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Personal protective equipment guidance during a global pandemic: A statistical analysis of National perceived confidence, knowledge and educational deficits amongst UK-based doctors

Shams Al-Hity[1] | Navdeep Bhamra[1] | Ravi Kumar[2] | Keshav Kumar Gupta[1] | James Howard[3] | Karan Jolly[1] | Adnan Darr[1]

[1]Department of Otolaryngology, The Royal Wolverhampton NHS Trust, Wolverhampton, UK

[2]Health Education England North East, Newcastle, UK

[3]National Heart and Lung Institute, Imperial College London, London, UK

Correspondence
Shams Al-Hity, The Royal Wolverhampton NHS Trust, Wolverhampton WV10 0QP, UK.
Email: shams.al-hity@nhs.net

Abstract

Introduction: On the 11th of March 2020, the World Health Organisation (WHO) declared a global pandemic following the upsurge of the novel coronavirus disease 2019 (COVID-19). Unprecedented global demand for personal protective equipment (PPE) resulted in restricted availability, as well as evolving guidance on use, the latter of which was complicated by conflicting guidance provided by numerous healthcare bodies.

Aim: To assess perceived confidence and knowledge of PPE guidance as published by Public Health England (PHE) amongst doctors of varying specialties and grades.

Method: A nationwide 11-point survey comprising of multiple-choice questions (MCQs) and a 5-point Likert scale assessing perceived confidence was disseminated to UK-based doctors using multiple platforms. Statistical analysis using one-way analysis of variance (ANOVA), Tukey's honest significant difference (Tukey HSD) and Pearson's chi-squared test was undertaken to assess for statistical significance.

Results: Data collated from 697 respondents revealed that average perceived confidence was low across all specialties and grades. Notably, 59% (n = 411) felt they had received insufficient education regarding up-to-date guidance, with 81% (n = 565) advocating further training. Anaesthetics and ophthalmology were highest and lowest scoring specialties in knowledge-based MCQs, achieving scores of 59% and 31%, respectively. Statistical analysis revealed significant differences between specialty, but not grade.

Conclusion: Ensuring uniformity in published guidance, coupled with education may aid knowledge and subsequent confidence regarding the appropriate use of PPE. The absence of a unified consensus and sustained training not only poses significant ramifications for patient and healthcare professional (HCP) safety, but also risks further depletion of already sparse resources. Because of the novelty of COVID-19, appropriate PPE is continually evolving leaving an absence in formal training and education. This paper reveals insight into confidence and knowledge of PPE amongst doctors of various specialities/grades during a global pandemic, highlighting key deficits in education and training.

1 | INTRODUCTION

The novel SARS-CoV-2 coronavirus (COVID-19) has overwhelmed international healthcare systems and was declared a global pandemic by the WHO on the 11 March 2020. The latest figures (as of 31 December 2020), released by John Hopkins University of Medicine, estimate the virus to have reached over 190 different regions and countries, with over 85 million confirmed cases and over 1.8 million global deaths.[1] To date, the United Kingdom (UK) has declared more than 450,000 cases and 42,000 deaths, the third largest in Europe, and the 14th largest worldwide.[2] The rate and speed of transmission of COVID-19 have precipitated unprecedented lockdown measures in attempts to reduce spread and to mitigate its impact on an already strained National Healthcare Service (NHS).

Data published from studies performed at the epicentre of the virus in Wuhan have revealed that healthcare practitioners (HCPs) accounted for a third of all documented COVID-19 infections.[3,4] In the UK, there have been over 100 deaths reported amongst NHS HCPs, although reports in the media suggest higher figures.[5] A key area of risk is with aerosol-generating procedures (AGPs), where respiratory and viral particles remain suspended in the air for prolonged periods of time. COVID-19 may remain viable within aerosols for at least 3 hours[6] and previous studies have shown this to be linked with increased rates of infection and morbidity amongst HCPs.[7,8] For HCPs, both the the appropriate use and availability of PPE are an imperative component in forming a defence barrier against a highly infectious and potentially fatal virus.

The dynamic nature of the COVID-19 pandemic has meant that PPE guidance surrounding AGPs is under continuous scrutiny and review. Public Health England (PHE) guidance, which forms the basis of national PPE policy, has undergone three significant amendments since its initial implementation in March 2020. A variety of national and international advisory committees have concomitantly published guidance, which deviates from that advised by PHE (Figure 1). Lack of clarity and inconsistency regarding appropriate use of PPE could undermine confidence and generate uncertainty amongst HCPs. Identifying areas where knowledge is deficient and assessing the impact of mercurial national guidelines is an essential first step towards addressing this issue through a unified consensus.

2 | AIM

Our novel study, the first to our knowledge to be described within the literature, aimed to assess awareness, perceived confidence and knowledge of current PHE PPE guidance amongst UK doctors of varying levels of experience and specialty.

