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Minimizing transmission of COVID-19 while delivering optimal cancer care in a National Cancer Centre



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ABSTRACT

The COVID-19 pandemic has disrupted current models of healthcare and adaptations will likely continue. With the gradual easing of lockdown measures worldwide, cancer centres must be prepared to implement novel means to prevent repeated waves of infection. There are two limitations unique to oncology – a higher susceptibility of patients to COVID-19 and the multidisciplinary approach required of cancer management. We describe the measures implemented in the largest cancer centre in Singapore to continue optimal cancer care in spite of the ongoing pandemic, with no nosocomial infections reported in our centre to date.

We adopted a multipronged approach, with an overall committee supervising the entire COVID-19 management effort. A screening clinic was setup to triage patients prior to entry to the centre. Each Oncology Division within the cancer centre designed solutions tailored to the specific needs of their discipline. We explore in detail the screening criteria and workflow of the screening clinic, as well as modifications by individual divisions to reduce infection risk to patients and healthcare professionals. This approach can be modelled by other cancer centres during this prolonged COVID-19 pandemic.

1. Introduction

Singapore diagnosed its first imported case of novel coronavirus disease 2019 (COVID-19) on 23 January 2020 in a visitor from Wuhan, China. [1,2] Following this, COVID-19 was diagnosed in foreign visitors and returning travelers [2,3] followed by a spike in local transmission within foreign worker dormitories [4]. The Ministry of Health (MOH) put forth a progressive range of public health measures, including entry restrictions into Singapore, quarantine of asymptomatic returning travelers, extensive contact tracing and screening of symptomatic contacts and entry restrictions into Singapore [5,6]. Most recently, a “circuit breaker” was introduced on 7 April 2020, enforcing partial closure of non-essential services, mandatory working-from-home, compulsory mask wearing outdoors and strict social distancing measures to staunch further spread of COVID-19 [7,8].

Since the first reported cases in December 2019, COVID-19 has spread throughout the world and escalated to the level of pandemic over a span of short months. [9] The World Health Organization declared COVID-19 to be a pandemic on 11 Mar 2020 [10]. A multitude of different measures have been introduced by various countries to combat the community outbreaks and prevent their healthcare system from being overwhelmed. Within each hospital, various specialties have also come up with diverse strategies of continuing care during the COVID-19 pandemic [11–15]. In other countries with strained healthcare resources, oncological care, especially palliative chemotherapy recommendations, have been reduced significantly [16–18]. Moreover, due to immunosuppression, cancer patients have been postulated to have a twofold increased risk of COVID-19 infection, as well as a fivefold increased likelihood of deterioration than non-oncology patients [19,20]. Oncologists worldwide are treading a fine line between

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adequate cancer treatment versus the risks of nosocomial infection during the COVID-19 era.

The main aim of cancer care now is to continue safe delivery of optimal oncology care, in spite of the COVID-19 pandemic. Approximately 70 % of all cancer cases in Singapore are seen at the National Cancer Centre Singapore (NCCS), with more than 9000 new cancer cases and over 1 million patient visits yearly. [21] NCCS first started measures to contain COVID-19 in February 2020, right after the national Disease Outbreak Response System Condition (DORSCON) alert level was raised from yellow to orange. [22] DORSCON Orange indicates an outbreak of a severe disease easily spread from person to person but has not spread widely in the community and is being contained. At the time of writing, there are over 28,000 COVID-19 cases detected from a population of 5.64 million, mostly amongst dormitory workers, with no cases of COVID-19 transmission within our cancer centre.

We describe in this manuscript the various strategies and infection control measures taken to ensure optimal continuation of cancer care in NCCS as the COVID-19 pandemic evolved. These progressive measures were adapted as published literature became available on the infective period and clinical characteristics of COVID-19 infection. [23,24] This manuscript also describes the NCCS screening workflow that was used to minimize nosocomial transmission of COVID-19.

