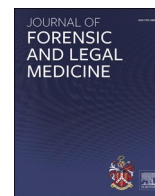




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Review: The safe handling of a corpse (suspected) with COVID-19

L.G.M. Dijkhuizen^{a,b,*}, H.T. Gelderman^{a,b}, W.L.J.M. Duijst^{a,b}

^a Maastricht University, Minderbroedersberg 4-6, 6211, LK, Maastricht, the Netherlands

^b GGD (Public Health Service) IJsselland, Zeven Alleetjes 1, 8011, CV, Zwolle, the Netherlands

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ABSTRACT

Introduction: Countries around the world are confronted with a rising count of patients that die from COVID-19. Up to this date, there is no scientific evidence that proves that a COVID-19 corpse is still infectious. Different guidelines are being followed worldwide on how to deal with a COVID-19 positive corpse. The aim of this review is to compare different guidelines and literature on best practice for handling a COVID-19 positive corpse.

Results: The guidelines vary greatly in the use of PPE's and other safety measures especially during autopsy. There is great variation in the use of disinfectant and its concentration. Also recommended funeral services and contact with relatives vary greatly.

Conclusion: In conclusion, there is very limited scientific evidence on which the researched guidelines are based. It is unclear why some guidelines propose a "business as usual" attitude and others a "code-red" attitude. More scientific evidence is needed to substantiate the handling of COVID-19 positive corpses to make an educated decision on how to safely handle a COVID-19 positive corpse.

1. Introduction

On December 31st 2019, a cluster of patients presenting with pneumonia was detected in Wuhan, China. On January 9th 2020, the WHO (World Health Organization) reported that this outbreak was caused by a new coronavirus later named COVID-19. The COVID-19 (SARS-CoV-2) is very similar to SARS (SARS-CoV-1). The virus has been detected in bodily fluids like sputum, feces and eye fluid.^{1,2} The most important transmission route of the virus is through sputum droplets. Direct and indirect transmission have also been described. It is unclear if fecal-oral is a transmission route.² By these transmission routes the virus spreads in the environment and can be detected outside the host. COVID-19 has been detected on surfaces after 5 days, with a temperature between 22 and 25° Celsius and a humidity of 40–50%.³ The virus has been detected on plastic after 72 h, stainless steel after 48 h and copper after 8 h.³ A recent article on a ship carrying COVID-19 positive patients, states that viral material could still be detected after 17 days.⁴ DNA-techniques indicated the presence of COVID-19 in Dutch sewage water. The Dutch authority on infectious diseases (Rijksinstituut voor Volksgezondheid en Milieu = RIVM) stated that the virus ended up

in the sewage water through bodily fluids.⁵

Little is known about the behavior of the COVID-19 virus after the human host has died. It is known that SARS can be detected in the lungs and small intestine until 90–175 h post mortal. It is unclear if the virus was still infective.⁶ How long COVID-19 can be detected in bodily fluids is unknown. Our research group has tested COVID-19 post mortem (through a nasopharynx and oropharynx swab) and the virus could still be detected 27 h after death. If the bodily fluids pose an infection risk when the virus can be detected, is unknown. The RIVM states a corpse can be infectious for some hours till a day after death, but does not refer to a scientific study.⁷

Countries around the world are confronted with a rising count of patients that die with/from COVID-19. Different guidelines are being followed worldwide on how to deal with a COVID-19 positive corpse to keep transmission risk as low as possible. The aim of this review is to compare different guidelines and literature on best practice for handling a COVID-19 positive corpse.

* Corresponding author. Maastricht University, Minderbroedersberg 4-6, 6211, LK, Maastricht, the Netherlands.

E-mail addresses: l.dijkhuizen@ggdijsselland.nl (L.G.M. Dijkhuizen), tgelderman@hotmail.com (H.T. Gelderman), Wilma.duijst@maastrichtuniversity.nl (W.L.J.M. Duijst).

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2. Material and methods

For this literary review government guidelines on the handling of COVID-19 positive corpses were used. Search criteria on google included “COVID-19” AND “guideline” AND (“post mortal” OR “corpse” OR “dead body” OR “funeral workers” OR “funeral service”). Only guidelines in English and Dutch were included. Guidelines were included from the Netherlands,^{7,8} China (Hong Kong),⁹ United States (USA),^{10,11} United Kingdom (UK),^{12–14} Scotland,¹ Europe,¹⁵ Australia¹⁶ and India.¹⁷ Guidelines on SARS and general infectious diseases from included countries were also reviewed when available. Recent published literature on the handling of COVID-19 positive corpses was also used,^{18–20} as well as reports from the WHO.^{2,21} See [Table 1](#) for an overview of used literature.

The guidelines, literature and reports were compared on measures needed to be taken in the morgue, during autopsy, during handling by

Table 1
Overview of used literature.