3 | METHOD

A nationwide 11-point confidential online survey (Figure 2) was distributed over a 2-week capture period spanning from 8 June to 21 June 2020. Dissemination platforms included social media, electronic mail, local trust distribution and central circulation through individual deaneries. Demographic data collated included training grade and speciality. Overall performance was assessed using six knowledge-based multiple-choice questions (MCQs) derived from

Procedure	PHE guidance?	WHO guidance?
Bronchoscopy	√	√
Cardiopulmonary Resuscitation (CPR)		√
Dental procedures involving high speed devices	√	√
High flow nasal oxygen (HFNO)	√	√
High frequency Oscillatory Ventilation (HFOV)	√	√
High speed cutting in surgery or post-mortem procedures involving respiratory tract or paranasal sinuses	√	√
Induction of sputum using nebulised saline	√	√
Manual ventilation	√	√
Non-invasive ventilation (NIV), Bi-level Positive Airway Pressure Ventilation (BiPAP) and Continuous Positive Airway Pressure Ventilation (CPAP)	√	√
Tracheotomy or tracheotomy procedures	√	√
Upper ENT airway/GI endoscopy procedures involving respiratory tract suctioning	√	√

FIGURE 1 Classification of AGP procedures as per Public Health England and the World Health Organisation

current PHE guidance, with a maximum attainable score of 10. Perceived confidence levels were assessed using a 5-point Likert scale (1 = not confident, 5 = very confident). Respondents were also questioned on the adequacy of education to date, as well as the need for further educational intervention.

Inter-group comparisons were performed with R version 4.0.2 (R Project for Statistical Computer, Vienna, Austria). One-way Analysis of Variance (ANOVA) was used to assess the link between specialty and score, with post hoc testing performed, where appropriate, using Tukey's Honest Significant Difference (Tukey HSD). Pearson's Chi-squared test with simulated *P*-values was used to assess the link between confidence grades and (a) speciality, and (b) training grade, with post hoc testing performed, where appropriate, using the residuals.

4 | RESULTS

A total of 697 responses were collated within the pre-defined capture period.

Responding specialties included surgery (20%, n = 137), primary care (19%, n = 134), medicine (19%, n = 129), Acute services (acute medical unit [AMU] and the emergency department [ED]) (12%, n = 85), critical care (10%, n = 67), anaesthetics (7%, n = 50),

1. What is your current specialty?
    a. Acute Services (AMU/ED)
    b. Anaesthetics
    c. Critical Care
    d. Medicine
    e. Obstetrics and Gynaecology
    f. Ophthalmology
    g. Primary Care
    h. Psychiatry
    i. Radiology
    j. Other (Please specify)

2. At what stage of training are you?
    a. Foundation doctor or equivalent
    b. Core Trainee or equivalent
    c. Registrar or equivalent
    d. Consultant

3. In which region are you based?
    a. East Midlands
    b. East of England
    c. Kent, Surrey, and Sussex
    d. North East
    e. North West
    f. South West
    g. London (North West London/Central London/North East London/South London)
    h. Thames Valley
    i. Wessex
    j. West Midlands
    k. Yorkshire and the Humber
    l. N. Ireland
    m. East Scotland
    n. West Scotland
    o. Wales

4. How confident are you in the recommended PPE for suspected or confirmed cases in various settings?
    a. 1 - Not confident
    b. 2
    c. 3
    d. 4
    e. 5 - Very confident

5. Based on Public Health England (PHE) guidance, which one of the following is NOT deemed to be an aerosol generating procedure (AGP)?
    a. Intubation, extubation and related procedures
    b. Procedures involving suctioning of the upper respiratory tract e.g. bronchoscopy, upper GI endoscopy
    c. Application of high flow nasal oxygen
    d. Chest compressions and defibrillation during cardiorespiratory resuscitation (CPR)
    e. Non-invasive ventilation (CPAP, Bi PAP)

FIGURE 2 Survey distributed to all participants

6. Which one of the following is NOT classed as a high-risk environment?
    a. Wards undertaking non-invasive ventilation
    b. Endoscopy Units
    c. Emergency Department bays and acute assessment unit
    d. Intensive care and high dependency care units
    e. Operating theatres undertaking AGPs

7. What are the current PHE indications for use of a respirator mask (FFP3)? Select all that apply:
    a. Administration of nebulised medication to suspected or confirmed case
    b. During direct care for a suspected or confirmed case
    c. During an AGP for a suspected or confirmed case
    d. During clinical examination of a patient in the emergency majors department
    e. Whilst in a high-risk area with suspected or confirmed case

8. As per PHE, which items of PPE are recommended for sessional use (NOT single use)? Select all that apply:
    a. Fluid resistant surgical mask (FRSM)
    b. Fluid repellent gown or overalls
    c. Filtering face piece (FFP) respirator
    d. Eye protection
    e. Sterile nitrile gloves

9. For a non-AGP, what is the correct procedure for donning (equipping) of PPE?
    a. Appropriate mask, eye protection, disposable apron, disposable gloves
    b. Disposable apron, appropriate mask, eye protection, disposable gloves
    c. Disposable apron, disposable gloves, appropriate mask, eye protection
    d. Disposable gloves, disposable apron, appropriate mask, eye protection
    e. Disposable gloves, appropriate mask, eye protection, disposable apron

