



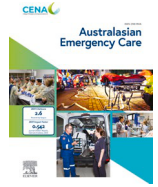
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Research paper

Rapid development and implementation of a behaviour change strategy to improve COVID-19 personal protective equipment use in a regional Australian emergency department



Kate Curtis^{a,b,c,*,1}, Peter Jansen^d, Margot Mains^d, Anna O'Hare^b, Bradley Scotcher^d, David Alcorn^d, Shizar Nahidi^{a,e,f}, Joanna Harris^d, Daniel Brouillard^b, Sarah Morton^b, Ramon Z. Shaban^{a,e,f,g}

^aSusan Wakil School of Nursing and Midwifery, Faculty of Medicine and Health, The University of Sydney, MO2 88 Mallett St, NSW 2006, Australia

^bEmergency Department, Wollongong Hospital, Illawarra Shoalhaven LHD, NSW, Australia

^cIllawarra Health and Medical Research Institute, Wollongong, NSW, Australia

^dIllawarra Shoalhaven LHD, NSW, Australia

^eSydney Institute for Infectious Diseases, University of Sydney, Camperdown, NSW, Australia

^fDivision of Infectious Diseases and Sexual Health, Westmead Hospital and Western Sydney Local Health District, Westmead, NSW, Australia

^gNew South Wales Biocontainment Centre, Western Sydney Local Health District and New South Wales Health, NSW, Australia

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ABSTRACT

Objective: To identify barriers to, describe the development of and evaluate the implementation of a behavioural theory informed strategy to improve staff personal protective equipment (PPE) compliance during COVID-19 in a regional Australian Emergency Department.

Methods: Barriers to PPE use were identified through staff consultation then categorised using the Theoretical Domains Framework. The Behaviour Change Wheel was used to develop a strategy to address the barriers to PPE compliance. The strategy was refined and endorsed by the site COVID taskforce. Data were collected through direct observation. Descriptive statistics were used to summarise PPE compliance and inductive content analysis for free text data of staff behaviours.

Results: 73 barriers were identified, mapped to 9 intervention functions and 42 behaviour change techniques. The predominant mechanisms were: (1) Executive communication reinforcing policy and consequences; (2) implementation of a PPE Marshal; (3) face to face reinforcement / modeling; (4) environmental restructuring including electronic medical record modifications. The PPE Marshal observed 281 PPE activities. PPE compliance varied between 47.9% (Buddy check) and 91.8% (Bare below elbow). The PPE Marshal intervened on 121 occasions, predominantly through buddying, explaining and demonstrating correct PPE use, most frequently with medical staff (72%).

Conclusion: We describe an evidence-based process to overcome barriers to PPE compliance that maximize safe work practice in a time critical situation. Staff require enabling, access to equipment and reinforcement to use PPE correctly.

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Introduction

The hierarchy of controls is a fundamental contemporary framework for protecting healthcare staff and patients from exposure to infectious diseases [1]. Effective infection prevention and control programs employ a combination of different control measures or mitigation strategies to minimize the risk of transmission of infectious diseases. These measures are used to 'eliminate' the risk

* Correspondence to: Wollongong Hospital Emergency Department, Crown St, 2500 Wollongong, Australia.

E-mail address: kate.curtis@sydney.edu.au (K. Curtis).

¹ ORCID ID: 0000-0002-3746-0348.

(considered the most effective measure), followed by 'substitution', 'engineering controls', 'administrative control' and the use of 'personal protective equipment (PPE)'. Although PPE is recognized as the least effective control measure, it is an integral component of infectious disease risk management programs [2]. Along with appropriate hand hygiene, PPE is a component of standard and transmission-based infection prevention and control precautions required in the care of any patients with a known or suspected communicable disease or multiresistant organism [3].

During the COVID-19 pandemic, adherence to the outlined hierarchy, including use of PPE, has been critical in the prevention and control of exposure to SARS-CoV-2. PPE is essential when caring for patients with suspected or confirmed COVID-19 and includes items such as gloves, surgical masks, P2/N95 particulate filter respirators, eye protection, and gowns [4,5]. Although the predominant mode of transmission of SARS-CoV-2 is close contact with respiratory particles (i.e., droplet transmission), there are well documented incidents indicating the transmission has occurred via small particles (i.e., aerosols and airborne transmission) especially in closed settings where the ventilation is suboptimal [6,7]. Furthermore, the higher transmissibility of the Delta variant of SARS-CoV-2 necessitates increased respiratory protection in high-risk clinical areas. Current jurisdictional guidelines recommend that healthcare workers use P2/N95 that are fit checked and fit tested to provide care or clinical support to COVID-19 suspected and confirmed cases.