Author ^a	Country	Year	Type of publication	Topic	Based on source
RIVM ⁷	The Netherlands	2020	Guideline	Corona	WHO/ECDC
RIVM ⁸	The Netherlands	2020	Guideline Addendum	Corona	No source
CHP ⁹	China	2020	Guideline	Corona/SARS	No source
CDC ¹⁰	United States of America	2020	Guideline	Corona	WHO/NCIRD
CDC ¹¹	United States of America	2004	Guideline	SARS	No source
HSE ¹²	United Kingdom	2018	Guideline	Infectious Diseases	NHS/HSE
HSE ¹³	United Kingdom	2020	Guideline	Corona	WHO/ECDC
DHSC ¹⁴	United Kingdom	2020	Guideline	Corona	NHS
HPS/NHS ¹	Scotland	2020	Literature Review	Corona	WHO/CDC/original articles
ECDC ¹⁵	Europe	2020	Guideline	Corona	WHO/ECDC
WHO ²		2020	Report	Corona	Field visits
NSW ¹⁶	Australia	2020	Guideline	Corona	NSW, no source
WHO ²¹		2014	Guideline	SARS/Infectious Diseases	WHO/CDC/original articles
DGHS ¹⁷	India	2020	Guideline	Corona	No source
Hanley B et al. ¹⁸	United Kingdom	2020	Original Article/Guideline	Corona	WHO, ECDC
Keten D et al. ¹⁹	Germany	2020	Original Article/Guideline	Corona	Hanley B et al.
Parekh UN ²⁰	India	2020	Original Article/Guideline	Corona	Hanley B et al.

CDC: Centers for Disease Control and Prevention.

CHP: Centre for Health Protection.

DGHS: Directorate General of Health Services.

DHSC: Department of Health and Social Care.

ECDC: European Centre for Disease Prevention and Control.

HPS: Health Protection Scotland.

HSE: Health and Safety Executive.

NCIRD: National Centre for Immunization and Respiratory Diseases.

NHS: National Health Service.

NSW: North South Wales.

RIVM: Rijksinstituut voor Volksgezondheid en Milieu.

WHO: World Health Organization.

^a Alphabetical abbreviation explanation.

funeral workers, transport, funeral services and relatives. The use of Personal Protection Equipment (PPE) was reviewed, as well as special measures to be taken with the corpse itself and cleaning and disinfecting the environment.

3. Results

[Table 1](#) shows the sources each guideline is based on. The developed guidelines appear to be derived from the WHO guidelines, in which the word ‘post-mortem’ is only named twice. The guidelines also reference each other, but they all lack a clear scientific basis. A review of the guidelines results in the following overview.

3.1. COVID-19 transmission

Much is still unknown about the transmission of COVID-19. The Netherlands state that the transmission risk is deemed highest during the symptomatic period. The WHO states that a person who has contracted COVID-19 could be symptomatic for 14 days in mild cases to several weeks in severe cases. The Netherlands state that a corpse could be infectious for several hours to days. No supporting scientific data is cited. None of the other reviewed literature state anything about how long bodily fluids stay infectious in the corpse, nor anything about post mortal transmission risk of COVID-19.

3.2. Handling of the corpse (without autopsy)

The use of PPE’s while handling the corpse has been outlined in [Table 2](#). Contact with bodily fluids should be minimized. The consensus appears to be that the body of the deceased should be transported as soon as possible to the morgue. Transport between place of death and morgue is advised to be in a leak-proof body bag to limit the contact with bodily fluids. China, India and Germany state that wound openings should be cleaned, disinfected and covered with a waterproof band aid. These three countries further state that the body orifices (mouth, nose and anus) should be plugged. In China, India and Germany the skin of the corpse should be disinfected. Body bags are required in China, USA, UK, Australia, India and by the WHO. These body bags then have to be disinfected in China, USA and India. In China and India, the body bags have to be covered by a sheet. In Germany, the corpse has to be wrapped in a double sheet doused in disinfectant, put in a double-layer (leak-proof) body bag with chlorine that is then placed in a coffin which has to be closed immediately. In Germany and India, the vehicle that has transported either a body bag or coffin should be disinfected after transport.

India states that a COVID-19 positive corpse should be stored separately from COVID-19 negative corpses, including separate ventilation. The body bag when disinfected can be handled with just the use of gloves and proper hand hygiene. Contact with the body bag should be minimized.

3.3. Handling of the corpse during autopsy

The use of PPE’s during autopsy has been outlined in [Table 2](#). In addition to extensive PPE’s and limited personnel, a cut-proof layer between double gloves is advised by Germany and India. The UK, India and Germany state that an autopsy should be performed in a negative pressure room with whole ventilation or down-drafts at the workstations. Germany further states that autopsy rooms should be in a separate building from patient care with stand-alone sewage and ventilation and that showers should be available for personnel. The USA, UK and Germany advise a whole-body suit with vented respirators while being in the autopsy room.