10. For a non-AGP what is the correct procedure for doffing (removal) of PPE?
    a. Remove gloves, hand hygiene, remove apron, remove eye protection, hand hygiene, remove mask, hand hygiene
    b. Remove gloves, hand hygiene, remove eye protection, remove apron, hand hygiene, remove mask, hand hygiene
    c. Remove gloves, hand hygiene, remove apron, hand hygiene, remove mask, remove eye protection, hand hygiene
    d. Remove eye protection, remove gloves, hand hygiene, remove apron, hand hygiene, remove mask, hand hygiene
    e. Remove eye protection, hand hygiene, remove apron, remove gloves, hand hygiene, remove mask, hand hygiene

11. Do you feel that you have received enough education regarding PPE guidance?
    a. Yes - No further training required
    b. Yes - I would like further training
    c. No - I would like further training
    d. Unsure

FIGURE 2 Continued

psychiatry (4%, n = 25), ophthalmology (3%, n = 21), radiology (3%, n = 19), and obstetrics and gynaecology (O&G) (2%, n = 15). Fifteen respondents (2%) identified as "other specialty," which comprised of paediatrics and neonatology.

Consultant was the highest represented training grade (34%, n = 236) followed by registrar or equivalent (32%, n = 220), foundation doctor or equivalent (18%, n = 122) and core trainee or equivalent (17%, n = 119).

4.1 | Overall questionnaire performance

There were significant differences in questionnaire performance across the medical specialties ($P < .0001$). Anaesthetics were the highest performing specialty with an average score of 59%, followed by critical care (58%), acute services (52%), surgery (49%), radiology (49%), medicine (48%), primary care (44%), O&G (39%), psychiatry (38%), ophthalmology (31%) (Figure 3).

Consultants achieved the highest score on average (49%), followed by registrars and foundation year doctors (47%), and core trainees (44%) (Figure 4).

Perceived confidence levels were consistent at 3/5 on the Likert scale across all grades. Acute services and anaesthetic doctors had the highest levels of perceived confidence, with a modal score on the Likert scale of 4/5, followed by critical care, medical, primary care, surgical and ophthalmology doctors at 3/5. Psychiatry, radiology and O&G doctors reported the lowest levels of perceived confidence with a level of 2/5.