Regardless of the type of PPE, correct usage is essential to achieve maximum protection. Healthcare workers must be trained in the correct use of PPE, including putting it on (donning) and removal (doffing) using correct sequential methods [4, 5, 8]. To enable staff competency health jurisdictions and authorities provide a range of guidance, training and resources [9], supported with in-person face-to-face training [10]. Research examining the experiences of emergency clinicians' experiences of managing COVID-19 in Australia identified the importance of access to and comprehensive training in use of PPE [12].

ED (emergency department) patients generally present with unknown COVID-19 status and PPE is universally required to protect staff from exposure [12]. High workload, chaotic working conditions and staff preoccupation with time efficiency have all been described as barriers to effective use of PPE [13–15]. Lack of physical space to establish rapid turnover hot zones (that is, dedicated areas for suspected infectious patients) and for adequate donning and doffing stations also adds to the challenge of providing COVID-19 safe care in ED [2]. The implications associated with improper PPE use include; transmission of disease to staff and patients, and, furloughing of staff to comply with public health orders relating to isolation of close and casual contacts [16]. These factors result in a reduced workforce and increased workload for remaining staff.

During the third COVID-19 wave in 2021 in New South Wales (NSW), Australia, the Wollongong Hospital COVID Taskforce committed to ensuring all hospital staff had the capability, opportunity and motivation to protect themselves, their colleagues and patients through appropriate PPE use as mandated by NSW Health [4]. The COVID Taskforce met daily, and comprised the chief executive of the health district, the general manager, directors of nursing and medical services, and heads of departments such as ED, ICU (intensive care unit), infectious diseases, infection management and control service (IMACS) and respiratory medicine. The ED as a high exposure risk was considered a priority, exemplified through an exposure incident that required 12 staff to be furloughed. To maximize appropriate use of PPE for safe work, the COVID-19 Taskforce chose to undertake a behavioral assessment of staff because central to

sustained compliance with any intervention is understanding individual and collective human behaviour [17].

This paper describes the behavioral analysis and intervention to improve appropriate PPE use for staff and patient safety in Wollongong ED in a time critical situation.

Methods

Design

In mid July 2021 we conducted a behavioral analysis to inform the design of a strategy to improve PPE compliance in a regional Australian ED using the framework suggested by French et al., [18]. This approach applies the Theoretical Domains Framework (TDF) and Behaviour Change Wheel [19] to examine the core questions of: 1. Who needs to do what, differently? 2. Using a theoretical framework (TDF), which barriers need to be addressed? 3. Which intervention components (behaviour change techniques and mode(s) of delivery using the Behaviour Change Wheel) could overcome the modifiable barriers and enhance the enablers? 4. How can behaviour change be measured and understood? We have successfully used this approach in the ED for several projects [20–22]. From August to early September 2021, we implemented the recommendations from the behavioral analysis.

Research steps

The following four steps guided the conduct and evaluation of this project over a six-week period.

1. Which staff need to improve their use of PPE? (July 2021).
2. What are the barriers to staff using PPE appropriately in the ED? (July 2021).
3. What can we implement that will ensure staff use PPE well in the ED? (August 2021).
4. How will we know if staff are using PPE appropriately? (August – early September 2021).

Human research ethics approval

This study was approved and registered on the ISLHD Quality Activity and Improvement Registry (ISLHD ref. 385) and conformed to the "National Statement on Ethical Conduct in Research Involving Humans" by the National Health and Medical Research Council of Australia,

Study setting and participants

The study was conducted at Wollongong Hospital ED, Australia. Wollongong is a regional area of NSW, Australia and the referral center for several smaller and rural hospitals in the district. Wollongong ED treats 70,000 + patients per year, a quarter of them pediatric. The ED had designated "Hotzones" to accommodate patients suspected or confirmed as having COVID-19.

Step 1. Which staff need to improve their use of PPE? All staff present in the ED during the study period were included.

Step 2. What are the barriers to staff using PPE appropriately in the ED?: Following the endorsement from executive and departmental leadership we began the process by consulting with clinical staff (nursing, medical, clerical and ancillary) at

beginning of shift huddles, education sessions, clinical handover, departmental meetings and in clinical areas. Over two days, we asked what made it hard for them to use PPE appropriately. Staff were encouraged to be open and honest; anonymity was ensured. The positive culture within the ED which embeds the NSW Health values of Collaboration, Openness, Respect and Empowerment enabled this.

