Managing Patient Flows in Radiation Oncology - Reworking Existing Treatment Designs to Prevent Infections During the COVID-19 Pandemic at a German University Hospital

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Abstract

Purpose
Implementing active Patient Flow Management practices in a large University Hospital Radiation Oncology Department to prevent nosocomial infections of patients and personnel during the COVID-19 pandemic, while safely enable continuation of essential therapies and optimizing infrastructure utilization.

Patients and methods
Year-to-date intervention analyses of calendar weeks 12 to 19 comparing years 2019 and 2020 inpatient and outpatient procedures evaluating active patient flow management effects on overall treatment and facility capacities while analysing COVID-19 nosocomial infections.

Results
Implementing changes in active patient flow management first visit overall appointment compliance maintained above 85.5%. Appointment reduction of publicly insured patients by 10.3% daily (p=0.004) significantly increased downstream planning CT appointment scheduling (p=0.00001) and performing (p=0.0001) resulting in absolute 20.1% (p=0.009) increment of CT performance. Daily treatment inception was significantly increased by absolute 18.5% (p=0.026). Hypofractionation and acceleration was significantly increased (p=0.0043). Integrating strict testing guidelines, distancing regimen for staff and patients, strict hygiene regulations and precise appointment scheduling, no SARS-CoV-2 infection in 164 tested Radiation Oncology Service inpatients was observed.

Conclusion
In times, where medical infrastructure capacities are shortened and resources reduced, controlling infrastructural time per patient, optimizing facility utilization, personnel workload and machine occupancy rates during therapy evaluation, planning and irradiation in the inpatient and outpatient setting can help increasing appointment compliance and securing time for quality management. Avoiding recurrent and preventable exposure to health care institutions has potential health benefits and might avert nosocomial infections during a pandemic such as the current COVID-19 pandemic enabling Radiation Oncologists continue essential treatments safely.

Introduction
Continued global spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the associated risk of pulmonary manifestations of Coronavirus disease 19 (COVID-19) posed a challenge to all human societies in late 2019 and early 2020 [24]. Mainly, three horizontal transmission pathways of SARS-CoV-2 are being discussed which impacted the contact guidelines from the Societies of Radiation Oncology [25] [26]: droplet infection, contact infection and airborne transmission [12] [27] [15]. In lack of targeted treatment options such as specific antiviral medication or vaccines against COVID-19, primary prevention in form of isolation, quarantine, social distancing, and community containment were key response mechanisms to control the pandemic [22]. Due to the late symptom onset along high numbers of asymptomatic manifestations of COVID-19 it has been widely reported that controlling the viral transmission especially in health care facilities is crucial to reduce disease spread from personnel and patients [28].

As a population at risk during the ongoing COVID-19 pandemic [29], cancer patients and their healthcare providers must constantly balance risks of infection associated with diagnostic or therapeutic procedures against the risk of potential treatment delay. For patients undergoing external beam radiation therapy (EBRT), this is of particular relevance as most regimens are fractionated and require sequential visits. While medical infrastructure capacities are shortened and medical resources reduced, procrastination of cancer treatment is associated with disease aggravation of clinical symptoms, cancer stage exacerbation, metastatic spread, therapy failure and worse overall survival. Therefore, amidst the COVID-19 outbreak, health-care providers globally need to adapt their patient flows and re-organize health-care pathways to continue delivery of indispensable treatments for patients. At the University-Hospital of Cologne, Germany, the Department of Radiation Oncology re-modelled ambulatory patient admissions and
re-shaped treatment delivery processes by actively managing patient flows to adapt to the potential shortage of staff, supply, and government-regulated reduction of hospital treatment capacity at the early onset of the pandemic [20] [30].

The German Board of Haematology and Oncology stated that “the fear of a potential infection with SARS-CoV-2 need not prohibit essential cancer treatment. Additionally, a cancer patient having been infected must not be endangered by the complications of COVID-19, as well as infect the whole treatment facility or ward” [31]. In the Department of Radiation Oncology, cancer patients of different entities are treated with (chemo-)radiation using different techniques and application schedules. Most of these require fractionated treatment and sequential visits over a period up to several weeks.

Optimally, prior to a patient’s first visit in Radiation-Oncology, diagnosis is already confirmed, staging frequently completed and alternative treatment options discussed in multidisciplinary meetings. Therefore, time-efficient treatment planning and start are primary measures of efficacy. At the beginning of the COVID-19 outbreak adherence to the aforementioned standard was utterly important to keep the treatment facilities uncontaminated and the personnel and patients healthy, to not risk delay of treatment before and during radiation.

