COVID-19 Infection Control Changing Radiology Clinical Practices: Adapting to the New Normal

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ABSTRACT

Healthcare systems are at risk of collapse from the COVID-19 pandemic and the global mortality rate of healthcare staff may never be known. Common symptoms are cough, fever, muscle aches, headache and shortness of breath. Comorbidities increase mortality rates, such as age with 8 out of 10 deaths in USA being adults +65 years old. Others are both type 1 and type 2 diabetes, COVID-19 damages the kidney and liver, obesity is linked to comorbidities, and cardiovascular disease, males are 2.4 times more at risk of dying than females, COVID-19 is linked to prothrombotic disseminated intravascular coagulation and venous thromboembolism and black and minority ethnic groups (BAME) are 4-fold at increased risk. In addition, a study evaluating initial computer tomography (CT) findings with mortality in older male patients (71.1 ± 8.5 years old) with severity and clinical outcomes, established CT score was higher in those patients that died. CT has become a key component for the detection of COVID-19, as virus causes lower respiratory tract infection. Resulting in radiology departments workloads increasing and an increased risk of cross-contamination and so robust standard operating procedures (SOPs) are needed. Risk assessment can assist in reducing mortalities, infection rates and minimalize virus transmission. Also, the implementation of technology to reduce face-to-face contacts will have a far reaching influence in the future. This paper aims to review, evaluate and summarize the risks and approaches necessary to develop radiology departments working practices.

Keywords: Chest X-ray; COVID-19; CT; Healthcare worker; Infection control

INTRODUCTION

A pneumonia virus was first detected and reported in Wuhan, China to the World Health Organization (WHO) in December 2019 [1]. A month later it was acknowledged as being a public health emergency of international concern and later the new coronavirus disease was given the name of COVID-19 (coronavirus disease 2019) and is caused by SARS-CoV-2. On 11 March 2020 the WHO declared COVID-19 a pandemic, the first pandemic since the 2009 H1N1 "swine flu" pandemic. With the WHO Director-General stating the number of COVID-19 cases outside of China had increased 13-fold.

The use of medical imaging for the diagnosis and treatment of COVID-19 plays a pivotal role in providing quick detection and diagnosis support for making medical judgements. Also, enabling more accurate diagnosis to differentiate other respiratory illnesses from COVID-19 [2]. As the initial symptoms of influenza (flu) and COVID-19 are alike, with cough, fever and respiratory symptoms being common.

In both cases COVID-19 and influenza can progress to pneumonia, the mortality rate worldwide for influenza is 290,000 to 650,000 per year, whilst COVID-19 mortality as of June 2020 is approximately 411,694 deaths worldwide. At this point there are approximately 7,257,519 cases worldwide and every year 1 billion people contract influenza according to WHO. Indicating COVID-19 has a higher fatality rate than influenza and additionally has more severe symptoms.

A major concern is the frontline medical staff such as radiologists who are at higher risk of infection, therefore it is imperative that staff is made aware of the correct use of personal protective equipment (PPE) and fully comply with working

guidelines to safeguard their safety and the safety of patients. Nevertheless, in May 2020 the International Council of Nurses (ICN) stated that COVID-19 had infected at least 90,000 healthcare workers and that over 260 nurses had died from the coronavirus pandemic. Furthermore, in March 2020 the Royal College of Physicians (RCP) reported approximately 25% of UK National Health Service (NHS) doctors were in isolation or sick from COVID-19 and unable to work.

Another aspect is the impact on healthcare workers mental health, a study of 1,563 hospital staff in China treating COVID-19 patients reported that 73% of staff had symptoms of distress, 51% suffered from depression, 45% anxiety and 36% insomnia [3-8]. Highlighting the requirement for research funding to identify the social and psychological consequences of pandemic.

