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Review Article

Infection Control Measures for Orthopaedic Operatories During Covid-19 Crisis: An Update

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Abstract

Surgical management of any trauma is a foundation of any healthcare system with both elective and emergency procedures contributing to the health of our patients. Healthcare professionals agree that stringent cleaning and disinfection of the orthopaedic operatories are essential elements of effective infection control programs. However, traditional manual cleaning and disinfection protocols carried out in operatories are often considered suboptimal at times. Factors influencing the risk to a healthcare professional include the number and types of blood contact experienced by the worker, risk of transmission of droplet infections, accidental blood splashes, sharp injuries, cutaneous scratches etc. However, operatories are high risk areas for transmission of respiratory infections given the urgency in management, the involvement of multiple staff, and the need for high transmission-risk activities such as airway management. The high prevalence of disease, limited resources, and staff under pressure, greatly increase the risk of transmission of coronavirus and also other healthcare associated pathogens, and this affects the efficacy of disinfection protocols. Advanced technologies in disinfection and newer disinfectants should be preferred in order to improve disinfection of surfaces in orthopaedic operatories.

Keywords: Infection Control; Orthopaedic Operatory; Occupational Exposure; Covid-19; Occupational Hazard

Introduction

Coronaviruses, a genus in the Coronaviridae family, are pleomorphic, enveloped viruses. Coronaviruses gained prominence during the Severe Acute Respiratory Syndrome (SARS) outbreaks of 2002–2003 [1,2]. On 11th February 2020, the World Health Organization (WHO) Director-General, Dr. Tedros Adhanom Ghebreyesus, named the disease caused by the SARS-CoV-2 as "COVID-19", and by March 11th, 2020 when the total number of countries affected with it reached 114, with more than 118,000 cases rising daily along with 4000 deaths, the WHO declared it as a pandemic [3-9]. Common symptoms at onset of illness were fever, cough, and myalgia; fewer common symptoms were sputum production, headache, haemoptysis, and diarrhoea, dyspnoea, lymphopenia, abnormal findings on chest CT [10-14].

The standard method of diagnosis is by real time reverse transcriptase polymerase chain reaction (rRT-PCR) from a nasopharyngeal swab. Virus-specific nucleic acid sequences were detected in lung fluid, blood and throat swabs [15-18]. The spread of covid is through air borne zoonotic droplets which spread through close contact with the infected individual [19]. Close contact includes being within approximately six feet with an infected individual for a prolonged period of time or having direct contact with infectious secretions without wearing personal protective equipment [20].

Cleaning and disinfection are a critical component of any infection prevention program [21]. Newer Products and practices should be taken into consideration for surface disinfection in orthopaedic operatories like: Inactivation of emerging pathogens (e.g., CRE, C. auris), Technologies for terminal room decontamination (not including technologies with limited data), Ultraviolet light, Vaporized hydrogen peroxide, Continuous room decontamination technologies, Light disinfection, Low-concentration hydrogen peroxide, Self-disinfecting surfaces [22-29]. Touchless cleaning techniques provide an incremental benefit to manual practices by limiting cross-transmission of pathogens via environmental surfaces, though evidence of prevention of certain pathogens remains limited. These technologies include a variety of products including self-disinfecting surfaces along with few fumigation methods [30-35].

The main objective of this article is to summarize a variety of disinfectants and other factors that affect standard cleaning and disinfection practices, to put forth certain newer technologies that can supplement manual traditional cleaning and disinfec-

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tion methods and thus support orthopaedic surgeons in their daily practice during this coronavirus pandemic [36-42].

Infection Control Measures: Personal Protective Equipment

Given the plentitude of challenges for achieving and maintaining adequate cleaning and disinfection in healthcare facilities, there is a need to consider the use of modern technologies designed to improve disinfection of surfaces in hospitals.

New technologies fall into several categories, including:
(A) Liquid surface disinfectants, (B) Improved methods for applying disinfectants, (C) Self-disinfecting technologies, (D) light-activated photosensitizers, (E) Automated or No-touch technologies.

