid primary data collection through surveys/interviews with relevant stakeholders to better comprehend the impacts of COVID-19 on the oncological landscape.

Limitations

Majority of the articles included in this review were geographically based in high-income/upper-middle income countries. Consequently, relevant learning from low-resource settings may be limited. This was evident in our search, as the majority of screened studies were from China, Italy, Singapore and the United States.

In addition, our search strategy only included publications in the English language, meaning that the review may be subject to geographical bias. Thus, learning from non-English speaking countries (such as high death toll countries like Italy) may have also been forfeited as it can be assumed that a large proportion of studies would have been published in their native language.

While descriptions of interventions were plentiful in the literature, many studies did not report outcomes on whether the strategies were effective in mitigating spread of the virus and facilitating care provision. Therefore, we cannot be certain on how effective the interventions were in yielding positive outcomes and reducing the number of COVID-19 cases in cancer patients and healthcare workers.

Since this review only provides a descriptive list of interventions adopted globally (which were largely adopted due to recommendations encouraged by governments and scientific organizations e.g. testing and triage), it is difficult to form a uniform summary of cancer care changes as different countries have experienced different COVID-19-related challenges. Thus, due to the varying healthcare system contexts and burdens, we are unable to provide definitive recommendations for cancer care provision since there is no one-size fits all solution.

Conclusion

Cancer patients are a high-risk population amid the COVID-19 pandemic. As a result, extensive planning must be undertaken to protect this population from infection and COVID-19-related risks, while also maintaining their cancer treatment and care. Many institutions have adopted various strategies to safeguard their patients and staff and streamline service provision, however the extent of success of these interventions is still unknown. This systematic review provides an updated summary of the evidence-base and presents 6 core themes of targeted intervention commonly adopted within numerous cancer institutions globally. The themes can be used as a tool to inform future interventions that can be implemented by healthcare institutions facing similar risks amid the COVID-19 outbreak.

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Ethical Statement

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