



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.



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Editorial

Why are we still polluting the marine environment with personal protective equipment?



ARTICLE INFO

Keywords

COVID-19
 Personal protective equipment (PPE)
 Mismanagement
 Plastic waste
 Disposal
 Reusable PPE

We have struggled with the global COVID-19 pandemic for well over a year and the marine environment has suffered unprecedented pollution from indiscriminate disposal of personal protective equipment (PPE) (Akhbarizadeh et al., 2021; De-la-Torre and Aragaw, 2021; De-la-Torre et al., 2021). Much of that time has been spent with mandatory mask wearing in public indoor spaces in many jurisdictions around the world (Patrício Silva et al., 2020). Early during the COVID-19 pandemic the widespread and indiscriminate use of PPE, was estimated at a staggering 129 billion face masks and 65 billion gloves used globally per month (Prata et al., 2020). Within weeks of the start of the COVID-19 pandemic, Gary Stokes of the marine conservation group OceansAsia found around 70 face masks on a beach on Hong Kong's uninhabited Soko Islands (Prata et al., 2020). Even as ongoing vaccine distribution is well underway around the world, mask wearing will continue to be a part of the 'new normal' life for everyone to help reduce the transmission of COVID-19, variants or other airborne respiratory diseases.

Concerns about mismanagement of disposal PPE has been widely documented in hundreds of media articles (see, for example <http://www.nationalgeographic.com/environment/article/how-to-stop-discarded-face-masks-from-polluting-the-planet>), peer-reviewed papers published in dozens of academic journals, including *Marine Pollution Bulletin*. Used gloves and masks have been found littering marine and urban environments globally (Prata et al., 2020; Ammendolia et al., 2021; Akhbarizadeh et al., 2021; De-la-Torre and Aragaw, 2021; De-la-Torre et al., 2021). Impacts from improper disposal of PPE includes entanglement or ingestion by wildlife (e.g., a juvenile Magellanic penguin was found dead off the coast of Brazil after ingesting a face mask during the COVID-19 pandemic, see Neto et al., 2021), persistent plastic pollution in the marine environment (including fragmenting into microplastics) (Akhbarizadeh et al., 2021; Saliu et al., 2021), as well as potential human health risks associated with contaminated PPE as potential vectors of the COVID-19 disease (Prata et al., 2020; Patrício Silva et al., 2020; Patrício Silva et al., 2021).

Mismanagement of PPE during the early days of the COVID-19

pandemic was understandable. Perhaps this was partly due to misguided information on disease transmission, lack of public health advice on the proper disposal of contaminated PPE (remember, at that time many jurisdictions were just overwhelmed and simply struggling to contain the spread of the virus), or because of the lack of suitable waste management infrastructure. Now, after more than a year of learning how to manage the COVID-19 pandemic, we are still witnessing unprecedented quantities of discarded PPE in the marine environment. This is now a particularly pressing issue as the United Nations has proclaimed a Decade of Ocean Science for Sustainable Development, yet plastic marine pollution combined with the increase of discarded PPE threatens the ability of the international community to implement the United Nations Sustainable Development Goals (Walker, 2021). Thus, there remains an urgent need to reinforce and raise public awareness on the proper use and disposal of single-use disposal PPE, including advice on the environmental and health benefits of using reusable PPE (Liao et al., 2021; Patrício Silva et al., 2021).

Potentially infectious PPE waste has triggered guidance by waste management agencies and health authorities in many jurisdictions, yet advice maybe contradictory or not properly understood. For example, the World Health Organization recommends that PPE be disposed of in closed-lid receptacles and not regular open garbage bins, as used PPE should be treated as potentially infectious. Other guidelines recommend that all potentially contaminated (with PPE) residential waste be disposed of in sealed and leak-proof garbage bags. While some jurisdictions are capable of managing PPE waste properly with high-temp incineration, landfilling or waste-to-energy conversion via pyrolysis (Aragaw and Mekonnen, 2021), other jurisdictions lack adequate waste management resources and are forced to use inappropriate strategies such as open-burning or poorly maintained open or shallow landfills (Prata et al., 2020; Patrício Silva et al., 2020; Patrício Silva et al., 2021). While these disposal options are not without some environmental impacts, they are all preferred over the indiscriminate disposal of PPE in the marine and terrestrial environment.

<https://doi.org/10.1016/j.marpolbul.2021.112528>

Received 13 May 2021; Accepted 18 May 2021

Available online 3 June 2021

0025-326X/© 2021 Elsevier Ltd. All rights reserved.