These newer disinfectants have Environmental Protection Agency (EPA) safety rating of category IV (housekeepers do not need to wear any personal protective equipment while using these products) [43-46].

Chemical disinfection has always played a crucial role in eradication of micro-organisms. Newer hydrogen peroxide-based liquid surface disinfectants with a combination of peracetic acid and hydrogen peroxide have proved effective alternatives to disinfectants during the ongoing COVID-19 pandemic, also use of electrolyzed water (hypochlorous acid) and cold atmospheric pressure plasma have shown antibacterial effect.

Newer "no-touch" (automated) decontamination technologies include aerosol and vaporized hydrogen peroxide, mobile devices that emit continuous ultraviolet (UV-C) light, a pulsed-xenon UV light system, and use of high-intensity narrow-spectrum (405 nm) light. These "no-touch" technologies have been shown to reduce bacterial contamination of surfaces.

A micro-condensation hydrogen peroxide system has been associated in various studies with reductions in healthcare-associated colonization or infection, while there is more limited evidence of microbial decline by the pulsed-xenon system [47].

Touch (Wiping) Vs No-Touch (Mechanical) Disinfection

Reduction of microbial contamination is an important aspect of infection control program. The rate of hospital acquired infections is increasing dramatically in the past few years because multi-drug resistant strains of certain micro-organisms. Utilizing vapours for decontamination overcomes many limitations of traditional Touch (wiping) method of disinfection. Vapours have high potential to permeate or penetrate complex surfaces, albeit varying levels of uniformity.

No-Touch or Touchless technologies are recent innovation in disinfection technologies. They encompass a broad range of self-disinfecting surfaces and fumigation methods. They limit cross contamination of pathogens and hence an effective method of disinfection. Humphreys recently reviewed Self-disinfecting surfaces, but enough literature is yet to be published for the same.

Personal Protective Equipment

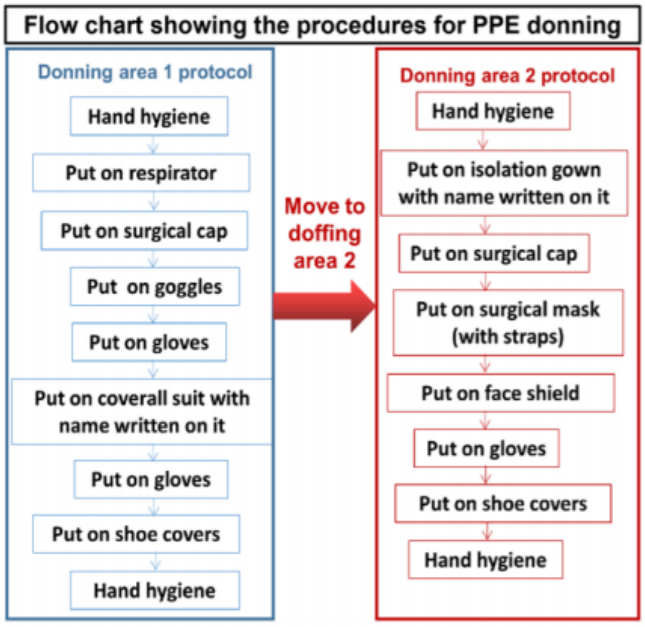
A comprehensive program for the use of PPE should be enforced. All the healthcare personnel should be trained in the use of PPE. They should be trained to clean, disinfect, store, and inspect their PPE. All staff should be strictly advised to use with the National Institute of Occupational Safety and Health (NIOSH)-certified N95 respirators. Personal goggles should be issued to every member of staff.