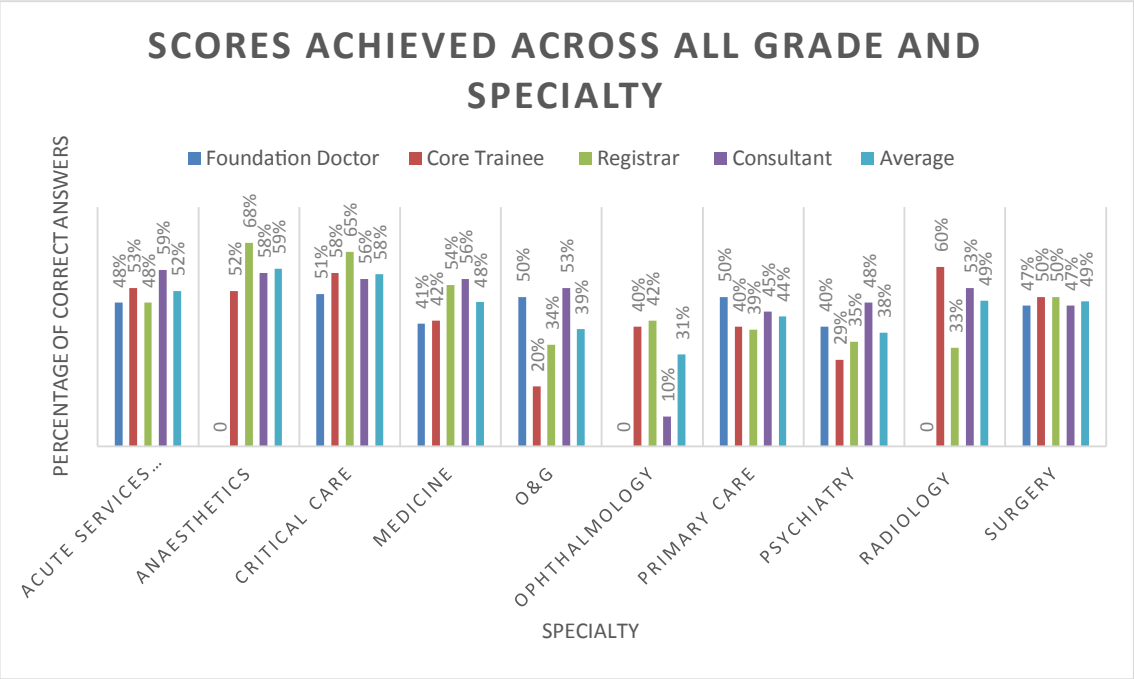

FIGURE 3 Performance across all grades and specialties

	Grade				
	Foundation Doctor	Core Trainee	Registrar	Consultant	Average
Acute Services (AMU/ED)	48%	53%	48%	59%	52%
Anaesthetics	n/a	52%	68%	58%	59%
Critical Care	51%	58%	65%	56%	58%
Medicine	41%	42%	54%	56%	48%
O&G	50%	20%	34%	53%	39%
Ophthalmology	n/a	40%	42%	10%	31%
Primary Care	50%	40%	39%	45%	44%
Psychiatry	40%	29%	35%	48%	38%
Radiology	n/a	60%	33%	53%	49%
Surgery	47%	50%	50%	47%	49%
Average	47%	44%	47%	49%	

FIGURE 4 Global assessment of overall performance by specialty and grade

Pairwise comparisons between the specialties, and their 95% confidence intervals and associated *P*-values, are presented in Figure 5.

4.2 | Aerosol-generating procedures

Thirty-five percent (n = 246) correctly identified cardio-respiratory resuscitation (CPR) as being a non-AGP, as per PHE guidance at the time of survey.

The highest performing cohort was those working in critical care (70%, n = 47). This was followed by anaesthetics (66%, n = 33), acute services (AMU/ED) (39%, n = 33), radiology (37%, n = 7), psychiatry (36%, n = 9), primary care (34%, n = 45), ophthalmology (29%, n = 6), surgery (24%, n = 33), medicine (19%, n = 24) and O&G who were the lowest performing cohort (7%, n = 1).

4.3 | High-risk environments

Fifty-three percent (n = 367) correctly identified emergency department bays and acute assessment units as being non-high risk as per PHE guidance.

Correct responses by specialty in order from most to least correct were anaesthetics 82% (n = 41), critical care 78% (n = 52), acute services 67% (n = 57), ophthalmology 57% (n = 12), primary care

$Speciality

	diff	lwr	upr	p adj
Anaesthetics-Acute Services (AMU/ED)	0.91882353	-0.01993461	1.85758167	0.0612715
Critical Care-Acute Services (AMU/ED)	0.93345040	0.07293979	1.79396100	0.0208786
Medicine-Acute Services (AMU/ED)	-0.48226174	-1.21810254	0.25357906	0.5656695
Obstetrics and Gynaecology-Acute Services (AMU/ED)	-1.20784314	-2.68295924	0.26727296	0.2281459
Ophthalmology-Acute Services (AMU/ED)	-0.90308123	-2.18663811	0.38047564	0.4542850
Other paediatrics-Acute Services (AMU/ED)	1.14453782	-0.37469878	2.66377441	0.3469641
Primary Care-Acute Services (AMU/ED)	-0.74565408	-1.47602167	-0.01528650	0.0406688
Psychiatry-Acute Services (AMU/ED)	-1.54117647	-2.73956646	-0.34278649	0.0018253
Radiology-Acute Services (AMU/ED)	-1.29907121	-2.63570274	0.03756032	0.0653442
Surgery-Acute Services (AMU/ED)	-0.28716187	-1.01441908	0.44009534	0.9727129
Critical Care-Anaesthetics	0.01462687	-0.96972830	0.99898203	1.0000000
Medicine-Anaesthetics	-1.40108527	-2.27854654	-0.52362401	0.0000177
Obstetrics and Gynaecology-Anaesthetics	-2.12666667	-3.67729367	-0.57603967	0.0005635
Ophthalmology-Anaesthetics	-1.82190476	-3.19157437	-0.45223515	0.0010045
Other paediatrics-Anaesthetics	0.22571429	-1.36694274	1.81837131	0.9999963
Primary Care-Anaesthetics	-1.66447761	-2.53735412	-0.79160110	0.0000001
Psychiatry-Anaesthetics	-2.46000000	-3.75019965	-1.16980035	0.0000001
Radiology-Anaesthetics	-2.21789474	-3.63742298	-0.79836649	0.0000310
Surgery-Anaesthetics	-1.20598540	-2.07626101	-0.33570979	0.0004596
Medicine-Critical Care	-1.41571214	-2.20890185	-0.62252242	0.0000007
Obstetrics and Gynaecology-Critical Care	-2.14129353	-3.64583856	-0.63674850	0.0002663
Ophthalmology-Critical Care	-1.83653163	-3.15380400	-0.51925926	0.0004069
Other paediatrics-Critical Care	0.21108742	-1.33673946	1.75891430	0.9999975
Primary Care-Critical Care	-1.67910448	-2.46721935	-0.89098960	0.0000000
Psychiatry-Critical Care	-2.47462687	-3.70906066	-1.24019307	0.0000000
Radiology-Critical Care	-2.23252160	-3.60156218	-0.86348103	0.0000101
Surgery-Critical Care	-1.22061227	-2.00584554	-0.43537899	0.0000352
Obstetrics and Gynaecology-Medicine	-0.72558140	-2.16246655	0.71130376	0.8687308
Ophthalmology-Medicine	-0.42081949	-1.66025069	0.81861170	0.9911479
Other paediatrics-Medicine	1.62679956	0.14465542	3.10894370	0.0181408
Primary Care-Medicine	-0.26339234	-0.91309092	0.38630624	0.9671560
Psychiatry-Medicine	-1.05891473	-2.20991863	0.09208917	0.1039521
Radiology-Medicine	-0.81680947	-2.11112599	0.47750706	0.6221042
Surgery-Medicine	0.19509987	-0.45110016	0.84129990	0.9965439
Ophthalmology-Obstetrics and Gynaecology	0.30476190	-1.47588279	2.08540659	0.9999780
Other paediatrics-Obstetrics and Gynaecology	2.35238095	0.39502123	4.30974067	0.0053678
Primary Care-Obstetrics and Gynaecology	0.46218905	-0.97190092	1.89627903	0.9941324
Psychiatry-Obstetrics and Gynaecology	-0.33333333	-2.05359954	1.38693287	0.9999301
Radiology-Obstetrics and Gynaecology	-0.09122807	-1.91050295	1.72804681	1.0000000
Surgery-Obstetrics and Gynaecology	0.92068127	-0.51182713	2.35318966	0.5952072
Other paediatrics-Ophthalmology	2.04761905	0.23025617	3.86498192	0.0130879
Primary Care-Ophthalmology	0.15742715	-1.07876249	1.39361679	0.9999987
Psychiatry-Ophthalmology	-0.63809524	-2.19721889	0.92102841	0.9649263
Radiology-Ophthalmology	-0.39598997	-2.06371653	1.27173658	0.9995589
Surgery-Ophthalmology	0.61591936	-0.61843515	1.85027387	0.8772649
Primary Care-Other paediatrics	-1.89019190	-3.36962638	-0.41075742	0.0020398
Psychiatry-Other paediatrics	-2.68571429	-4.44396004	-0.92746853	0.0000541
Radiology-Other paediatrics	-2.44360902	-4.29883769	-0.58838035	0.0012009
Surgery-Other paediatrics	-1.43169969	-2.90960111	0.04620174	0.0672939
Psychiatry-Primary Care	-0.79552239	-1.94303496	0.35199019	0.4777730
Radiology-Primary Care	-0.55341712	-1.84462989	0.73779564	0.9520337
Surgery-Primary Care	0.45849221	-0.18146842	1.09845284	0.4255007
Radiology-Psychiatry	0.24210526	-1.36099553	1.84520606	0.9999933
Surgery-Psychiatry	1.25401460	0.10847920	2.39955000	0.0187299
Surgery-Radiology	1.01190934	-0.27754661	2.30136529	0.2863429

