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COVID-19 CORRESPONDENCE

Quantifying the effect of personal protective equipment on speech understanding

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Editor—During the COVID-19 pandemic, personal protective equipment (PPE) has been invaluable for protecting healthcare workers and the public. However, widespread use of PPE has reduced clinicians' ability to express and interpret non-verbal cues, challenging them to adapt how they communicate.[1] Although much recognition has been made of this limitation, little research has been conducted to quantify how significant the effects of PPE are on speech clarity[2,3] despite many clinicians anecdotally remarking that 'they struggle to hear people who wear PPE'. This component of communication is highly susceptible to error which can adversely affect patient safety.[4] When this is combined with the likelihood that theatre teams will continue to use high levels of PPE for aerosol-generating procedures, even after COVID-19 infection rates begin to improve, research into this area could prove invaluable.

The authors set out to assess this issue using a commonly used audiology tool called the AzBio sentence list test.[5] This tool is a collection of non-contextual spoken word sentences that generate a score based on how many words the listener can correctly repeat back to the investigator in a quiet environment. It is a highly sensitive measure of a subjects 'real world' hearing performance in a quiet or noisy environment.[6] Using this test, a study was designed with the primary outcome to quantify and compare the deterioration in understanding of verbal communication whilst wearing different levels of PPE. The secondary outcome was to compare the understanding of verbal communication at two different distances to represent the space normally maintained in a functioning operating theatre between the anaesthetist and an operating department practitioner (1 m), and between the anaesthetist and a theatre circulator (2.5 m).

After Health Research Authority approval, five videos were recorded using a laptop with an in-built microphone, each consisting of 20 different AzBio sentences (with this number significantly reducing inter-video variability[6]) read aloud. Recorded videos were used to ensure that speech characteristics and non-verbal facial cues were consistently reproduced for each study participant. Each video included an author wearing either no PPE or one of three different forms of PPE including a fluid resistant surgical mask, a disposable filtering facepiece class 3 (FFP3) mask and protective goggles, and a disposable FFP3 mask and a visor. The fifth video included the same equipment as the fourth (FFP3 and visor) however was designed for the participant to also wear a visor to examine the effects of the speaker and listener both wearing one. A second set of five videos (creating a total of 10 videos) were recorded using the same increments of PPE to allow repeated assessment at a 2.5 m distance. A sample of convenience of 20 participants was chosen for this study because of clinical pressures. Inclusion criteria included age ≥18 yr and previous training to don PPE to ensure familiarity with the subject matter. Exclusion criteria included consent refusal and complete hearing/visual impairment. Characteristics of each participant were also recorded.

Each participant sat in an unoccupied theatre (to reduce sound variability) facing a computer 1 m away from them, with only the sound from the theatre air circulation in the background. The maximum background noise level was recorded using a sound meter to account for any variations in this level during analysis. Each sentence was played at the same volume as the speaker's live voice during recording, with a pause after each, and the participant asked to repeat it aloud. Each correctly repeated word was given a score of 1, with the total score for each video allowing a percentage understanding for each PPE level to be calculated. Once the first five videos had been shown, the participant was repositioned 2.5 m away from the screen with the second set of five videos administered. This gave a total of 10 sets of results to represent the relative comprehension of speech through each level of PPE and distance. Data were statistically analysed using a one-way