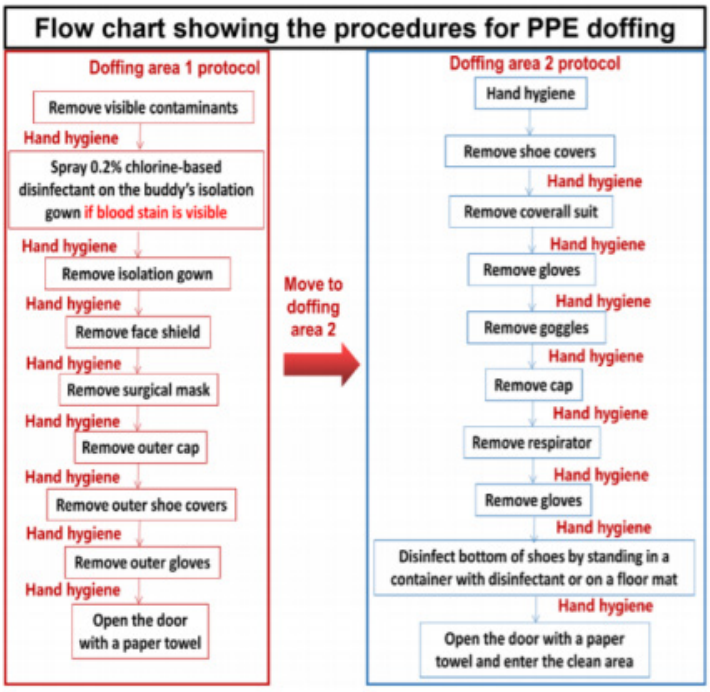
Hair covers or hoods should also be worn. Longer sleeved gloves are preferred to prevent exposure of the wrists with glove slippage. Alternately, vertical tape strips should be used to help keep gloves secured to the gown. Circumferential taping of gloves to the gown, such as used when wearing chemical PPE, is not necessary and makes gown and glove removal more challenging. Eye protection should include protection from side exposure with side shields or goggles. Full face shields advised since they help provide both eye protection and avoid facial and respirator contamination. Some disposable shoe covers may increase the risk of self-contamination during removal of protection clothing. Shoes worn should be impermeable to fluids and able to be decontaminated. Staff should wear operating room scrub suits or full coveralls under the PPE. Coveralls with an integrated hood may simplify the underlayer worn in conjunction with PPE, however the choice of product should be assessed for ease of removal to avoid contamination during removal. Hand hygiene must be performed after removing PPE, and in the event of inadvertent contamination of the hands by touching infected surfaces during PPE removal [48-50].

The Buddy System (two-person assistance system) with mutual supervision should be adopted unlike other countries. In addition, the Sky Eye monitoring system should be installed in nurse stations, physicians' offices, PPE donning areas, and PPE-doffing areas to observe and monitor in real-time during arranging shifts of infection control teams on a 24hour basis. The staff should be reminded in a timely manner for the precautions to be taken during donning and doffing of the PPE to ensure their utmost safety. During doffing, the PPE should be gently rolled on the body and any vigorous movements should be avoided, also thus the soiled outside surface of PPE should be rolled inwards. A proper distance should be maintained when spraying the chlorine-based disinfectant to allow for full atomization and to achieve effective sterilization. Moreover, the spraying of disinfectant should avoid the head and face to prevent the disinfectant from irritating the respiratory tract and mucous membranes of the person. Healthcare professionals should avoid touching the side edges or front surfaces of face shield, eye-wear, headcaps, facemasks to prevent contamination. All healthcare professionals should strictly implement the seven-step handwashing technique for a minimum of 15 seconds [51].

Flowchart enumerating procedures during donning and doffing of PPE kit [52].

The emergency response plan on exposure to contaminated PPE includes the following steps:
(1) Immediately suspend the doffing procedures once exposure occurs. The exposed area should be immediately disinfected by the buddy in the doffing area.
(2) If exposure occurs to the face or other skin surfaces, immediately apply 75% alcohol or ethanol-containing quick-drying hand sanitizer to wipe the exposed skin on the face or other area for 2 min.





(3) If exposure occurs to ocular mucosa, repeatedly rinse with normal saline and apply anti-infective eye drops.
(4) If exposure occurs to the oral mucosa, gargle with 75% alcohol once for 2 min, followed by gargling with normal saline three times.
(5) Continue doffing other PPE according to the procedures.
(6) Shower and change clothes.
(7) Finally, report the relevant information to the infection control team [52,53].

