



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## Short Communication

## How long can SARS-CoV-2 persist in human corpses?

Mario Gabbrielli<sup>a</sup>, Claudia Gandolfo<sup>b</sup>, Gabriele Anichini<sup>b</sup>, Tommaso Candelori<sup>a</sup>,  
Matteo Benvenuti<sup>a</sup>, Gianni Gori Savellini<sup>b</sup>, Maria Grazia Cusi<sup>b,\*</sup>

<sup>a</sup> Department of Molecular and Developmental Medicine, Forensic Medicine Unit, University of Siena, Siena, Italy

<sup>b</sup> Department of Medical Biotechnologies, Virology Unit, University of Siena, Siena, Italy



## ARTICLE INFO

## Article history:

Received 16 February 2021

Accepted in revised form 11 March 2021

Accepted 14 March 2021

## Keywords:

SARS-CoV-2

SARS-CoV-2 tissue persistence

Autopsy

## ABSTRACT

We report the finding of the SARS-CoV-2 genome in the corpse of an exhumed infected person, one month after her death. The viral gene targets were still present in her lungs and heart, however, the virus was no longer alive. Infectious risks from human corpses should be considered.

© 2021 The Author(s). Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

How long can SARS-CoV-2 persist in a body? This is question everyone asks but that cannot yet be answered. Many articles have reported the presence of the virus in infected people for more than 5 months (Zapor, 2020), but it is not clear how long SARS-CoV-2 can persist in a human body. The finding of SARS-CoV-2 genomic fragments in tissues of infected people does not say whether the virus is alive and can infect others or whether these are simple fragments of the viral genome, which do not constitute a threat to humans. We were interested to know how long SARS-CoV-2 could remain viable in a dead body. It is known that influenza virus genomic RNA could persist for decades in frozen bodies (Taubenberger et al., 2007). Here we demonstrate that SARS-CoV-2 genomic fragments were still present in the body of an exhumed person who died from COVID-19. SARS-CoV-2 belongs to the *Coronaviridae* family and contains a single-stranded RNA genome. Like a lot of viruses, it has an envelope, which makes it more sensitive to the environment. Indeed, temperature and humidity are important factors that influence the virus survival. SARS-CoV-2 can survive in cadavers for a long time; it depends on the amount of virus detected before death, on which organ and tissue the virus had been detected in, and also on the burial process. Few data are available on this topic. In Ebola virus-infected macaques, the virus remained easily detectable in samples 3 days postmortem, but its genome was still detected 7 weeks later (Prescott, 2015). In this study, autopsy was performed on a person

who died of COVID-19 one month earlier. A forensic autopsy was authorized for this study. The autopsy was performed in the Institute of Legal Medicine of the University of Siena, in a special autopsy room for infectious corpses (air suction directly at the autopsy table downwards). All people involved wore FFP3 masks and the usual protective clothing (WHO, 2020). The body was buried in a zinc casket, thus advanced corification processes were visible and organs were clearly identifiable and relatively well preserved. All the drawn organs, lungs, heart and kidneys were analyzed for the presence of SARS-CoV-2 by molecular testing. We revealed N and RdRp gene targets by real time PCR (Argene SARS-CoV-2 R-gene, Biomerieux, Italy) in both lungs (RdRp Ct 31, N Ct 31) and N target in heart (Ct 36); on the contrary, viral genes were not detected in kidneys. We infected Vero E6 cells (ATCC CRL-1586) with the samples, which were observed daily for the presence of viral cytopathic effect for one week. However, trials to grow the virus *in vitro* were unsuccessful, but we do not exclude that the use of an alternative cellular system, such as TMPRSS2-expressing Vero E6 cells and organoids, could be more useful in virus isolation (Matsuyama et al., 2020; Zhou et al. 2020). We could speculate that, despite cell lysis, the virus could persist in tissues at a temperature of 20 °C for a long time, as previously reported for other pathogens (Prescott, 2015; Douceron et al., 1993). We cannot assess how long SARS-CoV-2 could remain alive in a deceased body, but we can certainly assert that its viral genome could persist in tissues for more than 30 days, hypothesizing that transmission from deceased people could be possible for a certain period after death, despite the fact that the corpse was sprayed with disinfectant or a sodium hypochlorite solution. Furthermore, the risk of infection transmission is higher when it concerns positive-stranded naked-RNA viruses, such as SARS-CoV-2, because of the

\* Corresponding author at: Department of Medical Biotechnologies, Virology Unit, University of Siena, S. Maria delle Scotte Hospital, V.le Bracci, 1, 53100 Siena, Italy.

E-mail address: [mariagrazia.cusi@unisi.it](mailto:mariagrazia.cusi@unisi.it) (M.G. Cusi).

intrinsic nature of viral genome, defined as infectious. We can conclude that the autopsy (including histological and virological examinations) gives the opportunity to investigate on the virus spreading in bodies, tissues and organs affected by the infection and by the late and obscure effects of the disease. Moreover, the autopsy could provide answers to some questions that are not yet solved, such as the persistence of SARS-CoV-2 in human bodies. Lastly, it is worth noting that infectious risks from human corpses should be considered for pathologists and technicians in autopsy rooms and for people in contact with corpses during mourning and funeral practices. This fact becomes particularly important when certain funeral rites require different treatments of the corpse, putting dedicated personnel at risk.

#### Authors' contributions

Conceptualization, MG and MGC; methodology, GA and CG; formal analysis, GGS, CG, GA, TC and MB; investigation, GGS, GA, CG, TC and MB; data curation, MG and MGC; writing—original draft preparation, MG and MGC; supervision, MGC MG.

#### Declaration of interests

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.

#### Funding

No funding.

#### Ethical approval

Approved.

#### Declaration of Competing Interest

The authors report no declarations of interest.

#### References

- Douceron H, et al. Long-lasting postmortem viability of human immunodeficiency virus: a potential risk in forensic medicine practice. *Forensic Sci Int* 1993;60:61–6, doi:[http://dx.doi.org/10.1016/0379-0738\(93\)90093-p](http://dx.doi.org/10.1016/0379-0738(93)90093-p).
- Matsuyama S, et al. Enhanced isolation of SARS-CoV-2 by TMPRSS2-expressing cells. *Proc Natl Acad Sci U S A* 2020;117:7001–3, doi:<http://dx.doi.org/10.1073/pnas.2002589117>.
- Prescott J, et al. Postmortem stability of Ebola virus. *Emerg Infect Dis* 2015;21:856–9, doi:<http://dx.doi.org/10.3201/eid2105.150041>.
- Taubenberger JK, et al. Discovery and characterization of the 1918 pandemic influenza virus in historical context. *Antivir Ther* 2007;12:581–91.
- WHO. Infection prevention and control for the safe management of a dead body in the context of COVID-19. 2020. <https://apps.who.int/iris/handle/10665/331538>.
- Zapor M. Persistent detection and infectious potential of SARS-CoV-2 virus in clinical specimens from COVID-19 patients. *Viruses* 2020;12:1384, doi:<http://dx.doi.org/10.3390/v12121384>.
- Zhou J, et al. Infection of bat and human intestinal organoids by SARS-CoV-2. *Nat Med* 2020;26:1077–83, doi:<http://dx.doi.org/10.1038/s41591-020-0912-6>.