National Collaborating Centre for Environmental Health

Centre de collaboration nationale en santé environnementale

Field inquiry: COVID-19 risks from handling the deceased

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Primary inquiry

Information was requested on the SARS-CoV-2 transmission risks for individuals who are involved in the handling, transport, and examination of decedents known or suspected to have been infected with COVID-19 at the time of death. The following questions guided the inquiry:

1. How long does SARS-CoV-2 persist on the surface of a body, or in bodily tissues or fluids, that may be encountered post-mortem?
2. Is there evidence for transmission of SARS-CoV-2 from a deceased person to others?
3. Is there evidence that persons involved in the handling, transport, and examination of decedents are at higher risk of COVID-19 infection or mortality?

Background

In May 2020, a paper "Death care during the COVID-19 pandemic: understanding the public health risks" reported on the potential risks of exposure to SARS-CoV-2 in death care services and the associated guidance and good practice recommendations for reducing transmission risks. Standard precautions and good practice to reduce transmission risks of infectious diseases are a mainstay of death care professions. Throughout the COVID-19 pandemic, approaches that range from "business as usual" to more extreme precautionary approaches have been taken when handling decedents with known or suspected COVID-19 infection.[1,2] This has included the avoidance of procedures such as autopsy in some jurisdictions, despite the potential medicolegal and research benefits of performing such procedures. Other jurisdictions have modified their approaches and protocols for handling decedents. The current inquiry updates the evidence since May 2020 for COVID-19 transmission risks associated with the handling of dead bodies. Guidance and good practice recommendations are not reviewed in this inquiry but are presented in the May 2020 paper, with an updated list of key references included at the end of this document.[2-23]

What we know about COVID-19 transmission

The primary mode of person-to-person transmission of SARS-CoV-2 remains to be via direct contact with an infected person and their respiratory emissions (droplets and aerosols), and secondarily via contact with contaminated surfaces (fomites), followed by touching of the eyes, mouth, or nose.[24-26] Transmission may also be possible following exposure to aerosols during aerosol generating procedures (AGP) performed on a COVID-19 patient. In the absence of active respiratory emissions from a dead body, exposure to infectious droplets or aerosols or indirect contact transmission may occur due to the following:[27-29]

- Contact with contaminated fomites where sufficient viable virus to cause infection is transferred from a surface to the eyes, mouth, or nose of a susceptible host.
- Movement or manipulation of the body during handling or transfers, causing shifting of the respiratory cavity, resulting in possible sporadic emission of air or fluids.
- Movement, manipulation, or procedures (including AGP) that cause splashes, sprays, or aerosolization of bodily fluids or tissues, such as during autopsy.

What we know about COVID-19 risks in death care

The International Committee of the Red Cross (ICRC)[9] designated certain death care activities during the COVID-19 pandemic as low, medium, or high risk based on the potential for exposure to SARS-CoV-2 virus.

- ***Low-risk*** activities include those where there is minimal direct contact with the deceased such as during admission to the funeral home, preparation of the body for viewing, and release of the deceased for burial or cremation, which could result in contact with fomites.
- ***Medium-risk*** activities include rolling, undressing, or significant manual handling of the body, or other low-risk activity that results in inadvertent droplet generation (e.g., splashing of spilled fluid during admission to a funeral home), which could result in contact with droplets or contaminated fomites.
- ***High-risk*** activities include those such as autopsy or other invasive procedures, including embalming, and AGPs that could result in direct inhalation of droplets or aerosols or contact with bodily fluids of the deceased and contact with contaminated fomites.

The Occupational Safety and Health Administration's (OSHA) occupational risk pyramid also designates workers performing AGPs or collecting/handling specimens from decedents known or suspected to be infected with COVID-19 at the time of death as the highest risk category among death care occupations.[30] A review of the current evidence on the COVID-19 risks to death care personnel and others who may have physical contact with COVID-19 decedents is needed to continue to inform measures to mitigate risks.