2. Screening clinic

MOH put forth screening criteria to assist clinicians in detecting suspicious cases of COVID-19. Patients with a high index of suspicion who fulfil the MOH suspect case definition were admitted for isolation while investigations were underway. Patients at moderate risk of COVID-19 had swabs performed and were sent home for self-isolation, as part of the Swab-and-Send-Home (SASH) program. Specifically, to strengthen active case finding, cancer patients undergoing chemotherapy who had symptoms of acute respiratory infection (ARI) of any duration were swabbed for COVID-19 as part of the SASH program. However, due to the possibility of atypical presentations of infection in patients with cancer and asymptomatic COVID-19 carriers, our centre developed a screening criteria identifying higher risk patients, over and above the national guidelines. The screening criteria used by MOH and NCCS are shown in Table 1 (accurate as of 12 May 2020).

Patients were screened with a handheld thermometer and thermal sensor before entering NCCS. Patients who had low grade pyrexia (temperature greater or equal to 37.5 °C), ARI symptoms, or any of the abovementioned screening criteria were assessed in an outdoor screening clinic. Supplementary appendix A shows the setup of the screening clinic.

Doctors on duty would don full personal protective equipment

Table 1

MOH suspect case definition, MOH Swab-and-Send-Home (SASH) criteria and NCCS screening criteria.

MOH suspect case definition	(1) Clinical signs/ symptoms suggestive of community acquired pneumonia (2) Acute respiratory illness (eg. cough, sore throat, runny nose, anosmia), with or without fever, who, within 14 days before onset of illness had <ul style="list-style-type: none"> (i) Travelled abroad (outside Singapore) (ii) Close contact with a case of COVID-19 infection (iii) Stayed in a foreign worker dormitory (iv) Worked in occupations or environments with higher risk of COVID-19 exposure (3) Prolonged febrile acute respiratory infection (ARI) symptoms of 4 days or more, and not recovering
MOH Swab-and-Send-Home (SASH) criteria	(1) Person working or living in communal settings (eg. residential, custodial or special care facilities) (2) Immunosuppressed patients <ul style="list-style-type: none"> (i) End stage renal disease patients on hemodialysis (ii) Cancer patients on chemotherapy
NCCS screening criteria	(1) Person who travelled abroad to any country outside of Singapore or been to a hospital abroad in the last 1 month (2) Currently monitored by MOH for possible COVID-19 exposure (quarantine order/ stay-home notice / phone surveillance) (3) Visited known clusters/ cases at the locations in local COVID-19 surveillance list in the last 1 month (4) Been discharged within the last 2 weeks or are currently hospitalized (5) Living in an institutional care facility (eg nursing home)

(PPE), in accordance with World Health Organisation (WHO) infection prevention and control guidelines, comprising of N95 respirator, face shield, full body gown and gloves before seeing the patient. [25] Further assessment involved detailed history taking, especially occupation, household setup, travel and contact history, respiratory symptoms, physical examination, laboratory and portable radiological investigations. If necessary, management was discussed with the infectious disease (ID) specialist on the need to swab for SARS-CoV-2 virus. High risk patients were admitted to an isolation ward for swab, while low risk patients had a swab done in the fever area and were sent home with a “stay-home order” to self-quarantine for five days and until the results of the COVID-19 swab is known.

Details of patients found to be positive for COVID-19 were sent to MOH to begin contact tracing. These patients had all upcoming appointments postponed until a negative swab result is obtained. They were allowed to proceed with their appointment after recovery of their symptoms.

The NCCS screening clinic saw 679 patients with a total of 801 visits from inception on 10 February 2020 to 13 May 2020, an average of 10.4 patients per day. 56 COVID-19 swabs were performed on 55 patients, with one patient swabbed twice on separate occasions due to prolonged ARI symptoms. All swabs were negative except one patient, who was mistakenly sent to the NCCS screening clinic.

The patient was a 34-year-old female who presented with one day duration of phlegm production, loss of smell and taste. She has no past medical history of note and has neither active nor previous cancer history. Her contact history was significant for a lunch visit to a known COVID-19 cluster in Singapore. This patient was referred to the Singapore General Hospital (SGH), a tertiary hospital within the same campus. She was meant to be seen at the SGH fever screening area, a dedicated COVID-19 screening facility for the general population but the driver mistakenly brought the patient to NCCS. She was assessed at NCCS screening clinic, had a COVID-19 swab performed and discharged home with advice. Upon knowledge of her positive result, she was admitted to SGH for isolation and management. Because of the strict systems that were set up, the patient did not enter the NCCS building and no transmission of COVID-19 within NCCS has been documented to date.

