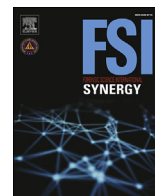




Contents lists available at ScienceDirect

## Forensic Science International: Synergy

journal homepage: <https://www.journals.elsevier.com/forensic-science-international-synergy/>

## Dental autopsy recommendations in SARS-CoV-2 infected cases

Emilio Nuzzolese<sup>a,\*</sup>, Hemlata Pandey<sup>b</sup>, Francesco Lupariello<sup>a</sup><sup>a</sup> Department of Public Health Sciences and Pediatrics, University of Turin, Italy<sup>b</sup> Department of Forensic Medicine and Toxicology, Seth GS Medical College and KEM Hospital, India

## ARTICLE INFO

## Article history:

Received 15 April 2020

Received in revised form

23 April 2020

Accepted 25 April 2020

Available online 4 May 2020

## Keywords:

Covid-19

Novel corona virus

Human identification

Dental autopsy

Forensic odontology

## ABSTRACT

Unidentified human remains with unknown medical history can always pose biological hazards to forensic pathologists and odontologists, including hepatitis C, HIV infection, Middle East respiratory syndrome (MERS), hemorrhagic fever viruses such as Ebola, meningitis and now Sars-Cov2. The pandemic of the new coronavirus disease (COVID-19) has reached 185 Countries with an increasing number of deaths. Forensic pathologists and odontologists may find themselves having to perform an identification autopsy to confirmed or suspected Sars-Cov2 positive deaths. By respecting the entire set of universal precautions and recommendations the highlighted risks can be minimized, and best practice in human identification should always be a priority for human rights of the dead. The following article is a summary of the recommendations for conducting dental autopsies and management of suspected COVID-19 cases.

© 2020 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Coronaviruses are a large family of zoonotic RNA beta-coronaviruses that mainly circulate among animals including mice, pigs, bats and avian hosts [1], but it has been known since the 1960s that they can infect humans too. They belong to the family of coronaviridae and have a large genetic diversity which, during viral replication, generate sub-genomic RNAs leading to an increase in the coronavirus species [2]. Also, human to human transmission has been reported [3].

Novel viruses are often associated with human outbreaks. There are already seven coronaviruses known to infect humans: OC43, SARS (Severe Acute Respiratory Syndrome Coronavirus), HKU1, 229E, NL63, and MERS (Middle East Respiratory Syndrome Coronavirus) [4,5]. The seventh strain emerged in China, whose epidemic started in Wuhan, on December 12th, 2019, from a local fresh seafood market [1] and was designated severe respiratory syndrome coronavirus 2 (SARS-CoV2-2) which causes the coronavirus disease 19, COVID-19 [3,6].

Cadavers can always pose biological hazards to forensic scientists, including hepatitis C, HIV infection, Middle East respiratory syndrome (MERS), hemorrhagic fever viruses such as Ebola, meningitis and now also Sars-Cov2. The pandemic of the new

coronavirus disease, as of April 14, 2020, has reached 185 Countries with 1,920,918 deceased [7]. According to our best knowledge, there are no cases reported of an infected medical examiner after an autopsy of a COVID-19 [8], and no identification autopsy has yet been reported with suspected or confirmed SARS-CoV2 positive human remains.

Nevertheless, considering the COVID-19 outbreak and the declaration of a pandemic on the March 11, 2020 by the World Health Organization and the increasing number of deaths, we have to consider this potential infectious risk for forensic pathologists and odontologists.

This short report provides specific recommendations to forensic odontologists in terms of biosafety and infection control practices during the post mortem dental data collection of unidentified human remains without any known medical history data.

## 2. Dental autopsy recommendations

A dental autopsy should be performed when identity is unknown, limiting the number of personnel working on the autopsy room to three people: three odontologists or two odontologists and one dental hygienist with forensic background. Alternatively, a forensic pathologist, may assist the dental autopsy, too. Immunosuppressed or high-risk autopsy personnel should not participate. The authors advise odontologists to always discuss the case with the forensic pathologist in charge before starting the dental autopsy.