In 2019, a total of 2,174 patients were treated within the Department of Radiation Oncology of the University Hospital of Cologne. 52% of the patients presenting to the outpatient clinic were of male gender and 48% were female. According to the annual reports, the University Hospital of Cologne is a German maximum medical care provider holding 1,540 beds. Generating about €5.72 million Earnings Before Interest and Taxes (EBIT) in 2018 [32] with 58 Departments a total number of 360,882 patients constituted of 62,862 inpatients and 321,585 outpatients were treated by 10,700 staff members in 2018. We here report on our experiences on coping with the early COVID-19 pandemic.

**Patients And Methods**

As Radiation-Oncology treatment planning requires multidisciplinary interactions across therapy teams, efforts were put into scaling IT capacities. Telemedical cancer board meetings via video-call options were implemented, while essential meetings that cannot be held via webinar interfaces were limited to a maximum of 5 persons. To comply with meeting regulations, regularly held daily morning, noon and afternoon physician meetings were reduced and replaced by phone and secure digital communication. IT infrastructures were implemented for home-office work such as contouring and treatment planning. Tele-medical routines were implemented and offered for appointments during and after full radiation treatment via telephone consultation and video-assisted options.

To abide by strict official desinfection-[9], hygiene- [33], contact- and distance regulations at the University Hospital of Cologne, it is mandatory for personnel and patients presenting to the hospital to wear a face mask across the entire campus. While at the inception of the pandemic, medical material was shortened, personnel received a medical face mouth mask daily, patients received a mask once a week. To act on hospital hygiene regulations, staff permanently wear filtering facepieces and additionally keeping a minimal distance of 1.5 meters to each individuum. Reducing the number of personnel within the facility, management further aimed to reduce shift fluctuation of the personnel to secure regular personnel and patient set-ups. Here, long-term shift assignment were implemented to team up the identical staff permanently and reduce cross team personnel fluctuation.

All sorts of business trips were prohibited. Staff showing symptoms of viral upper respiratory tract infection or flu-like symptoms were prohibited to enter the medical infrastructure up until 48 hours after stopping of symptoms along with negative diagnosis of COVID-19 by viral nucleic acid testing. In addition, a fourteen-day restraining order applied to personnel with proven history of transnational travelling.

Separating patient flows and triaging groups, patient appointments were individually re-scheduled. To reduce peaks of patients at the beginning of work-flow re-design, patients were given exact appointment slots and grouped into treatment severity groups for appointment order. For first-appointment scheduling purposes patients were grouped into malignant and benign diseases. All treatments regarding benign disease were pretermitted during the pandemic. Curative, definitive and palliative radiation treatment regimens which were prioritized over postoperative adjuvant treatments. Treatment protocols were performed according to standard of care practices.
To reduce the number of persons presenting to the Department, a strict ban on visitors was put in place for both, ambulance and ward. Exceptions were individually discussed and exceptions mainly applied to persons with legal medical attendants.

Monitoring and controlling the time per patient and increasing the patient appointment compliance is crucial. In the new workflow, overbooking of appointments to control for potential patient no-shows were suspended to increase patient and staff safety. To control patients’ show rate and precise appointment timing compliance, reminder were implemented by actively calling patients prior to their appointments. To increase Departments efficiency while reducing clustering of patient in common waiting spaces, patients were urged to wait outside the facility and allowed to enter the facility shortly before their designated appointment. The same individual appointment matching routine applied for the daily fractioning scheme for each patient.

It was aimed to reduce the time per patient spent in the facility. Patients were grouped in four time-categories A-D of short, medium, long and extra-long expected time slots to perform their planning CTs. This structure enables the treatment team to control the time per patient and to ensure time to comply with hygiene and desinfection guidelines. By optimizing the timing of treatment planning slots control of time was maximized and waiting time reduced. Patient appointments were aligned with time slots, to further reduce the simultaneously presenting number of patients to the Department and the number of patient contacts. Here, pre-screening of patient’s disease by physicians and preparation of full track of patient records were aimed to reduce the number of multiple appointments and to help triaging of patients into severity groups. Being characterized by groups A-D, the potential time per patient spent in the facility was estimated and defined as the complexity of patient interaction via assessment, examination and treatment discussion.