Methods

A rapid literature search was performed to identify recent evidence of persistence of SARS-CoV-2 post-mortem, transmission events resulting from handling of dead bodies, and evidence on incidence of COVID-19 infection or mortality associated with death care occupations. Ebscohost databases (includes Medline, Cinahl, Academic Search Complete, etc.) Google Scholar, and Google, with a date limit focus of May 1, 2020 to Dec 31, 2021 (to account for e-pubs ahead of print), no jurisdictional limit, and English language documents were scanned. Further examination of bibliographies of key articles was used to retrieve more extensive information, and forward chaining of key papers added to the search results.

Variants and Boolean operator combination of the following key search terms were used: (corpse OR cadaver OR mortuary OR funeral OR cemetary OR cemetery OR burial OR “death care” OR deceased OR bereavement OR memorial OR “dead bodies” OR “dead body” OR cremation OR greening OR morgue OR “preserving human remains” OR “body disposal” OR tahara OR “transporting bodies” OR open-casket OR “open casket” OR post-mortem OR autopsy); (undertaker OR caretaker OR “funeral industry worker” OR “funeral director” OR “funeral professional” OR embalmer OR embalm OR forensic OR “medical personnel” OR paramedic OR “ambulance driver OR “body preparation”); (virus OR coronavirus OR ncov OR "novel cov” OR COVID-19 OR SARSCOV-2 OR Sars-Cov-19 OR SarsCov-19 OR SARSCOV2019 OR "severe acute respiratory syndrome cov 2" OR "2019 ncov” OR "2019ncov” OR COV-2); (transfer OR spread OR infect OR infection OR transmission OR transmit OR contagious OR touch OR shed OR shedding OR secretion); (survival OR survive OR persist OR persistence OR viability); (tissue OR skin OR saliva OR mucous OR eye OR cell OR kidney OR testis OR clothing OR blood OR lung OR fomite).

Additional grey literature and government websites reporting on COVID-19 infection, death or risk factors by occupation were also scanned for information relevant to death care professions and expert advice was sought on key resources relevant to Canada.

How long does SARS-CoV-2 persist on the surface of a body or in bodily tissues or fluids that may be encountered post-mortem?

Where a person has died from an infectious respiratory virus, risk of transmission to others may depend on the quantity and the viability of the virus within the lungs and other bodily tissues and fluids, on the surface of the body, or on fomites that may be contaminated with droplets or bodily fluids from the deceased. Risks of infection from a dead body due to improper handling are greater soon after death when pathogens may still be viable but will decrease over time as viral replication in live cells ceases and the biochemistry of cells change, causing viable virus to diminish.[31,32]

Persistence of SARS-CoV-2 in bodily tissues and fluids post-mortem

Several studies have reported on the detection of SARS-CoV-2 viral RNA in dead bodies. The presence of viral RNA does not necessarily indicate the presence of infectious virus.[33] Viral RNA has been shown to diminish over time but may still be detected after viral particles cease to be infectious.[34] SARS-CoV-2 RNA has been detected several days post-mortem on eyes, [34,35] nose, and mouth,[36] periodontal tissue,[37] and the respiratory tract including the nasopharynx, throat, and lungs,[18,38-42] and other bodily tissues and fluids.[43] Aquila et al. (2021) detected SARS-CoV-2 RNA in oropharyngeal, nasal, and bronchial specimens collected at time intervals of 2, 4, 6, 12 and > 24 hours after death in the majority of 20 decedents with confirmed COVID-19 infection at time of death, with the number of positive results decreasing over time.[32] Rodic and Tahir (2020) detected a positive result for SARS-CoV-2 one day post-mortem, and subsequently one day post-embalming, indicating that embalming (replacement of blood with formaldehyde-based chemicals) does not preclude detection of virus, and care should be taken even post-embalming.[41]

Only one study was identified that reported on the viability of SARS-CoV-2 virus in post-mortem specimens, which indicated viable virus was detected up to 35.8 hours post-mortem in the throat of some patients[40,44]

Persistence of SARS-CoV-2 on skin

Few studies have measured how long SARS-CoV-2 virus can remain viable on skin. One study used swine skin as a surrogate for human skin, finding that SARS-CoV-2 remained stable for up to 14 days at 4°C, 96 hours at 22°C, and 8 hours at 37°C.[45] In comparison, a study measuring viability on human skin collected from autopsy specimens, approximately one day after death, found that mean survival time for SARS-CoV-2 was 9 (± 1) hours at 25°C.[46] The reasons for the difference in viability at room temperature for these two studies (96 versus 9 hours respectively) is unclear but may be related to experimental conditions such as dosing volume (50 µl versus 5 µl respectively) and skin preparation.