\* Corresponding author. Corso Galileo Galilei 22, 10121, Torino, Italy.  
E-mail address: [emilio.nuzzolese@unito.it](mailto:emilio.nuzzolese@unito.it) (E. Nuzzolese).

The infectious nature of case should be determined before any post mortem dental data collection, starting from the available history given by the police on the circumstances of the recovery of the body and as per Centers for Disease Controls and Prevention, 2020, the collection by the medical examiner of specimens for SARS-CoV-2 testing: nasopharyngeal swab and oropharyngeal swab [9].

It is well known that infection can be spread either by aerosol or directly through cuts and puncture wounds. When such cases are unsuspected or undiagnosed before death, it can be hazardous to the forensic pathologist, odontologist, technicians, and other personnel present in the mortuary. The most important aspect of protection for dental autopsy personnel is the correct use of personal protective equipment and training prior to conducting any autopsy and dental autopsy [9–12]. Full PPE and necessary equipment should be to hand in order to avoid leaving the mortuary area. These are the universal precautions and PPE recommended:

- Wear surgical uniform;
- Over the scrubs wear a long-sleeved waterproof or fluid-resistant gown to protect chest, arms and legs;
- A disposable apron covering chest and legs over the waterproof gown;
- Double non sterile gloves (preferably nitrile gloves); gloves must extend to cover wrists; the second nitrile gloves can be changed frequently, if needed;
- Wear heavy-duty gloves over the first nitrile gloves (if post mortem dental data collection involves checks' cuts);
- Consider using a whole-body suit;
- Use goggles and a plastic face shield or face mask to protect the face, eyes, nose, and mouth;
- Class 3 or Class 2 filtering face masks (certified disposable N-95 respirator or higher, FFP2, FFP3). Surgical masks do not provide adequate protection but can be worn over the an FFP2 mask, but FFP3 masks are preferred;
- Rubber boots and waterproof shoe protectors;
- Surgical cap.

The precautions listed above may exceed the capabilities of under-staffed or overwhelmed forensic facilities. In this event, forensic odontologists must protect at least eyes, mouth and hands with two physical barrier (two pairs of gloves; goggles or glasses and a face shield; multiple filtering masks). Where there is non-availability of PPE, the dental autopsy must not be performed and postponed.

To prevent exposure of the eye mucosa by any accidental splashing, goggles or face shield should fit the contours of the user's face. Ears and nose orifices and wound openings, like tracheostomy opening, should be packed using cotton or gauze dipped with disinfectant [13,14]. The splashing of water or fluids is to be strictly avoided while performing dental autopsy. When necessary, wipe the shield with a wet gauze to enhance visibility. Dental autopsies have no aerosol-generating procedures, but require instruments, photographic and radiographic equipment. Caution should be exercised while using any sharp instruments, and only one odontologist must be allowed to perform any cuts on the human remains.

Dental radiography with portable equipment must be performed but should limit the potential for staff exposure to COVID-19 [15]. To reduce the time of the dental autopsy, periapical X-rays should be limited to sound teeth for age estimation, treated teeth, teeth with decay, edentulous areas and any region with unique findings. All photography and radiography equipment should be covered with waterproof material such as plastic sheets to minimize contamination. The disinfection of such equipment is

paramount.

Gloves should be changed before using any photography or X-ray equipment. To make the process convenient, it is highly recommended that a clean (uncontaminated) PPE protected personnel assist in photography and radiography. This will allow the odontologist to complete dental examination without any break during the process, also minimizing the risk of skin contamination while removing and wearing gloves multiple times. When the case is SARS-Cov-2 confirmed is highly recommended to avoid any dental specimen collection, unless otherwise requested by the medical examiner for DNA sample.