FIGURE 5 Pairwise comparisons of performance by specialty

49% (n = 65), medicine 47% (n = 61), O&G 47% (n = 7), surgery 45% (n = 61), radiology 42% (n = 8), psychiatry 12% (n = 3).

4.4 | Indications for filtering facepiece class 3 (FFP3) respirator use

Fifty-four percent of respondents (n = 379) correctly identified the need for FFP3 respirator mask usage *"during an AGP for a suspected or confirmed case"* and *"whilst in a high-risk area with suspected or confirmed cases."*

4.5 | Single vs sessional use of PPE

Of the assessed cohort, only 18% (n = 126) correctly identified *"fluid resistant surgical masks (FRSM), fluid repellent gown or overalls, FFP respirator and eye protection"* as being appropriate for sessional use.

4.6 | Donning and doffing of PPE

Thirty-three percent (n = 229) of respondents were able to identify the correct order for the donning of PPE as "*disposable apron application*, *appropriate mask*, *eye protection*, *disposable gloves*." Thirty-four percent (n = 234) of respondents were able to identify the correct order for doffing of PPE as *"removal of gloves*, *hand hygiene*, *remove apron*, *remove eye protection*, *hand hygiene*, *remove mask*, *hand hygiene."*

Critical care was the highest performing specialty in identifying correct donning and doffing procedures (78%, n = 52), followed by anaesthetics (72%, n = 36), primary care (33%, n = 44), ophthalmology (29%, n = 6), surgery (28%, n = 39), O&G (27%, n = 4), acute services (24%, n = 20), medicine (17%, n = 22), radiology (5%, n = 1) and psychiatry (4%, n = 1).

4.7 | Confidence and education

Self-reported confidence grade varied significantly across the specialties ($P = 0.0005$) (Figure 6). Post hoc testing *P*-values for the proportion of each confidence grade by specialty are shown in Figure 7. Significant analyses include a higher number of primary care physicians stating the lowest confidence ($P = 0.0001$).

Our surveyed cohort reported a mode confidence level of 3/5 on the Likert scale regarding PHE PPE guidance across various settings. The highest perceived confidence levels were reported by doctors working within anaesthetics, critical care and acute services (4/5), surgery, medicine, ophthalmology, primary care (3/5), psychiatry, O&G, radiology (2/5). Confidence did not significantly vary by training grade, however ($P = 0.610$) (Figure 8).