While performing the autopsy, UK, India and Germany state it is preferred that only one body cavity should be opened at a time. Emphasis has been put on minimalizing the chance of cutting or

Table 2
Overview of the use of Personal Protection Equipment (PPE) when handling a dead body infected with COVID-19.

<i>Morgue</i>	Country of origin	Standard PPE ^a	Waterproof apron	Facemask	Goggles	Double gloves	Notes
CDC – COVID-19 ¹⁰	USA	+		+	+		
ECDC – COVID-19 ¹⁵	Europe	+					
CHP – COVID-19 ⁹	China	+	+	+	+		
DGHS – COVID-19 ¹⁷	India	+	+	+	+		
RIVM – COVID-19 ⁷	Netherlands	+		-	-		
Parekh UN – Covid-19 ²⁰	India	+		+			Separate ventilation in storage unit from non COVID-19 positive corpses
WHO – SARS ²¹		+	+	+	+		
CDC – SARS ¹¹	USA	+		+	+		
HSE – Infectious diseases ¹²	UK	+		+	+		
<i>Autopsy</i>	Country of origin	Standard PPE ^a	Waterproof apron	Facemask	Goggles	Double gloves	Notes
CDC – COVID-19 ¹⁰	USA	+	+	+	+	+	Limited personnel. Respirator N-95 is advised. Shoe caps and hair nets are advised.
ECDC – COVID-19 ¹⁵	Europe	+		+	+	+	
CHP – COVID-19 ⁹	China	+	+	+	+	+	Limited personnel.
DGHS – COVID-19 ¹⁷	India	+	+	+	+	+	Limited personnel.
Hanley B et al. – Covid-19 ¹⁸	UK	+	+	+	+	+	Limited personnel. Surgical mask is not sufficient, either vented face mask or whole-body suit is advised. Rubber boots with metal toecaps are advised.
Keten D et al. – Covid-19 ¹⁹	Germany	+	+	+	+	+	Limited personnel. Add a cut-proof layer between double gloves. Shoe and hair covers. A special suit with powered, air-purifying respirators (PAPRs) with HEPA filters and life support system should be worn
Parekh UN – Covid-19 ²⁰	India	+		+	+	+	Limited personnel. Add a cut-proof layer between double gloves. Hair cover.
WHO – SARS ²¹		+	+	+	+	+	Limited personnel
CDC – SARS ¹¹	USA	+		+	+	+	
HSE – Infectious diseases ¹²	UK	+	+	+	+	+	Limited personnel
<i>Funeral homes</i>	Country of origin	Standard PPE ^a	Waterproof apron	Facemask	Goggles	Double gloves	Notes
CDC – COVID-19 ¹⁰	USA	+	+	+	+		
ECDC – COVID-19 ¹⁵	Europe	+					Advise next of kin: no/least as possible physical contact with PPE.
CHP – COVID-19 ⁹	China	+	-	+	+		
NSW – COVID-19 ¹⁶	Australia	+		+	+		Advise next of kin: no/least as possible physical contact.
DGHS – COVID-19 ¹⁷	India	+		+			No contact with next of kin.
RIVM – COVID-19 ⁷	Netherlands	+			-		
Parekh UN – Covid-19 ²⁰	India	+					
WHO – SARS ²¹		+		+	+		

^a Standard PPE: gloves, disposable gown, hand hygiene.

puncture injuries. Most guidelines state that Aerosol Generating Procedures (AGP) or splashing procedures (use of high flow water, dropping organs in water) should be avoided or minimized. An oscillator saw should be either avoided or used with suction extraction.

3.4. Cleaning the morgue

The reviewed literature shows different cleaning and disinfectant protocols. Table 3 shows an overview of used disinfections and its concentration. Bleach/chlorine (in different solutions) and alcohol 70% is most frequently used. Different concentrations of disinfectants are

used. The surroundings where the deceased has come in contact with, need to be cleaned of visible bodily fluids and disinfected with chlorine or alcohol 70%. Germany states that the circulated air in the autopsy room should be sterilized with UV-light for 1 h and filtered through a Fan Filter Unit (FFU) for 2 h. Germany also states that body excretions should not be washed down the drain into normal sewage water, but has to be put for 1,5 h in 40 mg/l of chlorine. The mix should then be washed down the drain with more chlorine until the sewage water contains a concentration of 10 mg/l chlorine.

Table 3Overview of recommended disinfectants NaOCl^a and Alcohol (concentration in %, 1 part disinfectant: parts water).