Step 3. What can we implement that will ensure staff use PPE well in the ED?: Over the next two days, these comments were collated to the TDF domains then mapped to intervention functions and behaviour change techniques to develop a strategy to improve PPE compliance. Intervention functions are ‘broad categories by means of which an intervention can change behaviour’. A behaviour change technique (BCT) is a component of an intervention that will alter behaviour [19]. The strategy was co-created with end users, infectious diseases and emergency clinicians and managers, hospital executives and other members of the COVID taskforce. Components of the strategy were communicated with staff at beginning of shift huddles, clinical handover and in clinical areas by the research team. This included nursing, medical, administrative and support staff. Staff feedback was sought, for example “Do you think xxx would be useful?” “What do you think we should call the xxx role?” Feedback was noted by the research lead and alterations to the plan made where relevant. This iterative process was guided by the Behavioral Change Wheel [19].

The draft strategy to improve PPE compliance was then tabled at the COVID-19 Taskforce, reviewed and refined using APEASE criteria that consider affordability, practicality, effectiveness/cost-effectiveness, acceptability, side-effects/safety and equity [19,23]. The resulting BCTs were collated and integrated into an implementation plan approved by the COVID-19 Taskforce. The final list of actions from the strategy were prioritized and allocated to relevant personnel for action.

Step 4. How will we know if staff are using PPE appropriately? A PPE Marshal role was implemented as part of the strategy. The person allocated to this role collected data on PPE use through direct observation independent to the research team. The PPE Marshal worked 78 h over the 2-week period. Data were also collected on the number of staff furlough events related to incorrect PPE use. Furlough data are routinely collected by the study organization and reported to the NSW Ministry of Health. These data were made available to the research team by the ED leadership team.

Data management and analysis

Data were entered into MS Excel™. Descriptive statistical analyses were undertaken on variable for staff characteristics and the interventions undertaken by the PPE Marshal. An inductive content analysis was undertaken on the free text data recorded by the PPE Marshal on a PPE audit tool via categories and subcategories within NVIVO™. The categories were manually verified by authors (Kate Curtis and Shizar Nahidi).

Results

This study yielded three key outputs: clear description of the existing barriers to appropriate PPE use by ED staff, the development of an implementation strategy to improve PPE compliance, and a behaviour change intervention by way of a PPE Marshal to improve PPE use.

Which staff need to improve their use of PPE? (Results of Step 1). There were 115 nursing staff, 69 medical staff, 23 clerical and 24 support staff (allied health, cleaners, orderlies) employed in the ED at the time of the study. There were also many casual staff in all professional disciplines and inpatient teams that regularly attend the ED to review patients.

Barriers to staff PPE use in the ED (Results of step 2)

We identified 73 barriers that mapped to ten domains of the TDF (Supplementary material).

Barriers were most dominant in the Social Influence (n = 13) domain because some staff felt unsupported to change their practice “senior staff don’t so why should I?” and “the person I am working with doesn’t take it seriously” and “I get pressure to move faster so I can’t do things properly”. The Environmental Context and Resources domain was also highly influential (n = 12). Particularly because a high patient care load and prioritizing bedside care meant “no appointment available to get fit tested” “unable to do buddy checks for donning/doffing as can’t leave bedside” “my face hurts” and “large medical teams coming into the clinical area and decimate the floor stock of PPE that I don’t have time to go and restock”.

Staff knowledge (n = 8) was impacted by the large number of staff, staff turnover, and rapid changes in policy between rostered shifts “I don’t know when things change, especially if I have been on days off or leave”.

Emotion (n = 6) also featured “I just can’t do something else” and “Staff in clinical areas that don’t have to do all the extra stuff we do get paid the same – doesn’t seem fair” “We have been doing this for so long, we know it is our job, but all we get is a compliment, it would be nice to get some other sort of encouragement.” And “I keep getting allocated to the COVID area, it isn’t fair, I’m tired”.

The Memory, Attention and Decision Processes domain (n = 5) was reflected in because staff reported they were cognitively overloaded, for example “I am so busy providing patient care to very unwell patients I just forget” and “I am already doing so much, this is one more thing I can’t remember”.