Fifty-nine percent (n = 411) of participants reported receiving insufficient formal education on current PPE guidance. Thirty-seven percent (n = 258) of participants felt they had received adequate training on the use of PPE; however, 60% of these respondents (n = 154) felt that further training is necessitated. Overall, 81% of the cohort (n = 565) identified a need for additional education, whilst 11% (n = 77) were unsure (Figure 9).

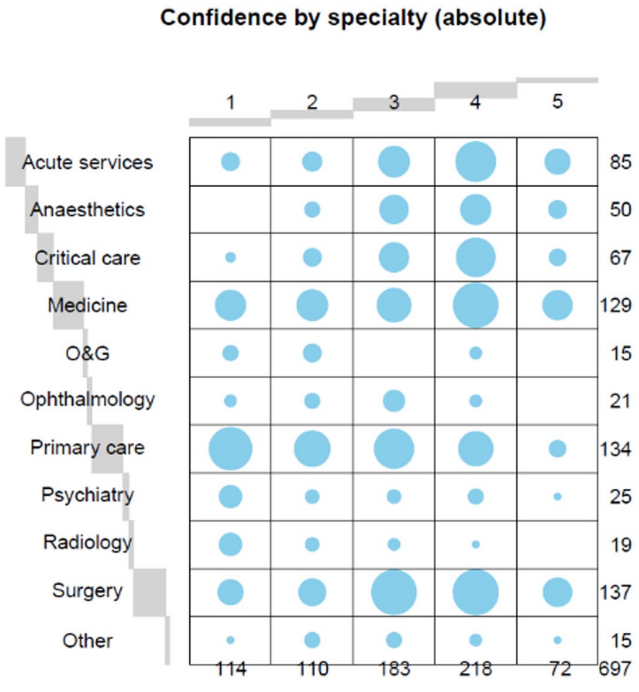

FIGURE 6 Statistical balloon plot reflecting perceived confidence across specialty

5 | DISCUSSION

The rapid escalation of COVID-19 into a global pandemic has compelled the challenging development of PPE guidance amongst international healthcare agencies. The safety of HCPs is integral to maintaining a functioning healthcare service and is of particular relevance in the context of the current global pandemic. The most recent PHE guidance (15 June 2020) advocates enhanced respiratory protection for healthcare workers undertaking or assisting in AGPs.[9] The level of PPE recommended reflects the potential risk of viral transmission via droplet, contact or airborne spread during a patient encounter. AGPs pose the highest risk within current PHE guidelines, which require "level 3" PPE. This comprises a FFP3 respirator, full-face shield or visor, fluid repellent gowns or coveralls and gloves, at a minimum. Situational knowledge and confidence in the appropriate selection and use of PPE resources is thus of vital importance not only from a morbidity and mortality aspect, but also accounting for constraints due to depleted resources.

The results of our pan-specialty survey suggest a lack of perceived confidence in the knowledge of current PHE PPE guidance amongst doctors, with the majority of respondents highlighting deficiencies in identifying AGPs and high-risk environments. Although the mode confidence level was 3/5, this was likely skewed by high scores from specialties with greater AGP exposure, such as anaesthetics and critical care staff, who utilise level 3 PPE at a proportionately higher rate than other groups. This is mirrored through the high-scoring performance of critical care and anaesthetic doctors on knowledge-based questions such as correctly identifying AGPs, high-risk environment and the correct procedure for donning and doffing, likely secondary to direct correlation with their increased daily exposure to significant COVID-19 disease in comparison to other specialties. Knowledge of high-risk environments was particularly well noted by acute services and ED staff, in keeping with knowledge required for department-based triage in such frontline hospital settings.

Perceived educational deficiency was high, with 76% (n = 536) of respondents reporting a need for additional education. Knowledge of the correct procedure for donning and doffing of PPE was particularly poor, with only a limited cohort of 33% (n = 229) able to identify the correct sequence for the donning of PPE and only and 34% (n = 234) able to identify the correct sequence for the doffing of PPE. This is of considerable significance considering the increased risk of