After the dental autopsy, keep the ventilation active and remove all PPE before leaving the autopsy suite, then follow appropriate waste disposal requirements. After removing PPE, hands and contaminated skin surfaces should be thoroughly washed with soap and water for 20 s avoiding any splashing, whenever changing gloves and before leaving the autopsy room. If water is not available, an alcohol-based hand sanitizer that contains 60%–95% alcohol must be used and avoid touching the face with unwashed hands.

As per guidelines issued by the Indian Ministry of Health & Family Welfare, 2020 [14], reusable clothing can be removed from the autopsy suite and will be laundered according to routine procedures. Besides washing and cleaning other dental autopsy instruments, all the surfaces, and transport trolleys should be properly disinfected with soap and water, and then disinfected with a disinfectant for at least 20 min in concentration of 0.5–1% sodium hypochlorite solution is to be followed by autoclaving of instruments. Other common effective hospital disinfectants are ethanol (62–71%) or hydrogen peroxide (0.5%). Cameras, telephones, laptops and X-ray portable devices once the protection film is removed, should still be treated as if they are contaminated and handled with gloves. All these items must be wiped with appropriate disinfectant.

### 3. Discussion

It is known that SARS-CoV-2 persist on surfaces for days [16], and persist in the nasal cavity for 3 days after death [17] and for this reason it is the possible that the virus persists on the bodies of the deceased, too. As a consequence, unidentified human remains must be handled safely during transportation, storage, autopsy and burial/cremation [18]. It must be stressed that an autopsy of unidentified person whose dead is due to COVID-19 should be performed only for forensic reasons [19] or identification purposes. On the other hand, identification process of COVID-19 cases should always follow proper management and humanitarian principles, adopting the entire set of universal precautions and recommendations described. The respecting of safety precautions can minimize risks, and it is unethical to refuse to perform a dental autopsy where requested by the medical examiner, except when there is non-availability of PPE or the odontologist himself is at high risk due to health issues. The identification process relies not only on dental post mortem data but also on DNA collections, which has been collected by the forensic pathologist. These two primary identifiers, DNA and dental, should both be considered when performing an identification autopsy, but when a dental autopsy is too risky and/or too labor intensive, DNA can be considered a stronger substitute for the identification [20].

Given the current spread of COVID-19, all autoptic procedures, including dental autopsies, must assume human remains are potentially infected [21]. Odontologists should be aware that the PPE will inevitably reduce the ability to perform fine motor skills and if there is a lack confidence or inadequate training, dental post mortem collection should be performed by a more experienced

colleague. Forensic dental identification process of suspected or positive COVID-19 cadavers should balance the protection of the personnel involved and the need of ensuring dignity to the human remains, but best practice in human identification requires the collection dental and dental radiology data [22,23]. Forensic odontologists and dental hygienists involved in autoptic procedures of unidentified human remains infected with COVID-19 must be well trained in infection prevention control practices and for the task of managing the dead in challenging circumstances [12,14].

The preparation of the body for funeral must finally be discussed with the medical examiner in charge, also considering cultural and religious practices. This should be in line with the directives issued by governing body in the relevant country. It is recommended that processed human remains shall be disposed without any embalming and preferably as soon as practicable directly from the mortuary to the burial or cremation. For best management of human remains, single burial should be preferred to cremation [12].

#### 4. Conclusions

The current spread of COVID-19 all autoptic procedures, including dental autopsies, must assume human remains are potentially infected. Risk should not prevent us from applying best practice in human identification through the collection of primary identifiers, fingerprint, DNA and dental data. To balance safety and the respect of the human rights of the dead, strict infection and safety protocols must be applied through planning, training, preparation and experience of all personnel entering the autopsy suite. Forensic odontologists and dental hygienists involved in autoptic procedures of infectious human remains should always be well trained in infection prevention control practices and management of the dead in challenging circumstances.

#### Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### 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.

#### CRediT authorship contribution statement

**Emilio Nuzzolese:** Conceptualization, Methodology, Resources, Writing - review & editing, Supervision. **Hemlata Pandey:** Resources, Writing - original draft. **Francesco Lupariello:** Resources, Visualization, Supervision.