It has been previously published, that >20% of infected persons remain asymptomatic [13]. To best prevent infrastructural contamination at the Department of Radiation Oncology, patients planned for in-hospital medical care receive a PCR test for COVID-19 at the day of ward admission. To secure staff and prevent horizontal transmissions for every elective invasive medical procedure such as interventions (fiducial implantation, Port-implantation, intra-uterine device implantation, Feeding Tube) patients must hold a negative test result at the moment of procedure beginning. This test must not be older than 72 hours. This routine does not apply to interventions or operations whose medical urgency do not tolerate any delay to await the negative test results prior to beginning. Here, special hygiene protocols apply to secure safe operation.

Over the course of eight weeks, we performed a detailed post-intervention analysis of the outpatient working routines totaling a 37 working days observation period of both 2019 and 2020 for calender weeks 12-19 year-to-date. From the inpatient clinics, analyses via PCR-testings of every hospital admission dating March 15th till May 7th 2020 were conducted.

For comparison, datasets used in this study cover the periods from March 18th 2019 to May 10th 2019, and March 16th to May 08th 2020 encompassing outpatient and inpatient care setting received by both publicly and privately insured patients. Statistic analyses of two-sided-t-tests were performed by the authors using Microsoft Excel Office16 and R version 3.5.0 released on 2018-04-23. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Patient Flow Management Figures of 2019 and 2020
|                          | 2019            |             | 2020            |             |
|--------------------------|-----------------|-------------|-----------------|-------------|
|                          | Total Number    | Daily Number| Total Number    | Daily Number|
| Public Ambulance         | 262             | 7.08        | 235             | 6.35        |
| Scheduled                |                 |             |                 |             |
| Public Ambulance         | 233             | 6.30        | 199             | 5.80        |
| Presented                |                 |             |                 |             |
| Show Rate Public         | 88.93%          | -           | 84.68%          | -           |
| Ambulance                |                 |             |                 |             |
| Private Ambulance        | 99              | 2.70        | 105             | 2.84        |
| Scheduled                |                 |             |                 |             |
| Privat Ambulance         | 91              | 2.46        | 92              | 2.49        |
| Presented                |                 |             |                 |             |
| Show Rate Private        | 91.92%          | -           | 87.62%          | -           |
| Ambulance                |                 |             |                 |             |
| Planning CT              | 346             | 9.35        | 394             | 10.68       |
| Scheduled                |                 |             |                 |             |
| Planning CT              | 305             | 8.24        | 369             | 9.97        |
| Performed                |                 |             |                 |             |
| Show Rate CT             | 88.15%          | -           | 93.65%          | -           |
| Treatment Started        | 276             | 7.46        | 327             | 8.84        |
| Aftercare Clinic Public  | 318             | 12.23       | 6               | 0.16        |
| Aftercare Clinic Private | 48              | 2.08        | 13              | 0.35        |
| Cyberknife Treatment     | 48              | 1.45        | 67              | 2.23        |
| Start                    |                 |             |                 |             |
| Cyberknife Treatments    | 105             | 3.18        | 99              | 3.3         |

For the observed periods, the daily number of first-contact, public-healthcare patients scheduled ([CI 95%; SD 1.0 vs. 1.3] 7.1 vs. 6.4; p = 0.004) and presenting ([CI 95%; SD 1.4 vs.1.3] 6.3 vs. 5.4; p = 0.0024) to the outpatient clinic was significantly lower in 2020 compared to 2019. We observed a 10.3% reduced scheduling rate to 89.7% for 2020 appointments compared to 2019 number of patients scheduled and a 14.3% reduction of patient presentation to 85.7% of the previous year. However, there was no significant difference in the overall show-rate (88.9% vs. 85.5%) p=0.165 (α=5%).

For the private outpatient clinic, there was no difference evident for daily scheduled ([CI 95%; SD 1.4 vs. 1.1 ; 2.7 vs. 2.8, p=0.331) and presenting ([CI 95%; SD 1.4 vs. 0.1] 2.5 vs. 2.5, p=0.468) patients. Notably, we observed slight increases in both scheduled patients (6.1%) and presented patients (1.1%) compared to 2019 appointments.