3. Outpatient clinics

Patients who cleared the above criteria were then allowed to enter NCCS main building for their medical appointment or chemotherapy session. All patients and healthcare workers were provided with surgical masks to be worn at all times in NCCS and to minimize cross contamination. Visitor number was limited to one accompanying member for medical appointment, while no visitor was allowed in the

ambulatory treatment unit (ATU) where chemotherapy was administered. With social distancing recommended as an effective measure to break the chain of transmission, alternate seats were cordoned off in the waiting area to ensure a distance of at least one metre between patients. [26] This strict one-metre distancing policy was enforced throughout NCCS including staff offices and pantries.

In an effort to further reduce patient density in NCCS, clinic lists were screened in advance and non-urgent appointments and scans were deferred by two to three months. Alternatively, patients on routine cancer surveillance with normal test results were called and screened for new symptoms. Those who self-reported to be well were updated on the normal test outcomes over the phone, and had their appointments postponed. This reduced the clinic outpatient load by 50 %. All survivorship clinics were cancelled, and the number of patients per clinic session was capped at ten persons, spaced 15 min apart. This ensured that few patients would be in the waiting area at any point, and they could be seated physically apart. After consultation, patients could leave the premise immediately – billing and prescriptions were settled electronically, and medicines couriered directly to the patients' home to avoid a congregation at NCCS pharmacy. The pharmacy was closed and home delivery of medication was mandatory to reduce patients' dwell time in NCCS.

4. Continuity of optimal cancer care

4.1. Medical oncology

Traditionally, medical oncology in NCCS consists of four teams – Gastrointestinal/Hepatobiliary/Neurooncology, Breast/Gynaecology, Lung/Genitourinary/Head & Neck and Lymphoma/Sarcoma/Melanoma/Skin/ Rare cancers. This arrangement ensured subspecialists within each team attended to every patient and thus can be accorded the best possible care. To effect continuity of optimal oncology care, the four subspecialty teams continue to operate in the outpatient clinic. In line with the ongoing COVID-19 pandemic, each individual team came up with recommendations for management of various cancers in light of possible limited resources during the COVID-19 pandemic, these were tailored to the Singapore healthcare setup and put forth after discussion and review of international guidelines.

Patients at low risk of COVID-19 but with ARI symptoms were seen in a dedicated cohort area for their medical appointment. Their oncologist had to don full personal protective equipment prior to seeing them to negate possibility of cross infection. These patients were also cohorted in the ATU and seated in a separate cubicle to minimize risk of risk of dissemination to other immunocompromised individuals.

The risk of exposure to COVID-19 meant that inpatient medical oncology teams had to be segregated into smaller teams so as to reduce the chance of large scale nosocomial spread among inpatient healthcare workers. Hence, the medical oncology inpatient service was split into six different teams by geographical blocks, with a dedicated team to see cancer patients with suspected COVID-19 infection. Each team consists of one to two medical officers, one senior resident and one consultant, and team size ranged from two to a maximum of five. Cross coverage amongst different blocks was discouraged.

A dedicated ARI ward for cancer patients was set up within the oncology ward for patients with cancer and suspected COVID-19 infection. The team was kept small, with a consultant and a senior resident seeing all the patients. The involved personnel wore full PPE at all times. Working with PPE can be uncomfortable and especially so if procedures are required. Therefore, the ARI ward team was rotated on a two weekly basis to prevent fatigue.

Thirdly, review of patients after discharge was scheduled two weeks after discharge from the general hospital. Those who had pneumonia, ARI symptoms or were admitted to an ARI ward, were reviewed in cohort clinics within NCCS.

4.2. Radiation oncology

The Division of Radiation Oncology in NCCS operates across two sites within Singapore General Hospital (SGH) and NCCS. Because of this unique setup, the radiation therapists, physicists, dosimetrists and nurses were split into two separate teams to service each site within the campus. The doctors of each subsite split into two teams to cover each site to run their weekly reviews and outpatient clinics. Audits of new and planned cases are done remotely via teleconferencing.