#### References

- [1] H. Naji, The emerging of the novel coronavirus 2019-nCoV, *Eur. J. Med. Health Sci.* 2 (2020) 1–4, <https://doi.org/10.24018/ejmed.2020.2.1.169>.
- [2] E.J. Lefkowitz, D.M. Dempsey, R.C. Hendrickson, R.J. Orton, S.G. Siddell, D.B. Smith, Virus taxonomy: the database of the international committee on taxonomy of viruses (ICTV), *Nucleic Acids Res.* 46 (2018) D708–D717, <https://doi.org/10.1093/nar/gkx932>.
- [3] R. Lu, X. Zhao, J. Li, P. Niu, B. Yang, H. Wu, et al., Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding, *Lancet* 395 (2020) 565–574, [https://doi.org/10.1016/S0140-6736\(20\)30251-8](https://doi.org/10.1016/S0140-6736(20)30251-8).

- [4] V.M. Corman, D. Muth, D. Niemeyer, C. Drosten, Hosts and sources of endemic human coronaviruses, *Adv. Virus Res.* 100 (2018) 163–188, <https://doi.org/10.1016/bs.aivir.2018.01.001>.
- [5] A.M. Zaki, S. van Boheemen, T.M. Bestebroer, A.D. Osterhaus, R.A. Fouchier, Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia, *N. Engl. J. Med.* 367 (2012) 1814–1820, <https://doi.org/10.1056/NEJMoa1211721>.
- [6] L.L. Ren, Y.M. Wang, Z.Q. Wu, Z.C. Xiang, L. Guo, T. Xu, et al., Identification of a novel coronavirus causing severe pneumonia in human: a descriptive study, *Chin. Med. J.* (2020), <https://doi.org/10.1097/CM9.0000000000000722>.
- [7] Coronavirus Resource Center, Johns Hopkins University. <https://coronavirus.jhu.edu/map.html>, 2020 accessed on 14 April 2020.
- [8] W. Sriwijitalai, V. Wiwanitkit, Corrigendum to “COVID-19 in forensic medicine unit personnel: Observation from Thailand” [*J Forensic Legal Med* 72 May 2020, 101964], *J. Forensic Leg. Med.* (2020) 101964, <https://doi.org/10.1016/j.jflm.2020.101967> [In Press].
- [9] Collection and submission of postmortem specimens from deceased persons with known or suspected COVID-19, March 2020 (interim guidance), Centers for disease control and prevention. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-postmortem-specimens.html> accessed on 14 April 2020.
- [10] Istituto Superiore di Sanità, Recommendations to perform autopsies in patients with SARS-CoV-2 infection. ISS Working group on causes of death assessment COVID-19 2020 (in Italian), ii, 7 pp. Rapporti ISS COVID-19 n. 6, [http://www.quotidianosanita.it/iss\\_docs/8edcab746276b9eb8a5d5080095e88b52b8bcd8f.pdf](http://www.quotidianosanita.it/iss_docs/8edcab746276b9eb8a5d5080095e88b52b8bcd8f.pdf), 2020. accessed on 14 April 2020.
- [11] M. Osborn, S. Lucas, R. Stewart, B. Swift, E. Youd, Briefing on COVID-19: Autopsy Practice Relating to Possible Cases of COVID-19 (2019-nCoV, Novel Coronavirus from China 2019/20), The Royal College of Pathologists, London, 2020. [http://refhub.elsevier.com/S2589-871X\(20\)30030-9/sref9](http://refhub.elsevier.com/S2589-871X(20)30030-9/sref9). accessed on 14 April 2020.
- [12] O. Finegan, S. Fonseca, P. Guyomarch, M.D. Morcillo Mandez, J.R. Gonzalez, et al., International committee of the red cross (ICRC): general guidance for the management of the dead related to COVID-19, *Forensic Sci. Int.: Synergy* 2 (2020) 129–137, <https://doi.org/10.1016/j.fsisyn.2020.03.007>.