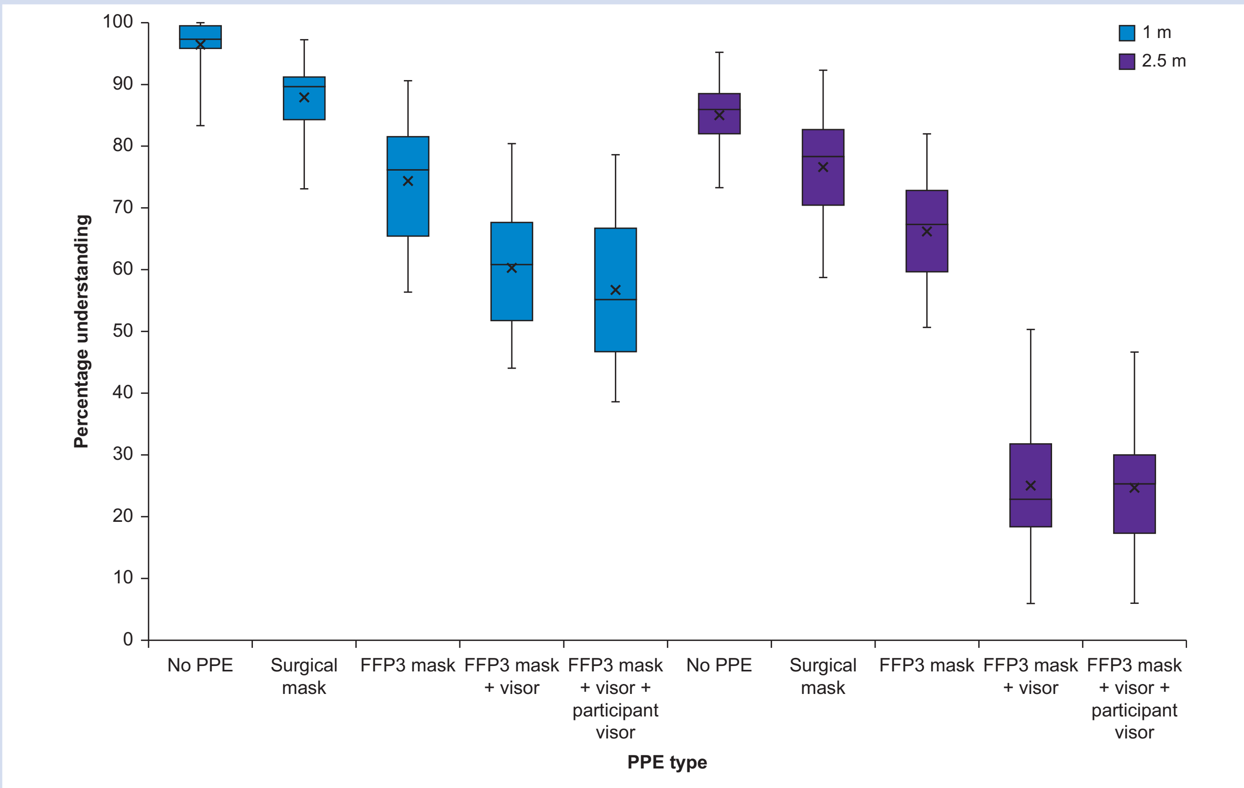

Fig 1. Box plot demonstrating the percentage of words correctly repeated for each video at distnaces of 1 m and 2.5 m from speaker. PPE, personal protective equipment; FFP3, filtering facepiece class 3.

repeated-measure analysis of variance for both primary and secondary outcomes using SPSS Statistics (IBM Corp., Armonk, NY, USA).

The summarised results for each video are shown in Figure 1 consisting of obstetric, general practice and anaesthetic trainees and consultants, theatre staff, and midwife participants. Analysis showed that at 1 m with no PPE, mean understanding was 96% (4.5%) but this dramatically reduced to 25% (11.0%) when an FFP3 mask and visor were used at 2.5 m. Increases in both PPE level and distance were negatively correlated with participant understanding. Each consecutive PPE level for each distance showed a significant difference (P=<0.05) apart from when the participant also donned a visor (P=0.317 at 1 m and P=0.85 at 2.5 m). The mean reduction in speech comprehension between each consecutive PPE level increase where a significant difference existed was 11% (15.2%) with the exception of donning a visor at 2.5 m which led to a mean 41% (6.7%) reduction. The secondary outcome measure showed that when participants sat at 2.5 m from the speaker they could understand a mean of 10% (11.6%) less than when sitting at 1 m. The exception to this was after a visor was donned, which led to a mean 35% (9.9%) reduction.

This study, although underpowered because of its sample of convenience, is the largest of its type using evidence-based audiological tests, and has confirmed conventional thinking[7] that increasing levels of PPE and distance can diminish communication between members of a clinical team or with patients. It has also quantified how significant this deterioration is, especially because of visors, even in optimal conditions. Owing to a frequent reliance by humans on the unconscious assumption of unheard words,[8] clear verbal communication is integral for clinicians, especially during high stakes situations.[9] As a result, its deterioration can create a substantial opportunity for error in patient care or adverse long-term health effects for staff.[10] In light of these findings, we would like to highlight the need for institutions to conduct larger-scale investigations into both this issue and methods to circumvent these barriers to communication in order to protect the safety of both patients and staff during this and any subsequent disease pandemics.

Declarations of interest

The authors declare no conflicts of interest.

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In-hospital mortality rates of critically ill COVID-19 patients in France: a nationwide cross-sectional study of 45 409 ICU patients

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Editor—We examined the temporal trend of in-hospital mortality of critically ill COVID-19 patients in France during the first year of the pandemic. We performed a cross-sectional, nationwide study, using data from the French Hospital Discharge Database (HDD). This database relies on the mandatory notification of each hospital stay, through a coded summary, for all public and private French hospitals. No nominative, sensitive, or personal data of patients were collected. Our study involved the reuse of previously recorded and anonymised data. The study falls within the scope of the French Reference Methodology MR-005 (declaration 2205437 v 0, 22 August 2018, subscripted by the Teaching Hospital of Tours), which requires neither information nor consent of the included individuals. This study was consequently registered with the French Data Protection Board (*CNIL* MR-005 #2018160620).

Patients were included according to the following criteria: adults (≥18 yr), admitted to an ICU between March 1, 2020 and March 14, 2021, with an ICD-10 diagnosis code of COVID-19.[1,2] The following characteristics were considered: age, sex, Charlson Comorbidity Index,[3,4] SAPS II (Simplified Acute Physiology Score II), invasive mechanical ventilation, and ICU length of stay. The outcome measure of interest was vital status at the end of the hospital stay. Deaths were assigned to the week of admission. To identify alteration in weekly mortality rates over the 12-month period, a linear regression model was performed using R, version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria); $P<0.05$ was considered statistically significant. No nominative, sensitive, or personal data were collected.

In France over the first year of the pandemic, 45 409 patients were admitted to ICU for COVID-19. Global patient characteristics were (median [inter-quartile range]): age 67 [57–74] yr; sex ratio male:female 2:3; Charlson Comorbidity Index 0: 41%, 1–2: 34%, ≥3: 25%; SAPS II 36 [27–46]; invasive mechanical ventilation 55%; ICU length of stay 9 [4–20] days; and global in-hospital mortality 31%. Trends in hospital presentation and in-hospital mortality are presented in Figure 1. Weekly mortality rate for patients hospitalised in ICU for COVID-19 remained constant throughout the first year of the pandemic (r^2=0.009, P=0.50).

Particular trends can be highlighted. A reduction of mortality rate appeared to be observed in the first weeks of the