The number of daily scheduled and performed planning-CTs was significantly higher in 2020 ([CI 95%, SD 1.4 vs. 1.6] 10.6 vs 9.4, p=0.0001) and ([CI 95%; SD 1.4 vs. 1.6] 10.0 vs 8.2, p= 0.0001), respectively. Moreover, the daily patient-show rate was significantly increased from 88.2% in 2019 to 93.7% in 2020 (p=0.009) (α=5%). Overall, we see a 13.9% increase in CT’s scheduled and increase in CT-performed rate by 20.1% for 2020 compared to the 2019 baseline.
The daily number of patients starting radiation treatment significantly increased from 2019 to 2020 ([CI 95%; SD 2.93 vs. 0.63] 7.5 vs 8.8, p=0.026). Out of the patients scheduled for treatment, we identified an 18.5% increase in treatment inception rate of 2020 compared to 2019.

While for the daily average of treated patients using SRS at the Cyberknife we did not observe significant differences ([CI 95%, SD 1.53 vs. 1.14] p=0.364) 3.18 vs. 3.3 patients for 2019 compared to 2020, we observed significantly higher daily treatment beginners ([CI 95%, SD 1.20 vs. 1.14] p=0.0043) 1.45 vs 2.23 in 2020. Hence, leading to 45.71% (48/105) vs. 67.68% (67/99) of first treatment of overall fractions per day comparing 2019 and 2020.

The number of patients presenting to the after-care clinic was reduced from 2019 to 2020 for both public (318 vs 6, p = 0.0001) and private (48 vs 13 p=0.001) sector. Despite expectable financial losses, daily presentation was reduced from average 8.6 in 2019 to 0.2 for the public sector and from averaging 1.3 to 0.35 patients daily.

Out of a total of 913 hospital bed days, patients on average spent 5.67 days [median 3; SD 6.72] at the Radiation Oncology ward. Testing a total number of 74 patients or individual 164 inhospital cases during the observation period of March 15 to May 07th, we did not observe a positive RT-PCR test result for any probe analysed within the cohort.

**Discussion**

Health-care providers must increasingly integrate supply chain management routines into their workflows. According to Jiang, Friedman and Begun [11], quality management and prediction drive hospital efficiency, care providers productivity and patient satisfaction. Direct costs associated with prevention and treatment along with indirect costs of lost economic value of lives lost and disability caused, cancer globally accounts for approximately $1.16 tn. Including long-term costs to patients and their families, annual global cost of cancer are expected to spiral up to $2.5 tn. [34] It is estimated that reducing the amount of cancer death by 10% could potentially save $5 tn. in economic value. Hence, health care providers are expected to focus on tactics to control service cost and utilization rates to control future costs of cancer care.

After adjusting for age and smoking status, COPD, diabetes, hypertension and malignancy were identified as risk factors for severe complications during SARS-CoV-2 infections [3]. As cancer patients form a major risk group during this pandemic [29], Oncologist need to consider the potential risks of mortality and COVID-19 morbidity against the advantages of intended oncology therapies [5], as delaying potentially curative treatments affects oncologic outcome. Therefore, it is of paramount importance for the patients to counter the existing limitations of the hospital infrastructure by optimal infection protection of the staff and the best possible use of the capacities.

Detaining cancer therapy due to infrastructural capacity restrictions should be prevented according to a Germany wide survey [1]. In multi-modal therapy concepts for colorectal carcinoma, 95% of surgeons postulate that timely operative interventions should be performed according to standard therapy indications despite COVID-19 pandemic. A 16% increased mortality risk for every month of deferral of radiotherapy head- and neck cancer patients (risk ratio (RR) 1.16, 95% CI 1.02–1.32), as well as delay in adjuvant chemotherapy for colorectal cancer (HR 1.14, 95% CI 1.10–1.17 per 4 weeks) and breast cancer (RR 1.08, 95% CI 1.01–1.15 per 4 weeks) are associated with poorer overall-survival [5].