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> conf_spec_post_hoc
        Dimension     Value          1          2          3          4          5
1  Acute services Residuals -2.160130 -1.7191656 -0.3464709  2.1008896  1.9851241
2  Acute services  p values  1.000000  1.0000000  1.0000000  1.0000000  1.0000000
3    Anaesthetics Residuals -3.245394 -1.1639623  1.6253235  1.3808828  0.8850005
4    Anaesthetics  p values  0.064509  1.0000000  1.0000000  1.0000000  1.0000000
5   Critical care Residuals -3.112325 -1.2596998  0.4114462  3.3383619 -0.3888996
6   Critical care  p values  0.102091  1.0000000  1.0000000  0.0463510  1.0000000
7        Medicine Residuals -0.289794  0.1715693 -1.9659355  0.7684396  1.8183924
8        Medicine  p values  1.000000  1.0000000  1.0000000  1.0000000  1.0000000
9             O&G Residuals  1.797174  3.3168912 -2.3362204 -0.9523495 -1.3289115
10            O&G  p values  1.000000  0.0500640  1.0000000  1.0000000  1.0000000
11  Ophthalmology Residuals -0.260429  1.0246036  2.2591974 -1.7053486 -1.5793520
12  Ophthalmology  p values  1.000000  1.0000000  1.0000000  1.0000000  1.0000000
13   Primary care Residuals  4.699282  1.8065863 -0.2582438 -3.2987191 -2.4766986
14   Primary care  p values  0.000144  1.0000000  1.0000000  0.0534200  0.7293210
15     Psychiatry Residuals  3.805850  0.0304600 -1.1868045 -1.2385921 -1.0590855
16     Psychiatry  p values  0.007772  1.0000000  1.0000000  1.0000000  1.0000000
17      Radiology Residuals  4.963405  0.6389469 -1.0511891 -2.4798075 -1.5000460
18      Radiology  p values  0.000038  1.0000000  1.0000000  0.7229930  1.0000000
19        Surgery Residuals -2.166571 -1.4696406  1.7394434  0.4421481  1.2050765
20        Surgery  p values  1.000000  1.0000000  1.0000000  1.0000000  1.0000000
21          Other Residuals -1.025655  1.8849475  0.6298008 -0.9523495 -0.4712714
22          Other  p values  1.000000  1.0000000  1.0000000  1.0000000  1.0000000
>
```

FIGURE 7 *P*-values by specialty

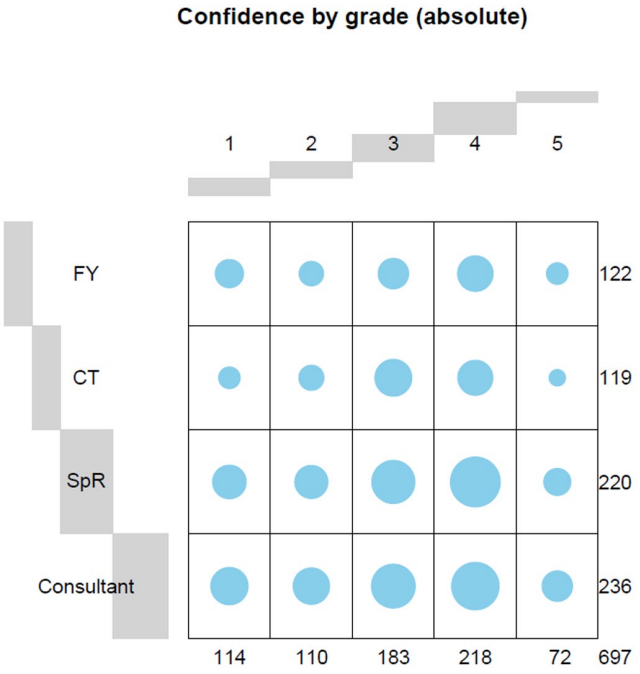

FIGURE 8 Statistical balloon plot reflecting perceived confidence across grade

self-contamination and potential subsequent nosocomial spread of communicable disease during donning and doffing when users deviate from established protocols.[7,10,11] Interestingly, doctors working within anaesthetics and critical care scored most highly within this knowledge sector, with 75% (n = 88) identifying the correct donning procedure, and 51% (n = 61) the correct doffing procedure. This is again most likely attributed to the higher exposure to advanced viral disease, requiring more frequent use of level 3 PPE by such clinicians, both pre- and post-COVID-19.

The discrepancies highlighted by our data may be influenced by the heterogeneity in defining AGPs and the contrasting guidance provided by PHE and professional bodies. A notable example of this involves CPR, which has been classified by PHE as being a non-AGP. This hypothesis is supported by the Royal College of Anaesthetists (RCoA) [12] as well as the New and Emerging Virus Threats Advisor Group (NERVTAG), an expert committee reporting from the Department of Health, stating that *"it is biologically plausible that chest compressions could generate an aerosol, but only in the same way that an exhalation breath would do"* thus supporting the adequacy of recommended level 2 PPE.[13] Conversely, the Resuscitation Council UK (RCUK) highlighted a paucity of evidence demonstrating an absence of risk to HCPs, and thus recommend level 3 PPE for CPR in keeping with PPE guidance for AGPs.[14] This is echoed by the Royal College of Emergency Medicine (RCEM), Royal College of Physicians (RCP) and Health Protection Surveillance Centre of Ireland (HPSC).[15-17] This significant discrepancy between professional bodies is reflected in the results of our study, where HCPs from anaesthetics and critical care achieved higher scores in excluding chest compressions as AGPs (66% and 71%, respectively), in comparison to acute services and medicine (39% and 21%, respectively), replicating the positions of their corresponding professional bodies. A lack of consensus between advisory groups thus appears to be a factor contributing to the lack of confidence in our surveyed cohort.

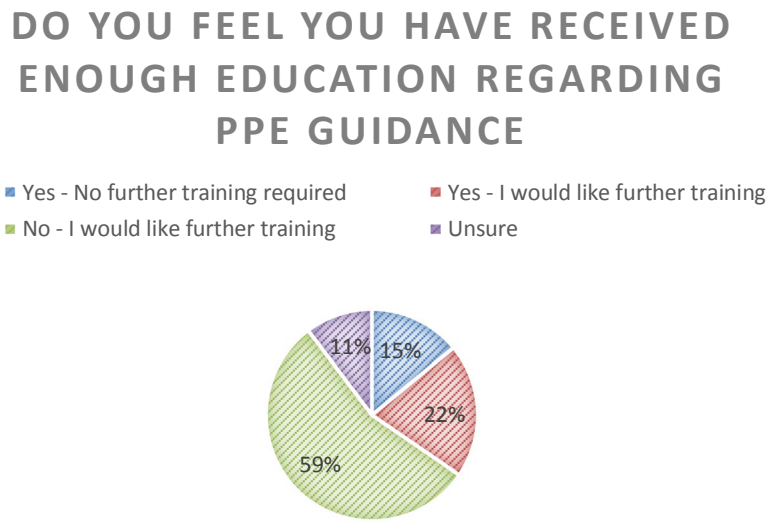

FIGURE 9 Percentage of respondents who have received previous education and advocate further training