Source	Country of origin	Skin of the corpse	Body Bag	Transport vehicle	Surface possibly contaminated	Surface visibly contaminated	Metal surface	Notes
CDC – COVID-19 ¹⁰	USA		“Disinfectant”		“clean and disinfect”	“clean and disinfect”		
ECDC – COVID-19 ¹⁵	Europe				NaOCl 0,1% 1:50/Alcohol 70%			
CHP – COVID-19 ⁹	China	NaOCl 5,25% 1:49	NaOCl 5,25% 1:4		NaOCl 5,25% 1:49	NaOCl 5,25% 1:4	Alcohol 70%	
NSW – COVID-19 ¹⁶	Australia				“clean and disinfect”	“clean and disinfect”	“clean and disinfect”	
DGHS – COVID-19 ¹⁷	India	NaOCl 1%	“Disinfectant”	NaOCl 1%	“clean” and NaOCl 1%	“clean” and NaOCl 1%		
DHSC – COVID-19 ¹⁴	United Kingdom/Scotland				“clean and disinfect”	“clean and disinfect”	“clean and disinfect”	
HPS/NHS ¹	Scotland				NaOCl 1%/Alcohol 70%			
Keten D et al. – Covid-19 ¹⁹	Germany	“Disinfectant” 1:10	“Disinfectant” 1:10	NaOCl 1%	“clean” and NaOCl 1%	“clean” and NaOCl 1%		Circulating air: 1 h UV lamp, 2 h FFU ^b . Water: no bodily fluids into the sewage, has to be soaked in 40 mg/l NaOCl first.
Parekh UN – Covid-19 ²⁰	India	NaOCl 1%	NaOCl 1%	NaOCl 1%	“clean” and NaOCl 1%			
WHO – SARS ²¹					“clean” and NaOCl	“clean and disinfect”	“clean and disinfect”	

^a NaOCl: Sodium Hypochlorite, also known as bleach, or chlorine.

^b FFU = Fan Filter Unit, used to filter air.

3.5. Funeral services

The use of PPE's by funeral workers has been outlined in Table 2. Embalming (or thanatopraxis) is not allowed in China and India. In the Netherlands only thanatopraxis is allowed, in the UK and Australia embalming is allowed when using proper additional protection equipment. Family of the deceased is allowed to have physical contact with the deceased with proper hand hygiene in the Netherlands. Other countries advise limited (with the use of PPE's) to no physical contact with the deceased. In China, it is advised to cremate corpses positive for COVID-19. Germany states that the body has to be buried at least 2 m below the surface.

4. Discussion and conclusion

Throughout the world many guidelines on the handling of deceased due to COVID-19 exist. Some guidelines concentrate on corpses that have been tested positive for COVID-19 before death, others also include corpses of people suspected to have COVID-19. Since not everyone suspected of COVID-19 infection is tested before death, a suspected positive COVID-19 corpse should be handled the same as a positive COVID-19 corpse.

The guidelines vary greatly. On the one hand, there is the 'no problem, business as usual' attitude. No extra precautions are necessary and the relatives can say goodbye to the deceased in the way they want, because there is no risk of contamination since the corpse is not breathing. On the other hand, there is the 'code red' attitude. All possible precautions should be taken and the corpse should be touched as little as possible and the surroundings should be decontaminated, because the risk of contamination is enormous. Why in a guideline is chosen for one or the other attitude is unclear. The developed guidelines appear to be derived from the WHO guidelines, in which the word 'post-mortem' is only named twice. The WHO-guidelines are based on field visits. Scientific evidence about post-mortem handling lacks to a great extent. The

WHO does not mention the post-mortem contamination as a major knowledge gap. However, the WHO does advice to conduct pathogenesis studies using biopsy/post-mortem specimens. Until this moment no such a study has been published.

Up to this date, there is no scientific evidence that proves that a COVID-19 corpse is still infectious. The guidelines vary greatly in the use of PPE's and other safety measures especially during autopsy. There is great variation in the use of disinfectant and its concentration. Also recommended funeral services and contact with relatives vary greatly.

Some COVID-19 guidelines are based on SARS/MERS guidelines, while others are a complete new set of guidelines specific to COVID-19. The United Kingdom is the only country that classifies COVID-19 in Hazard Group 3, the same group as SARS and MERS. The guidelines for both therefore are the same. Other countries imply COVID-19 is similar to SARS, but the guidelines don't. It is still unclear if COVID-19 (SARS-CoV2) has the same infectious properties in a corpse as SARS (SARS-CoV1). In fact, too little is scientifically known of COVID-19 to propose an educated guideline at this moment.

In conclusion, there is very limited scientific evidence on which the guidelines in this research are based. More scientific evidence is needed to substantiate the safe handling of COVID-19 positive corpses to make an educated decision between a 'no problem' and a 'code red' attitude.

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