- [13] Ö. Erdeve, M. Çetinkaya, A.Y. Baş, N. Narh, N. Duman, et al., The Turkish Neonatal Society proposal for the management of COVID-19 in the neonatal intensive care unit, *Turk Pediatri. Ars.* 55 (2) (2020) 86–92. <https://www.journalagent.com/tpa/pdfs/TPA-43788-REVIEW-ERDEVE.pdf>. accessed on 20 April 2020.
- [14] Ministry of Health & Family Welfare, COVID19 Guidelines on Dead Body Management, Directorate General of health service, Government of India, 2020. [https://www.mohfw.gov.in/pdf/1584423700568\\_COVID19GuidelinesonDeadbodymanagement.pdf](https://www.mohfw.gov.in/pdf/1584423700568_COVID19GuidelinesonDeadbodymanagement.pdf). accessed on 14 April 2020.
- [15] Infection Prevention and Control for the Safe Management of a Dead Body in the Context of COVID-19, World Health Organization, 25 January 2020. WHO/2019-nCoV/IPC\_DBMgmt/2020.1.
- [16] N. van Doremalen, T. Bushmaker, D.H. Morris, M.G. Holbrook, A. Gamble, B.N. Williamson, et al., Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1, *N. Engl. J. Med.* (2020), <https://doi.org/10.1056/NEJMc2004973>.
- [17] D. Mao, N. Zhou, D. Zheng, J. Yue, Q. Zhao, B. Luo, et al., Guide to Forensic Pathology Practice for Death Cases Related to Coronavirus Disease 2019 (COVID-19) (Trial Draft), Forensic Sciences Research, 2020, <https://doi.org/10.1080/20961790.2020.1744400>.
- [18] European Centre for Disease Prevention and Control ECDC, Infection Prevention and Control for COVID-19 in Healthcare Settings, ECDC, Stockholm, 2020. [https://www.ecdc.europa.eu/sites/default/files/documents/Infection-prevention-control-for-the-care-of-patients-with-2019-nCoV-healthcare-settings\\_update-31-March-2020.pdf](https://www.ecdc.europa.eu/sites/default/files/documents/Infection-prevention-control-for-the-care-of-patients-with-2019-nCoV-healthcare-settings_update-31-March-2020.pdf). accessed on 12 April 2020.
- [19] B. Hanley, S.B. Lucas, E. Youd, B. Swift, M. Osborn, Autopsy in suspected COVID-19 cases, *J. Clin. Pathol.* (2020), <https://doi.org/10.1136/jclinpath-2020-206522>. Mar 20.
- [20] M. Prinz, A. Carracedo, W.R. Mayr, N. Morling, T.J. Parsons, et al., DNA commission of the International Society for Forensic Genetics, Recommendations regarding the role of forensic genetics for disaster victim identification, *Forensic Sci. Int.: Genetics* 1 (1) (March 2007) 3–12.
- [21] V. Fineschi, A. Aprile, I. Aquila, A. Arcangeli, A. Asmundo, et al., Management of the corpse with suspect, probable or confirmed COVID-19 respiratory infection – Italian interim recommendations for personnel potentially exposed to material from corpses, including body fluids, in morgue structures and during autopsy practice, *Pathologica* (2020), <https://doi.org/10.32074/1591-951X-13-20>. Epub 2020 Mar 26.
- [22] E. Nuzzolese, Missing people, migrants, identification and human rights, *J. Forensic Odonto-Stomatology* 30 (2020) 47–59. [http://www.iofos.eu/Journals/JFOS%20sup1\\_Nov12/IDEALS%206-96.pdf](http://www.iofos.eu/Journals/JFOS%20sup1_Nov12/IDEALS%206-96.pdf).
- [23] E. Nuzzolese, F. Lupariello, P. Ricci, Human Identification and Human Rights through Humanitarian Forensic Odontology, *Int. J. Forensic Odontol.* (2020). In press.