Development of the implementation strategy to improve PPE use (Results of step 3)

The 73 barriers mapped to ten domains of the TDF, nine intervention functions and 42 behaviour change techniques (Supplementary material). The nine intervention functions were assessed and endorsed by the COVID taskforce using the APEASE criteria (Table 1). The predominant mechanisms chosen to operationalize the 42 BCTs were: (1) Executive communication reinforcing policy and consequences; (2) implementation of a PPE Marshal role; (3) face to face reinforcement and modeling; (4) environmental restructuring and (5) eMR modifications (Table 2). These mechanisms were implemented from August 2021 and all but the PPE Marshal have been sustained to date of publication.

Behaviour change intervention: The PPE marshal

One of the recommendations to improve PPE compliance was to introduce a role that monitored PPE use, provided immediate advice and feedback to staff, was an extra resource to facilitate buddying and restocking and educated real-time. To address this recommendation, a PPE Marshal role was created to monitor compliance and effect behaviour change. The role encompassed most intervention functions and BCTs (Fig. 1). To support this role, a

Table 1

Assessment of proposed intervention functions for affordability, practicality, effectiveness/cost-effectiveness, acceptability, side-effects/safety and equity.

Intervention functions and comments around APEASE criteria	
Education (<i>Increasing knowledge or understanding</i>)	Education is affordable and practical within existing roles and orientation processes. The PPE program is supported by executive, with support for Train the trainer education, with capacity for short in-service education and elearning to be completed in existing in-service time. Excessive educational focus may lead to neglect in other domains. Educational meetings alone are unlikely to effectively change behaviours.
Persuasion (<i>Using communication to induce positive or negative feelings or stimulate action</i>)	Using persuasive communication to motivate staff in use of PPE – senior staff, managers and peers. But need to consider method of persuasion not to be construed as “pushy”. Needs to be conducted equitably – not single out individual staff.
Incentivization (<i>Creating an expectation of reward</i>)	Provision of incentive is an essential characteristic to motivate staff to use PPE. This can be in the form of positive feedback from managers/ senior staff. Care must be taken that the incentive chosen must be widely available – all staff have opportunity for acknowledgment. Staff can also be incentivized through communication of the results of documentation review and patient and staff experience.
Coercion (<i>Creating and expectation of punishment or cost</i>)	Creating expectation of use is appropriate as the use of PPE is considered role responsibility. It is affordable, with managers required to evaluate and monitor staff performance in line with unit practice guidelines and policy. However it is difficult to monitor and observe compliance without formal and regular auditing
Training (<i>Imparting skills</i>)	Imparting skills is affordable and practical within existing roles and orientation processes but staff need motivation and capacity to use them.
Restriction (<i>Using rules to reduce the opportunity to increase the target behaviour by reducing the opportunity to engage in competing behaviours</i>)	Using rules to increase staff using PPE is possible and can be mandatory. However staff have the capacity to alter or not use if they choose to do so unless there is clear monitoring and repercussion.
Environmental restructuring (<i>Changing the physical or social context</i>)	Ensuring all staff have PPE available at the coal face will involve cost in the form of additional PPE trolleys, ability to restock, adequate supply.
Modeling (<i>Providing an example for people aspire to</i>)	Clinical Champions will provide an example for people to aspire to or imitate by modeling is affordable, practical, effective, acceptable and equitable within existing roles and orientation processes. Role models will need to be engaged.
Enablement (<i>increasing means/ reducing barriers to increase capability or opportunity</i>)	Increasing the means and reducing barriers to increase staff to use of PPE is possible.

position description and PPE audit tool based on NSW Health guidance[4] was developed in consultation with the IMACS team (Fig. 2). The PPE Marshal used paper forms on a clipboard to record PPE use (or breaches of), any interventions required by the PPE Marshal, responses to their intervention, and any problems encountered. A senior registered emergency nurse was appointed to the position who had significant confidence, assertiveness and credibility with staff to effectively provide advice and intervention in the high-pressure ED environment. This nurse had already undergone routine hospital PPE training and fit testing and received additional training and assessment by the IMACS team, for example in donning, doffing and appropriate PPE for different circumstances, such as aerosol generating procedures in all patients, not only those suspected or confirmed as having COVID-19. Following orientation to the role, and familiarization with NSW Health and Hospital policy, the PPE Marshal was trialed for two weeks from August 23rd – September 4th 2021.