Frequent review and unification of national guidelines based on emerging evidence could serve to standardise advice and improve HCPs' confidence in appropriate use of PPE. This, however, proves to be inherently challenging because of the novel and continually evolving nature of the COVID-19 virus. Previous studies investigating the use of PPE in epidemics of highly infectious diseases utilise data derived from SARS, Influenza or Ebola patients[7] and whilst studies involving COVID-19 infection are ongoing, the principle theme seems to demonstrate an increased incidence in HCP infection where awareness of PPE is insufficient, and a converse reduction in HCP infection where adequate PPE and infection control protocols are implemented.[9,18-21]

Following the emergence of COVID-19, PPE has become necessary but the challenging part of daily clinical practice for HCPs, none more so than within the field of surgery. Yánez Benítez et al[22] reported that over half of the surveyed surgical respondents (54%, n = 72) perceived a degree of visual and communicative impediment, increased fatigue and reduced comfort, as a result of enhanced PPE required during emergency surgery, which they perceived to impede surgical performance. With COVID-19 currently displaying a heightening disease trajectory, it is likely that these intense working conditions will continue. Feedback on the user-friendliness and ergonomic nature of essential PPE is, therefore, crucial in the potential re-design of PPE to optimise surgical performance for future use.

When managing COVID-19 patients in the emergency surgical setting, it is important to consider and reduce the risk of transmission wherever possible, in addition to appropriate PPE use. Such emergency procedures are common within the field of general surgery, with cases of an acute abdomen frequently requiring diagnostic exploration. It has been postulated that the potential for viral spread is higher with laparoscopic vs open procedures, because of theories regarding vapour generation secondary to heat-generating cautery devices and aerosolisation associated with pneumoperitoneum.[23] This has led to the consideration of increased open approach where appropriate within colorectal surgery, aiding the protection of surgeons and operators in the field. The possible introduction of thoracic imaging such as computerised tomography (CT) in patients presenting with an acute abdomen, with otherwise no respiratory symptoms, has been postulated in order to evaluate radiological evidence of respiratory disease and guide further management.[24,25]

Verbeek et al[3] published an update to their 2019 Cochrane systematic review with newer COVID-19 studies included in their literature search. They noted an overall lack of robust evidence and were unable to strongly recommend a specific combination of PPE. However, in the context of training and improving skills in PPE knowledge, donning and doffing, they noted better scores and reduction in user error with the use of face-to-face instruction, video lectures and computer simulation. This represents a useful adjunct to meet the perceived need for more education amongst our surveyed cohort of clinicians, as our paradigm shifts towards increased use of video-streaming and virtual media to exchange knowledge and facilitate learning.

A clear agreement between governing and professional bodies, combined with an evidence-based approach to education and training, is of paramount importance to optimise the safety of HCPs and maintain a functioning healthcare service.

6 | CONCLUSION

For this generation of HCPs, the COVID-19 pandemic remains an unpredictable battle, with our limited understanding of this unfamiliar disease threatening to derail the functionality of an already underfunded and overstretched NHS. Despite the resilience demonstrated by HCPs, additional efforts are required to avoid occupational transmission of COVID-19 to frontline workers. A unified consensus regarding guidance should be accompanied by robust education across training doctors at local and national levels to optimise situational awareness and promote the correct use of PPE in high-risk settings.

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DISCLOSURES

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ORCID

Shams Al-Hity https://orcid.org/0000-0003-2161-3183
Keshav Kumar Gupta https://orcid.org/0000-0001-8155-0001

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