To ascertain uninterruptible treatment procedures and control for contant workstations, by implementing novel workflows to continue essential treatment planning and delivery in the outpatient and inpatient setting. Underutilization of medical resources hold negative impacts by increasing healthcare costs, decreasing access to care, and reducing efficiency and productivity of care providers [7]. As the most common reasons for missing medical appointments are forgetting (35.5.%) and miscommunication (31.5%) [35], it is recommended to and proactively schedule patients to diminish negative impacts of patient no-shows [8]. While predictive models propose overbooking approaches to significantly reduce patient waiting by at least 6%, 27% on overtime, and 3% on total costs compared to flat-overbooking methods [7], our Department early focused on controlling appointment compliance while avoiding over-booking. Analysing calendar weeks 12-19 of years 2019 and 2020 year-to-date, we found that while reducing the overall number of patients presenting to the Department of Radiation Oncology by 10.3%, the resulting daily number of patients starting radiation therapy was increased by 18.5% (7.5 vs. 8.8; SD 2.93 vs. 0.63) p=0.026 year to date. Comparably, pre-appointment reminder calls effectively decreased no-show rates by 19% [14]. Patients with deferrable treatments were selected for...
reduction of first appointments after having actively been discussed in interdisciplinary cancer board meetings and triaged by pre-
selection. Additionally, external patients were referred to near to home treatment facilities. Generally, avoiding aggressive
scheduling of outpatients is associated with losses of considerable and less flexible transportation of inpatients [36].
Aforementioned interventions can significantly reduce no-show rates of 29.2% to as low as 22.8 % (absolute risk difference −6.4 %,
p < 0.001, while cancellation rates (13.1 % vs. 11.5 %, p = 0.15), and reschedule rates (14.2 % vs 12.2 %, p = 0.09) can insignificantly
be reduced. In general health, staff reminder calls can reduce no-show rates from 23.1% to 13.6% [16]. While during a pandemic
punctuality was important for our Departments' patient ow, attempts to actively use reminders shortly before designated
appointments and to reassure radiation treatment onset and continuation were implemented. This was important to alleviate the
patient's anxiety and insecurity towards safety of therapy during the pandemic.

To control for patient punctuality, nonreceipt of appointment reminders 2 hours before appointments strongly correlate with 15- to
60-minute tardiness (odds ratio [OR], 1.25; 95% confidence interval [CI], 1.13-1.38; P < .0001), >60-minute tardiness (OR, 1.56; 95%
CI, 1.34-1.82; P < .0001) and no-shows (OR, 6.77; 95% CI, 5.45-8.41; P < .0001) [19].

We can observe that is possible to remodel the CT-programme. Signicantly increasing the amount of CT's scheduled (9.4 vs. 10.6;
SD 1.4 vs. 1.6; p=0.0001) and performed (8.2 vs. 10.0; SD 1.9 vs. 1.8, p=0.0001), we observe a 13.9% increase in CTs scheduled
and 20.1% CTs performed in the intervention period and reducing the CT-maschine time occupied per patient during the whole
shift. According to Rosenbaum et. al. [17] modality, younger patient age, appointment time, day of week, and scheduling lead time
are independent variables associated with no-show visits in Radiology. Delays in diagnosis and treatment can lead to increased
morbidity and mortality [18].

Wang et al. [21] describe human-to-human as the primary transmission mode. It is reported, that 1080 health workers in Wuhan
were infected and among 138 hospitalized patients diagnosed with COVID-19, 41% were suspects of nosocomial transmission
resulting in 26% intensive care unit treatments and a mortality rate at 4.3%. To reduce potential nosocomial infections, our
Department aimed to avoid patient clustering. Existing entries to the Department were reduced to a single-entry door equipped with
contactless door-opening mechanisms and a separate exit of same kind to separate patient groups. To reduce airborne
transfection, keeping a one-meter distance from an infected person is beneficial [10].

Despite dedicated testing, we observed neither positive tests for staff nor patients in our Department, while exploratory analyses
[37] of the rst 72,000 cases of COVID-19 in China report 3.8% of cases detected among health care personnel, leading to 0.3%
death of health-care workers. Of all cases reported, only 0.5% the overall collective showed malignancies as comorbidities. Not
detecting positive RT-PCRs for our inpatient cohort could potentially be attributed to the relatively low overall prevalence in
Germany [38]. However, it has been described, that false negative test results could occur due to test and sampling errors [39]. Yet,
unobserved nosocomial infections among patients and personnel nor symptoms of ARDS have led us to have conidence in the
true positivity of our test results. In addition, we did not experience the urge to treat a patient that has been positively testet.
However, alternative patient ow management procedures were prepared by installing hermetically sealed infrastructure and
exclusively assignet personnel governed by security concepts. These mechanisms are not subject of this analysis.

Moreover, as numbers of infected individuals are at rise globally, patient screening, developing rapid diagnostics, vaccines, and
therapeutics are essential to management [10].