In order to reduce the number of attendances required, there has been a move to adopt hypofractionated treatment such as the FAST-Forward trial regimen for breast radiotherapy [27] or single fraction RT for palliative cases [28].

All patients coming for treatment are screened prior to entry. Symptomatic patients with pyrexia or any ARI symptoms would be seen at the screening clinic described above. Inpatient referrals from the hospital are traditionally brought to the department to be seen, often with family members present. However, to optimize safe distancing measures and minimize the number of people in outpatient clinic, consultants now routinely review the patients on the wards to assess their fitness for treatment. All patients with ARI symptoms would be treated as the last case of the day. Staff would wear PPE for high-risk cases, and full cleaning of treatment rooms and radiotherapy machines would be done after treatment of these cases.

Moving forward, the department is looking into the possibility of remote contouring and plan verification, as well as teleconferencing with patients.

4.3. Surgical oncology

The guiding principles for the surgical oncology department were to maintain diagnostic surgical services and therapeutic cancer surgery. Surgical oncology clinics remained open to referrals from primary care. Since the advent of the circuit breaker, population cancer screening services throughout Singapore were ceased. Consequently, a large proportion of new referrals to the surgical oncology clinics during the COVID-19 pandemic were patients with signs and symptoms suggestive of malignancy. New cases with a confirmed diagnosis of cancer that required tertiary cancer care were also allowed. To keep patient visits to a minimum, new referrals assessed to have a high likelihood of cancer would undergo diagnostic imaging and biopsy on the same day where possible. Otherwise, diagnostic procedures and scans would be arranged to minimize the number of visits.

While maintaining cancer surgery services, it was important to mitigate the risk of exposing patients and healthcare workers to COVID-19. With knowledge of asymptomatic transmissions [29–31] and studies reporting poor outcomes in patients who had surgery during the viral incubation period [32,33], patients were thoroughly screened with a questionnaire that surveyed travel history, contact with known local clusters or persons, and symptom reporting both at the time of listing for surgery, and prior to hospital admission. As NCCS is part of a larger general hospital, the number of surgeries performed on a weekly basis was coordinated centrally. This is in view of possible bed constraints as bed occupancy by COVID-19 patients increased. To reduce length of stay in the hospital, Enhanced Recovery After Surgery (ERAS) protocols were employed, and same-day admission for surgery was standard of care. For surgeries that require a post op stay in the Intensive Care Unit (ICU), centralized coordination ensured that such cases were well spaced out, and ICU facilities were not overwhelmed at any one point.

On the day of surgery, special precautions were taken for aerosol-generating procedures. At the time of intubation and extubation, the anesthetic team dons full PPE with eye protection (goggles and face shield). All personnel not directly involved in intubation or extubation exit the operating theatre, and there is a mandatory ten-minute pause prior to re-entry. For surgical procedures deemed to be at risk of

generating aerosols from the aerodigestive tracts, such as endoscopy, tracheostomy or gastrointestinal surgery/ head and neck surgery with high speed devices, including electrocautery or energy devices, the surgical team is similarly suited in full PPE. For other surgeries like mastectomies or soft tissue resections, the surgical team is outfitted in the regular manner where surgical masks and face shields suffice. Hospital stay post-surgery was kept to a minimum, and patients could not have visitors during the stay. Where possible, patients post-discharge would be seen at the general hospital outpatient clinic instead of the cancer centre to avoid exposing other vulnerable, immunocompromised cancer patients.

The surgical subspecialties were reorganized to smaller sub-teams. Management of patients occurred entirely within a sub-team, and personnel were not allowed to mingle between teams. This would allow for containment should a healthcare worker get COVID-19, and allow for service provision to be maintained. Surgeons who had to provide emergency services for general surgery were taken out of elective surgical oncology duties entirely, further protecting our cancer patients.

4.4. Oncologic imaging

Medical imaging has shown to aid clinical diagnosis and prognosis of COVID-19 patients [34], and had even been used as primary screening in countries overwhelmed by the infection. As it is imperative to detect possible infected patients and prevent cross infection with others in NCCS, chest radiography for suspect cases can be performed in the screening clinic with staff in full PPE and is an indispensable tool in the NCCS multi-pronged strategy.