Detailing staff training in infection control, personal protection, disinfection protocols and patient contact minimization. In addition, radiology departments were reconfigured for infection control and designating only one scanner for imaging suspected COVID-19 cases. Furthermore, the Centers for Disease Control and Prevention (CDC) published guidance on "Managing Operations during the COVID-19 Pandemic", providing healthcare facilities with a number of recommendations. Additionally, research into alternative routes of transmission has identified the risk from faecal matter, urine and COVID-19 viral particles on surfaces.

As a result, the virus then enters a person's body via the eyes; nose or mouth after the person has touched infected surfaces [9]. The epidemiological comparison of COVID-19 to flu and SARS [10]. Of note is the incubation period of COVID-19 which is longer than both flu and SARS and is an important aspect of quarantine control to lessen virus transmission.

Furthermore, research into asymptomatic COVID-19 carriers is alarming as 80% of the passengers tested on a cruise ship for COVID-19 were positive but did not display any of the classic symptoms [11]. Recently, a cross sectional study of 420 medical staff working on average 16.2 hours each week in intensive care units treating patients with covid-19 were given and trained in the use of appropriate PPE. The study was from 24 January to 7 April 2020 and on completion, all staff tested negative for SARS-CoV-2 with non-showing any symptoms [12].

In addition, recent research funded by the WHO investigated the effectiveness of eye protection, face masks and physical distancing from a systematic review and meta-analysis of data from 216 studies from 16 countries [13]. The findings established that both eye protection and face masks were beneficial for healthcare workers and additionally physical distancing of at least 1 meter but preferably 2 meters was linked to a greater reduction in virus transmission.

They discovered speech emits thousands of droplets per second lasting 8-14 minutes in a closed environment. Similarly, Zhang, Renyi, et al. established that airborne transmission is a dominant means of COVID-19 transmission and concluded that to prevent human-to-human transmission face masks should we worn in public places [14]. Further underlining the necessity of social distancing and good hygiene practices to lessen the risk of transmission from asymptomatic carriers and also the importance of mass testing [15].

Once the dust has settled if not before from COVID-19 pandemic it is hoped that governments globally will look very closely how they handled the situation to ascertain what lessons were learnt and to then implement robust strategies to mitigate the impact of future pandemics. The dilemma that all governments are having to deal with is the cost of COVID-19 to their economies versus the cost in human life and the danger of their healthcare systems collapsing from too many cases. Therefore, the ideal strategic policy in handling a pandemic such as COVID-19 ought to be enabling a trade-off: preserving the economy and people's livelihoods whilst reducing COVID-19 transmission and mortality rate.

A consequence of the COVID-19 pandemic is that it has highlighted inefficiencies in pandemic containment and the impact on both the population and economy [16]. As restrictions around the world COVID-19 restrictions are eased there is a fear that this has the potential to trigger a "second wave", further damaging economies and increasing mortality rates. In the past, pandemic waves returned within months as in the case of the 1918 Spanish flu pandemic the second wave resulted in significantly higher mortality [17].

It is believed the second wave severity was triggered by the virus mutating. Consequently, as a result of lessons learnt from the Spanish flu pandemic public healthcare was improved, encompassing better health education, methods to contain the pandemic such as surveillance measures, isolating the sick, and improved sanitation [18].

Therefore, robust testing and tracing measures need to become a key tool to curtail a potential second wave or third wave and will probably become an ongoing part of triage standard operating [19]. This review highlights the increased mortality risk from comorbidities, the psychological impact and methods that can reduce the rate of infection in radiology departments. As a second wave is highly probable and radiology departments should consider and implement ongoing strategies to protect staff and patient's well-being.

PROTECTING RADIOLOGY DEPARTMENTS

To enable radiology departments during the COVID-19 pandemic to function as safely and efficiently as possible, requires focusing resources on infection prevention and control. In particular, as COVID-19 diagnostic imaging plays a key role in the diagnosis of lung complications resulting from COVID-19 [20]. Therefore, it is imperative that healthcare management follow guidance provided by bodies such as the WHO, International Atomic Energy Authority (IAEA), and other medical associations. Radiology departments have been increasingly affected by COVID-19 and have had to implement strategies to reduce infection and spread of the virus. Resulting in longer patient processing times, as equipment and areas need deep cleaning after each patient. However, infection risk to healthcare staff and patients is high. Additionally, the added burden of reduced staff numbers as staff self-isolate or centres close because of a reported infection places more stress on the

system. Recent research of radiotherapy centres in Austria, Germany, and Switzerland affected by COVID-19 established their major challenges are longer patient processing times, increased number of patients not attending appointments and reduced department staffing levels [21].