One solution to help curb the staggering quantities of mismanaged single-use disposal PPE in the marine environment is for the widespread use of reusable PPE. Last year a group of virologists, epidemiologists and health experts issued a Health Expert Statement Addressing Safety of Reusables and COVID-19 (see, https://www.greenpeace.org/usa/wp-content/uploads/2020/06/Health-Expert-Statement_Updated.pdf). The health experts agreed that the risk of transmitting COVID-19 via surface contact was unlikely and reusable options were safe and should be encouraged. Reusable PPE can be easily cleaned, and studies have demonstrated the effectiveness of using reusable PPE (e.g., washable cloth masks) (Liao et al., 2021). Therefore, reusable alternatives are effective, and if properly cleaned and safely used will have continued environmental and health benefits for everyone.

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.

Acknowledgements

No funding was required for this perspective article research.

References

- Akhbarizadeh, R., Dobaradaran, S., Nabipour, I., Tangestani, M., Abedi, D., Javanfekr, F., Jeddi, F., Zendehtoodi, A., 2021. Abandoned Covid-19 personal protective equipment along the Bushehr shores, the Persian Gulf: an emerging source of secondary microplastics in coastlines. *Mar. Pollut. Bull.* 168, 112386.
- Ammendolia, J., Saturno, J., Brooks, A.L., Jacobs, S., Jambeck, J.R., 2021. An emerging source of plastic pollution: environmental presence of plastic personal protective equipment (PPE) debris related to COVID-19 in a metropolitan city. *Environ. Pollut.* 269, 116160.
- Aragaw, T.A., Mekonnen, B.A., 2021. Current plastics pollution threats due to COVID-19 and its possible mitigation techniques: a waste-to-energy conversion via pyrolysis. *Environ. Syst. Res.* 10 (1), 1–11.
- De-la-Torre, G.E., Aragaw, T.A., 2021. What we need to know about PPE associated with the COVID-19 pandemic in the marine environment. *Mar. Pollut. Bull.* 163, 111879.
- De-la-Torre, G.E., Rakib, M.R.J., Pizarro-Ortega, C.I., Dioses-Salinas, D.C., 2021. Occurrence of personal protective equipment (PPE) associated with the COVID-19 pandemic along the coast of Lima, Peru. *Sci. Total Environ.* 774, 145774.
- Liao, M., Liu, H., Wang, X., Hu, X., Huang, Y., Liu, X., Brennan, K., Mecha, J., Nirmalan, M., Lu, J.R., 2021. A technical review of face mask wearing in preventing respiratory COVID-19 transmission. *Curr. Opin. Colloid Interface Sci.* 52, 101417.
- Neto, H.G., Bantel, C.G., Browning, J., Della Fina, N., Ballabio, T.A., de Santana, F.T., e Britto, M.D.K., Barbosa, C.B., 2021. Mortality of a juvenile Magellanic penguin (*Spheniscus magellanicus*, Spheniscidae) associated with the ingestion of a PFF-2 protective mask during the Covid-19 pandemic. *Mar. Pollut. Bull.* 166, 112232.
- Patrício Silva, A.L.P., Prata, J.C., Walker, T.R., Campos, D., Duarte, A.C., Soares, A.M., Barcelò, D., Rocha-Santos, T., 2020. Rethinking and optimising plastic waste management under COVID-19 pandemic: policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Sci. Total Environ.* 742, 140565.
- Patrício Silva, A.L.P., Prata, J.C., Walker, T.R., Duarte, A.C., Ouyang, W., Barcelò, D., Rocha-Santos, T., 2021. Increased plastic pollution due to COVID-19 pandemic: challenges and recommendations. *Chem. Eng. J.* 405, 126683.
- Prata, J.C., Silva, A.L., Walker, T.R., Duarte, A.C., Rocha-Santos, T., 2020. COVID-19 pandemic repercussions on the use and management of plastics. *Environ. Sci. Technol.* 54 (13), 7760–7765.
- Saliu, F., Veronelli, M., Raguso, C., Barana, D., Galli, P., Lasagni, M., 2021. The release process of microfibers: from surgical face masks into the marine environment. *Environ. Adv.* 4, 100042.
- Walker, T.R., 2021. (Micro) plastics and the UN sustainable development goals. *Curr. Opin. Green Sustain. Chem.* 30, 100497.

Tony R. Walker

School for Resource and Environmental Studies, Dalhousie University,
Halifax, NS B3H 4R2, Canada
E-mail address: trwalker@dal.ca