Recommended practices for extending the use and/or re-using an N95 respirator mask [54-57]:
a)Avoid removing, adjusting, or touching the respirator (both outside and inside surfaces.
b)Discard the respirator if it becomes grossly contaminated or damaged or if breathing through it becomes difficult.
Perform hand hygiene before and after handling/touching the respirator.
a)Store the respirator in a clean, dry location to avoid contamination and maintain its integrity. It can be stored in a single-use breathable container, or hung in a designated area.
b)Inspect the respirator and perform a seal check before each use.

There might be a risk of a shortage of N95 respirators during any pandemic, especially if it is extended for a prolonged period of time. In that case, alternatives such as Powered Air Purifying Respirator (PAPRs) may be used and practices may be introduced to extend the use of each N95 respirator [58].

Use of Powered air purifying respirators (PAPR) vs N95 mask as part of PPE during elective orthopaedic surgeries [59]:

Potential advantages of PAPR	Potential disadvantages of PAPR
Higher protection factor	May be more complicated than required for mode of transmission, leading to greater risk of contamination when removing PAPR
Full facial and head coverage	Higher cost compared with N95 respirators
More comfortable for prolonged resuscitations or transports and resistance to being accidentally dislodged	Inability to reuse disposable filters between 2 surgeries, need large supply of filters
Eliminates N95 fit testing concerns (especially for those who cannot be successfully fit tested because of facial features)	Need explicit procedures for decontamination and recycling of blower units for next use
No need to maintain supply of variety of N95 respirators to meet fit testing requirements	Potential compromise of disposable components (e.g., hoods, hoses) through inappropriate attempts to sterilize and reuse if supplies run low, leading to infection risk
Can be used with facial hair or for staff who cannot be successfully fit tested	Communication challenges between surgeons due to fan noise
	Need for recurrent training of staff to maintain competence if not frequently used

The Public Health Agency of Canada has Released Interim Infection Control Recommendations Related to COVID:

Localized aerosol may be generated during certain medical interventions like intubation, non-invasive ventilation, bag valve-mask ventilation that could result in airborne transmission of contagious diseases.

As earlier mentioned, bag mask ventilation could generate aerosols, prior to intubation due coughing of the patient during laryngoscopy. An exhalation filter can therefore, be attached between the mask or endotracheal tube and the bag to the resuscitation bag. Intubator could be placed at a higher risk in cases of inadequate sedation, which could result in patient agitation and also dislodgement of the PPE. Adequate pre-oxygenation refrains the risk of bag-mask ventilation. Video laryngoscopy

should be used with a display for smooth intubation. A flexible bronchoscopic intubation with a help of video bronchoscope can be an effective alternative for complex cases. End-tidal carbondioxide should be detected to check the position of endotracheal tube placement [60,61].

Once intubated, lung protective mechanical ventilation strategies should be used (target tidal volume 6 mL_kg-1 predicted body weight, plateau pressure B30 cm H20, target SaO2 88–95% and pH C 7.25). All exhaled gas from the ventilator should be filtered. Pneumothorax was noted in some ventilated patients affected with SARS. Extrapolating to 2019-nCoV infected patients, clinicians should strongly consider pneumothorax in any ventilated patient with sudden respiratory deterioration. Given the potential delay in obtaining a chest x-ray for a patient in airborne isolation, portable ultrasound may be used to quickly assist in the diagnosis of a pneumothorax [62].

Conclusion

The Entire Orthopaedic Fraternity is continuing to develop strategies to deliver a safe musculoskeletal care during this ongoing COVID-19 crisis, while many surgeons of the orthopaedic workforce move to the front line. Orthopaedic surgeons and patients are having difficult choices about management options for a wide variety of orthopaedic injuries and urgent conditions due to the brisk nature of transmission of virus. In the current trend of evolving guidelines and infection control protocols about operative as well as non-operative management of COVID-19 patients, Orthopaedic surgeons are making a redoubled effort to get back to their interrupted practice amidst the pandemic. Utilization of newly developed disinfection practices will help deliver optimum treatment.

Conflict of interest: None

Author Contribution: All authors have equally contributed for completion of this manuscript.

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