In order to ensure sufficient medical capacity, elective surgeries and non-urgent medical appointments have been rescheduled along with the accompanying cancer surveillance imaging appointments. This allowed precious imaging resources to be devoted to the care of high-risk cancer patients in a safe environment where stringent social distancing guidelines were adopted to minimize risk of cross-infections among patients. The number of people in common waiting areas was limited and waiting times for scans shortened. Overall turnaround time for imaging in urgent cases and for patients requiring close interval imaging follow ups was significantly reduced.

Screening processes are also augmented with portable radiographic imaging to minimize patient movement and to allow for rapid diagnosis of pneumonia in cases of high clinical suspicion who may be asymptomatic. Imaging findings are discussed and reported with the clinical teams within one hour of imaging, often significantly earlier in the event of positive findings to ensure rapid clinical action.

Rarely, asymptomatic patients may have incidental chest CT findings suspicious for COVID-19. These are immediately identified upon scan completion and the patient will be isolated away from other patients and sent to the screening clinic for further review. As COVID-19 imaging findings are often times indistinguishable from pneumonitis from infection or post-treatment inflammation, consistent with known low specificity of CT findings [35], final COVID-19 diagnosis will be confirmed with swab tests.

4.5. Supportive and palliative care

COVID-19 resulted in several key changes to supportive and palliative care service provision within NCCS and SGH. With the requirement to defer non-urgent clinic appointments, a nurse liaison service was established to screen patients coming to the outpatient specialist clinic, linking up actively with community hospice teams thereby encouraging continued care at home. The existing supportive care nurse clinics, which manages patients with high distress scores on the distress thermometer, evolved into a telehealth service, conducting clinical reviews via telephone and video conferencing.

As stringent hospital visitor policies increased social isolation of hospitalized cancer patients at their most vulnerable, facilitating

telecommunication between families and patients and conducting family conferences and advanced care planning via video conferencing became a crucial task for the inpatient consult team. Many cancer patients were requesting for expedited hospital discharges, resulting in increased involvement with complex discharge planning and liaison with community hospice partners. An additional COVID-19 supportive care team was also introduced to help the COVID-19 ICU team with distressed patients and families.

In preparation for potential ICU surgery, a drug conservation strategy was put in place for parenteral fentanyl and midazolam, while a clinical guidance for generalist supportive and palliative care was circulated amongst physicians in NCCS and SGH.

5. Peripheral activities (tumour boards, teaching, research)

The need for a multidisciplinary tumour board in the management of cancer cannot be overemphasized to ensure optimal care of each patient. Tumour boards then took a variety of means to continue in spite of COVID-19, with methods such as e-mail discussions, teleconferencing and social distancing in a room while wearing surgical masks. This ensured that cancer patients being managed during the COVID-19 pandemic continued to have access to the input of various specialists at these ongoing tumour boards. The various tumour-specific multidisciplinary teams also coordinated amongst themselves to ensure seamless referrals and continuity of care for neoadjuvant and adjuvant regimens, and planned for contingencies should resources and manpower become overwhelmed.

We also strived to continue teaching at the senior resident and junior resident level to ensure that learning is not compromised in spite of the pandemic and increased workload. This took the form of weekly teleconferencing, made up of didactic lectures and interactive virtual case discussion. The attendance at these teaching sessions showed remarkable improvement during the COVID-19 pandemic compared to previous in-person teaching. This was likely due to a variety of factors; the key is likely due to convenience of attending online teaching from any location within the hospital.

Non COVID-19-related and non life-saving research had to be put on hold during the COVID-19 pandemic. All new research enrollments was halted upon escalation to DORSCON Orange [36,37]. Research staff was mobilized to augment the triage screening stations.

6. Summary

We herein detailed multiple steps taken by NCCS to ensure optimal continuation of cancer care in patients in Singapore. These were taken in a stepwise approach in accordance with the development of the COVID-19 pandemic in Singapore. Changes were made in inpatient, outpatient and peripheral activities to ensure a smooth business continuation plan in spite of the COVID-19 pandemic.

Ethical statement

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolve.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the

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