Stochastic models identified the efficacy of reducing interpersonnel contacts [6]. We implemented workflows to maximize isolation
of patients under treatment by reducing the number of patient contacts within the facility. Non-treatment related routine follow-up
appointments were deferred in mutual agreement with patients and rescheduled within 2-4 months horizon in close consultation
with the primary oncology care giver. Routine follow up imaging procedures were recommended and performed after individual
case discussion. However, exception was made for the rst aftercare appointment and prioritized via tele-medical infrastructure.
Hereby, the overall daily number of patients presenting to the after-care clinic was signicantly reduced for both the public
(p<0.001) and for the private sector (p=0.001), saving resources for immediate cancer care.

In addition, considerations of moderate hypofractionated treatment regimes to accelerate the treatment and reduce the time span
under therapy might be considered for health care practitioners for established treatment protocols that do not show inferiority to
normofractionation protocols [4] [40]. Our Department performed acceleration and hypofractionation schemes as recommended
by Radiation Oncology Specialits Societies [25] [20] [23] [41] for example for bone metastases (1x8 Gy, and 5x4 Gy Radiation Schemes preferable), and mild hypofractionation for localised prostate cancer (pT1b–T3aN0M0)) analogously to phase 3 CHHip Trial with 20x 3 Gy [2]. For SRS, single fractionation treatments were increased. Here, significantly higher numbers of daily Cyberknife treatment beginners (CI 95%, p=0.0043) averaging 1.45 vs 2.23 patients led to 45.71% (48/105) vs. 67.68% (67/99) of first treatment of overall fractions per day comparing 2019 and 2020. However, there was no significant difference observed for daily treated patients (CI 95%, p=0.364) 3.18 vs. 3.3 patients.

During the upcoming recovery period and increasing treatment-facility reopenings within health care services, medical providers will be challenged with pivotal process reconsiderations. Implementing re-shaped workflows within hospital-medical routines is fundamental to meet the demand of patients accumulated during the lock-down period. We learned from closely related medical fields, such as Medical Oncology, that caregivers need to adapt their modes of medical operations to safeguard therapy. To be best protected against the uncertainty of the COVID-19 pandemic, controlling the patient medical journey should be emphasized.

From our reported experience we conclude that measurements to reduce SARS-CoV-2 transmission in Radiation Oncology Departments might include:

### Table 2: Recommendations to Reduce Viral Spread in Radiation Oncology Treatment Centers

| Recommendations                                                                 |
|----------------------------------------------------------------------------------|
| Identification of high risk and high touch surface areas based on walkthrough assessment. |
| Reduction of entries and exits to guide patient flows to limit entrances for non-employees. |
| Increasing hygiene and secure time for frequency of cleaning and desinfection |
| Personnel Safety Equipment required at all times, provided by facility for personnel and patients. |
| Increasing PCR-testing of patients to detect asymptomatic courses and prevent nosokomial infections |
| Reorganizing seating and reducing number of patients/companions and time spent in the facility |
| Optimizing timing of appointments, procedures and treatment |
| Controlling show-rates while preventing over-booking |
| Modularized spaces, with limited interaction across spaces for personnel |
| Teaming up patients and personnel consistently while reducing staff per designated workplace |
| Integration of telemedical infrastructure in existing working routines |
| Digitizing essential multidisciplinary meetings and reducing number of participants |
| Improving air filtration/ventilation |
| Discussing non-inferior hypofractionated accellerated treatments over normofractionation schemes where alternatively applicable |
| Reserving personnel and separated infrastructure for positively tested patients under therapy |

**Summary**

Precise scheduling and appointment communication amidst a period of decreased institutional capacities can help reducing no-show rates. Stream-lined patient flows allow to decrease overall time per patient spent within the facility while still increasing treatment capabilities.

Implementation of hygiene- and distancing mechanisms can minimize risks of horizontal and nosocomial transmissions of viral particles for high risk group patients and personnel to safely continue essential radiation treatments. Prefering accellerated hypofractionated treatment over normofractionated regimes where applicable can downscale average machine occupancy rates and maintain treatment capabilities for patients accumulated during a lock-down.
Further investigation should be performed to identify non-inferior treatment regimes to hypofractionate and accelerate radiation fractionation schedules and hence reduce overall facility time per patient and its associated financial impact. Restructuring key processes might be beneficial for health care providers to implement adapted patient-flow management into future routines.

Declarations

Competing interests: The authors declare no competing interests.

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