The PPE Marshal worked 78 h over the 2-week period. The PPE Marshal was active within the ED COVID-19 Hotzone areas, observed staff, and intervened when needed. For example, if the Marshal noted a staff member was about to enter an area without the correct mask type they were to stop the staff member, advise on correct mask use, assist in sourcing that mask and ensure correct application per NSW Health guidelines.

Staff use of PPE and furlough incidence (Results of step 4)

The PPE Marshal completed 281 audits of nursing (ED nurses, n = 113; inpatient nurses, n = 3), medical (ED medical officers, n = 69;

inpatient medical officers, n = 44; medical students, n = 5) and support staff (ED radiographer, n = 25; ancillary staff, n = 15; paramedics, n = 6) in multiple areas of the ED (Table 3). During the study period there were 2313 patients treated at Wollongong ED.

The rate of compliance with appropriate PPE for the clinical situation varied between 47.9% (Buddy check for donning and doffing prior to and following suspect COVID patient care) and 91.8% (Bare below elbow) (Fig. 3). Compliance also varied between staff type. Radiographers and medical students were the most compliant, followed by nurses, paramedics and ED medical officers. Inpatient medical officers were the least compliant (Fig. 4).

The PPE Marshal identified reasons for lack of PPE compliance on 67 occasions, which was most commonly due to a lack of access to a staff member to be a buddy (n = 35), depleted PPE stock at the bedside (n = 13), general attire (eg wearing watches, long sleeves n = 35) and incorrect use of PPE (not wearing gown because did not want to “get all sweaty”, gloves on but hands in pockets, surgical mask around neck under N95 mask, n = 35).

The PPE Marshal intervened on 121 occasions, mostly in HotZones (91/120), and with of junior medical officers (JMOs) (51/121) and ED physicians (36/121). Fig. 5 illustrates the number of interventions by the PPE Marshal. On the 34 occasions where a reaction to Marshal intervention was recorded the sentiment was 50% (17/34) positive. In the positive interactions staff (of all disciplines) were appreciative, compliant with suggestions and engaged. They felt “safer” and were noted to be very polite and grateful.

“Thanked me for helping them prior to going and seeing a positive COVID patient, said they felt supported and much safer”

Table 2
Mechanisms to action the selected behaviour change techniques to improve PPE compliance and COVID safe practice.

Mechanism	Content
1. Chief Executive Memo outlining expectations and consequences – 1 page Recurrent follow-up memos	1. PPE use per local guidelines and alert level 2. Address facial hair 3. If unable to comply – redeploy 4. Non compliance = formal meeting with manager 5. Line managers need to know they will be backed up in this 6. But also, that staff are looked after by rotating through areas, adequate PPE
2. Memo to all staff from medical and nursing directorate	Informing staff of the following: 1. reminder on fit checking, facial hair 2. reinforcing requirement for screening of all staff at entrances 3. reminder on resources available to support appropriate use of PPE 4. asking staff to assist colleagues to use PPE 5. noting there may be consequences for not following screening requirement, using PPE 6. Line manager/Nurse manager / Director of medical services, heads of department will reinforce the memos 7. Ensure rotation of staff through areas so same people not always there. Reduce burnout and exposure
3. Line managers to reinforce and ask questions about non compliance	Based on findings from PPE audits conducted by PPE role.
4. Dedicated roving PPE role for 2 weeks with PPE audits	1. Central to monitoring, feeding back to managers about compliance. Without this, the reinforcement won't happen. 2. Conducts audits. Need audit tool 3. Face to face feedback through monitoring, auditing, enforcing locally like hand hygiene 4. They could also assist with PPE restocking at bedside, PPE for staff from outside the hot zone departments 5. This person could be a return to work person, Enrolled Nurse, Registered Nurse, clerical / orderly appropriately trained. 6. Audit tool inclusive of Clinical Excellence Commission recommendations
5. Infection management and control service (IMACS) presence	1. At morning and afternoon shift changes – medical and nursing. 2. Walk throughs during peak medical team rounding times 3. Poster / templates / signage at all donning and doffing stations – confirm with clinical nurse educators
6. Executive staff walk through ED each shift	1. to monitor, answer questions, assist, praise, feedback 2. Some exec will not be known to floor staff, so they should introduce self, say what they are doing etc 3. Congratulate staff, but also so they know they are being watched, acknowledge, empathise 4. Listen “hear” staff
7. Modification documentation	1. Modification to nursing documentation: Template used by all nursing staff updated to include INFECTION RISK “Is patient at risk of infection or suspected/confirmed communicable disease? Precautions / PPE used” 2. Medical and Nursing staff reminded daily to document what PPE worn with each patient encounter
8. Daily huddle	1. Communicate exec memos to staff 2. Inform re walk throughs 3. Provide positive reinforcement and results of audits, 4. IMACS refreshers / requestions 5. consequences of non compliance (warnings, staff having to go off, leave team short) 6. Ask staff to commit to using PPE. At each huddle / handover, the person leading the handover says “can I please have a show of hands to demonstrate you understand what you need to do about PPE and you commit to doing so”
9. Reward / recognition	Local donations of COVID safe food delivery
10. Fit testing enhancement	Increased support to achieve 100% in high priority areas – 170 staff to get through in ED. One fit tester gets 10 staff done / day