Computer tomography (CT) is a key component for the detection of COVID-19 infection, the virus results in a pneumonia pattern lung injury, as the virus causes lower respiratory tract infection [22]. A recent study evaluating the prognostic usefulness of chest radiography (CXR) as a scoring method for non-elderly (21-50 years old) COVID-19 patients, confirmed CXR use as a prognostic indicator of COVID-19 [23]. In fact, in both the UK and Italy for first-line triage diagnosis chest radiography is being used, a factor could be portable radiography equipment can easily be located in isolation wards or triage settings [24]. Of interest, researchers at Princeton University, USA developed a process to quickly and efficiently find patterns in diseased lungs from chest x-ray images [25].

By utilizing machine learning they are able to quickly identify those patients as either L phenotype or H phenotype. As COVID-19 patients with type L phenotype can suffer injury from mechanical ventilation assistance and H phenotype patients are known to have pneumonia-like thickening of the lungs which does require ventilation in order to survive [26]. Another source of information is the Fleischner statement from pulmonologists and radiologists from 10 countries imparting valuable information for radiology departments dealing with the COVID-19 pandemic [27]. In addition to radiology departments providing vital services to patients with cancer, cardiac and other health conditions, hybrid imaging scanners such as SPECT/CT, and PET/CT could also be used to support radiology departments. In order to facilitate dedicated CT scanners solely for imaging COVID-19 patients, thereby reducing the potential spread of infection [11, 20, 21, 24, 28].

However, the Royal College of Radiologists raised concern about the substantial increase in pre-operative chest CT and chest x-rays. Their opinion is the use of COVID-19 CT screening has a low pick up rate in asymptomatic patients and additionally a false negative rate of 20% in symptomatic patients [29]. The concern is that some referrals for CT chest scans were not necessary as they made no improvement to a patient's management and so published guidance on "use of CT Chest to screen for COVID-19 in pre-operative patients". Therefore, radiology departments while examining potentially infected patients have a duty of care to protect both patients and staff and assess and manage the risks and include questioning if a scan is necessary or not.

Furthermore, the COVID-19 pandemic is having a momentous impact on the accessibility of hospital resources worldwide [30]. The first international survey on the impact of COVID-19 in radiology was conducted by the Italian Association of Nuclear Medicine (AIMN) [31]. This survey found that radiology departments had or were in the process of applying new radiology procedures. The key such as following recommended guidelines and pre-screening all patients. As a consequence of the increased workload created by COVID-19 pandemic radiology departments have to develop and implement new

praxes and procedures, the reality is that these maybe a permanent requirement for the foreseeable future [32]. If a second COVID-19 wave occurs working practices and staffing levels need to be prepared in advance to enable a prompt and effective response [33]. In addition, further guidelines have been created for emergency department attendees with suspected COVID-19 [34].

The evidence is that cardiovascular (CV) is a significant risk factor of COVID-19 mortality as patients suffer from arterial and venous thrombotic complications, arrhythmias, congestive heart failure, myocardial injury, myocarditis, and thromboembolism. The most common was atrial fibrillation in patients critically ill with COVID-19. When imaging CV patients with suspected COVID-19 the major problem has been the lack of testing in order to test every patient.

Additionally, the lack gowns, masks, gowns and other PPE has put frontline radiology staff at risk of infection therefore radiology departments have had to make the judgement is the procedure necessary or can it be postponed. Also, Farooqi, Kanwal M., et al identified the risks of congenital heart disease (CHD) cardiac computed tomography through the pandemic [35]. Which emphasized the necessity of robust screening and protection of imaging staff with appropriate PPE? Also categorizing cardiac CT levels of urgency in CHD patients to manage the urgency of CT imaging. An example, of a radiology department COVID-19 decision making flow chart, outlining the patient's status and the relevant diagnostic approaches.