Persistence of SARS-CoV-2 on other surfaces (fomites)

Several studies have measured the persistence of SARS-CoV-2 on common surfaces under experimental conditions.[47-51] The virus appears to remain viable for longer periods (one to seven days or more) on smooth, hard surfaces such as stainless steel, hard plastic, glass, and ceramics and for shorter periods (several hours to two days) on porous materials such as paper, cardboard, and textiles. Persistence determined under experimental conditions may be dependent on other factors such as the initial volume and dose deposited, which may not be representative of real-world conditions.[45,47-55] Ambient temperature also has a significant effect on persistence, with SARS-CoV-2 remaining viable for longer under cool conditions as indicated in these experimental studies. No studies were identified that assessed whether viable SARS-CoV-2 virus is present on surfaces or objects present in rooms/facilities where dead bodies are stored, examined, or prepared for burial or cremation. The available evidence suggests that viable virus may remain in or on the body for several hours to a few days post-mortem, but contamination of surfaces with viable virus may depend on whether leaks, splashes, sprays, or aerosolization of bodily fluids or tissues have occurred.

Is there evidence for transmission of SARS-CoV-2 from a deceased person to others?

The rapid literature search found no evidence of a confirmed case of transmission of COVID-19 from a deceased person to date.[1,7,56,57]A short communication in April 2020 reported the possible transmission from a deceased COVID-19 patient to a forensic examiner in Thailand. This report was later revised to clarify that transmission from the corpse to the examiner was a possibility only, and the pathway was not confirmed.[58,59] In May 2020, a funeral home worker in Atlanta claimed to have been infected with SARS-CoV-2 following transport and preparation of a deceased COVID-19 patient at a funeral home, resulting in his hospitalization 17 days following contact with the body. No details of other potential exposure routes or an epidemiological investigation were provided in the news report.[60]

Is there evidence that persons involved in the handling, transport, and examination of decedents are at higher risk of COVID-19 infection or mortality?

The risk of transmission of SARS-CoV-2 from deceased bodies was identified to be greatest for persons who may be exposed to contaminated surfaces, respiratory droplets or bodily fluids of COVID-19 decedents, with persons involved in conducting autopsies or other invasive procedures, including AGPs, to be at the highest risk, as described previously.[9,27,30]

A systematic review by Yaacoub et al. (2020) on the effectiveness of procedures for safe handling of COVID-19 decedents found no primary studies reporting on COVID-19 outcomes for death care workers. Only one primary study (low certainty of evidence) was included in the review originating from the SARS pandemic, which found no evidence of adverse outcomes for 23 pathologists and technicians involved in autopsies of 16 SARS-CoV decedents under biosafety level 3 conditions.[61] Kritselis and Remick (2020) reviewed the potential transmission of respiratory disease during autopsy. They found no evidence for transmission to laboratory personnel during the SARS and MERS pandemics, and limited risk of infection in the COVID-19 pandemic for autopsy personnel when appropriate precautions are used.[62] The present review examined literature on autopsies of COVID-19 decedents where follow-up of COVID-19 outcomes (positive test, illness, hospitalization, or mortality) were reported for personnel involved. No evidence of onward transmission among autopsy personnel was identified in these reports, although this represents only a small sample of all autopsies performed throughout the pandemic.[32,37,63-65]

Davis and Williamson (2020) report on a survey of approximately 200 listserv pathologists on COVID-19 outcomes for persons performing autopsies on deceased patients with COVID-19.[66] Of 225 autopsies, most involving multiple autopsy staff, only one person reported having developed COVID-19 infection. None of the 12 other personnel working in the same morgue developed symptoms or tested positive for COVID-19,and it was postulated that the infected person may have been exposed in the community, rather than during autopsies.[66] This report should be treated with some caution and considered an anecdotal account of experiences of a selected group of US pathologists. Without further supporting information such as the type and duration of exposure, safety protocols applied, and the level of follow-up for detecting onward transmission in each of the 225 autopsies reported, firm conclusions cannot be drawn.[67]

For non-autopsy-related death care occupations, no additional literature was identified that reported on COVID-19 outcomes for personnel involved. Literature reporting on incidence of COVID-19 across general occupational groups provides some insight into which occupations experience proportionally higher levels of COVID-19-related illness or death, but no literature was identified that reported on death care occupations in Canada.[68,69] International studies that assess COVID-19 incidence and mortality across occupational units vary widely in the level of granularity reported, but no evidence of higher rates among death care professions was identified.[70-74]

Occupations related to "*social and personal services*" or "*personal care and service occupations,*" which include death care occupations, have a higher level of physical proximity and frequency of contact compared to some other occupations, and may also have higher likelihood of exposure to disease. A retrospective analysis of COVID-19 incidence by occupation in Washington State by Zhang (2021) found that the characteristics of "*exposure to disease*" and "*physical proximity to others*" were correlated with COVID-19 case prevalence among workers.[74] Others have used occupational characteristics such as these to identify the occupations at highest risk for COVID-19 infection. Using the United States occupational classification database (O*Net), healthcare occupations were identified to be among the top 15 highest risk occupations for COVID-19 infection.[75,76] Among non-healthcare occupations, "*morticians, undertakers and funeral directors*" were listed as 8th highest and "*embalmers*" as 13th highest of 15 non-healthcare professions.[75,76] Despite these classifications, evidence of heightened incidence of COVID-19 infection or

mortality has not been identified among death care professions covered by these categories, suggesting that measures to mitigate risks are being successfully applied.

Summary

Excess deaths throughout the COVID-19 pandemic have increased the handling of dead bodies required by death care professionals. Handling of COVID-19 decedents has required heightened awareness of standard precautions and good practice to reduce transmission risks, and a precautionary approach has typically been taken where the COVID-19 status of a deceased person is unknown. Concerns raised about the risk of infection among death care personnel due to contact with dead bodies prompted this rapid review of evidence of COVID-19 transmission in the death care sector.[77]

Key findings

- The expanding literature on the presence of SARS-CoV-2 viral RNA in or on a dead body indicates that the virus may be present in a wide array of bodily tissues and fluids and can be detected at extended intervals of several hours to days post-mortem. Detection of viral RNA does not necessarily equate to a risk of transmission leading to infection but provides an indicator of tissues and fluids that may present a risk. Further study is needed to understand the presence and duration of viability of virus in various tissues and fluids, as well as likelihood of indirect transmission occurring.
- To date, with over two million COVID-19 deaths reported worldwide, there have been no confirmed reports of SARS-CoV-2 transmission from a dead body to a living host, including among persons with the greater risk of exposure, namely autopsy personnel. Current data does not indicate that post-mortem examinations and autopsies of COVID-19 patients are resulting in secondary transmission to personnel involved in these procedures. Current approaches to mitigating risks appear to be successful in preventing transmission.
- Data gaps exist for rates of infection, hospitalization, or death due to COVID-19 by occupational groups in Canada. The available data from elsewhere does not indicate a disproportionate level of COVID-19 infection or mortality among death care occupations compared to other professions with similar occupational predictors of risk (degree of frequent and close-proximity contact, exposure to disease). These predictors of risks suggest that death care professions should continue to apply all necessary precautions to prevent transmission from occurring.
- Further monitoring and data gathering on COVID-19 outcomes for high-risk occupations should be conducted to better understand the effectiveness of existing mitigation measures, and to be alert to any changes in outcomes, particularly as emerging variants with the potential for increased transmissibility become more prevalent.

Acknowledgements

The author gratefully acknowledges Dr. Michael Pollanen (Chief Forensic Pathologist, Ontario Forensic Pathology Service) for expert review of this document and Michele Wiens (Information Specialist, NCCEH) and Lydia Ma (Manager, NCCEH) for contributions in preparation and review.

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ISBN: 978-1-988234-55-7

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This document can be cited as: O'Keeffe, J. Field inquiry: COVID-19 risks from handling the deceased. Vancouver, BC: National Collaborating Centre for Environmental Health. 2021 Feb.

 Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through the National Collaborating Centre for Environmental Health.

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