Historically medical care was founded on the principle of face-to-face care, resulting in a throng of patients waiting for treatments in waiting areas or accident and emergency making them the ideal breeding ground for viruses. For this reason, technology can have a pivotal role in patient appointment booking, workload scheduling and communicating patient's results to minimize patient department waiting times and reduce human-to-human contact. Additionally, to reduce hospital visits the development of technology systems to monitor patients and provide good lines of communication would lessen the need for visits or inpatient care [36].

Additionally, to protect staff and patients infection control measures need to be strictly implemented and ensure adequate stock levels of PPE are available for both healthcare staff and patients [37]. Following new data that has indicated face masks afford a protective barrier against infectious droplets. This is good news as the concern is growing regarding the spread of COVID-19 from minimal symptomatic and asymptomatic carriers of the virus from patients to healthcare workers and hospital staff measures need to be considered [38].

Furthermore, a crisis management plan should be considered for radiology departments based on the "5E" framework, engage suppliers, staff and patients in framing the crisis, explore the crisis and how to manage it, explain the crisis plan to all and take action, execute the plan and constantly monitor it, evaluate the effectiveness of the plan and adapt, a framework for crisis management [39]. Furthermore, radiology departments should carry out a COVID-19 employee risk assessment as outlined in for all staff and amends and update SOP and ascertain the

correct level of PPE. Together with, all staff trained in donning and doffing PPE and its safe disposal [40].

In a like manner a workforce assessment is required to assess all staff to ascertain staff who are at increased risk. The assessment of individual staff members will assess job role, age, gender ethnicity and any underlying health conditions. Furthermore, as more evidence of asymptomatic COVID-19 transmission is published the significance of social distancing practices and contact tracking will be more apparent [41]. A healthcare worker in a long-term care facility was 30.3% tested positive with approximately 50% were asymptomatic or pre-symptomatic. To achieve social distancing radiology departments should consider measures outlined [42]. As the number of COVID-19 infection start to decline and easing of lockdowns starts to occur a critical aspect of containment will be the testing and screening for the disease. A viral test is used to detect an active viral infection and carried out by either a reverse transcription polymerase chain reaction (RT-PCR) or an antigen test. However, the antigen test is less sensitive but it is much quicker. In addition, COVID-19 clinical evaluation guide is shown in and outlines the key symptoms, the clinical tests followed by diagnostic imaging.

DISCUSSION AND CONCLUSION

Since SARS-CoV outbreak in 2003 not enough has been done to protect healthcare workers and patients from new outbreaks such as COVID-19. This latest pandemic has demonstrated there are significant shortcomings in prevention and control of COVID-19. Historically pandemics are inclined to have a second wave if not a third wave, and radiology departments must prepare for this eventuality and possibly the long-term existence of COVID-19. Radiology departments have become a vital part in the early diagnosis of COVID-19 to reduce both infection rates and mortality. As a result, healthcare facilities have been forced to balance services while reducing exposure to staff and patients and the necessity to conserve health care resources. Furthermore, the evidence is suggesting comorbidities increase mortality rates and some ethnic groups are at a higher risk than others. A number of medical health professional bodies have provided guidelines in reducing infection in radiology departments. In addition, COVID-19 risk assessment for healthcare workers must be an ongoing management task throughout this pandemic and possibly beyond. Especially, as an alarming aspect of the COVID-19 pandemic are the high levels of asymptomatic carriers of COVID-19. Additionally, there is growing evidence that airborne transmission is a key factor in virus transmission and that wearing face masks significantly reduces infection rates. Therefore, the strategy of radiology departments implementing intensive staff and patient testing and isolation of positive cases could play a positive role in lessening the impact of COVID-19. Undoubtedly, working practices will have changed or will change in many radiology departments, but the question is, will these changes become the new normal.

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