BCTs encompassed by the above mechanisms: (1) Goals and planning: 1.1 goal setting (behaviour), 1.2 problem solving, 1.3 goal setting (outcome), 1.4 action planning, 1.5 review behaviour goal, 1.9 Commitment. (2) Feedback and monitoring: 2.2 Feedback on behaviour, 2.5 Monitoring outcomes of behaviours by others without feedback, 2.7 Feedback on outcomes of behaviour. (3) Social Support: 3.2 social support (practical). (4) Shaping knowledge: 4.1 Instruction on how to perform behaviour. (5) Natural Consequences: 5.1 info on health consequences, 5.2 salience of consequences, 5.3 Info about social and environmental, consequences, 5.5 anticipated regret, 5.6 info emotional consequences. (6) Comparison of behaviour: 6.1 Demonstration of the behaviour, 6.2 social comparison, 6.3 Info about others approval (7) Associations: 7.1 Prompts / Cues, 7.5 remove aversive stimulus. (8) Repetition and substitution: 8.1 practice rehearsal, 8.2 behaviour substitution, 8.3 Habit formation, 8.4 Habit reversal. (9) Comparison of outcomes: 9.1 credible source, 9.2 Pros and cons, 9.3 Comparative imagining of future outcomes. (10) Reward and threat: 10.1 material incentive, 10.2 material reward, 10.4 social reward. (11) Regulation: 11.3 conserving mental resources (12) Antecedents: 12.1 Restructuring the physical environment, 12.2 changing the social environment, 12.5 adding objects to the environment. (13) Identity: 13.1 identification of self as a role model, 13.2 framing / reframing, 13.3 Incompatible beliefs, 13.5 identity associated with changed behaviour. (14) Scheduled consequences: 14.2 Punishment, 14.6 situation specific reward (15) Self belief: 15.1 Verbal persuasion about capability. (16) Covert Learning: 16.1 imaginary punishment, 16.2 imaginary reward, 16.3 Vicarious consequences.

In contrast, there were 17 interactions that were unpleasant. Some staff demonstrated unacceptable breaches in PPE and unacceptable behaviours that were inconsistent with the NSW Code of Conduct:

“Doctors coming into staff tearoom with N95 at their necks. Advised to take it off and wash hands. One scoffed and did so

while walking away. The other took it off without hand hygiene”.

“After informing team they would need to gown up to see patient, the team declined to see the patient and would “see him on the ward”.

“RN wearing N95 mask not clean shaven. Reminded/asked to shave at home. Responded with “maybe”.

<p>PPE MARSHAL (RN)</p> <p>Role: Enable staff to work safely through appropriate use of PPE</p> <p>Clinical priorities:</p> <ul style="list-style-type: none"> • Assist all staff entering hotzones use PPE appropriately through <ul style="list-style-type: none"> ○ Assistance with safe donning and doffing (buddy) ○ PPE donning Station restocking ○ PPE doffing station availability ○ Provide face to face feedback / training • Conduct PPE audits in each Hotzone each shift x 10 • Answer PPE questions, praise, feedback • Escalate to Clinical NUM when indicated <p>Working with:</p> <ul style="list-style-type: none"> • All staff entering the HotZone areas <p>You report to</p> <ul style="list-style-type: none"> • Shift clinical manager and ED Senior nurse manager <p>Your job is to</p> <ul style="list-style-type: none"> • Review PPE guidance and case definition at the beginning of each shift <ul style="list-style-type: none"> ○ GO SLOW - stop and think about your PPE process • Make sure you know the steps for Donning and doffing, you will be checking that staff do this right • Check Donning and Doffing stations in each area for stock and location • Ensure posters current and visible at Donning and Doffing stations • Attend huddles to check in with staff, explain your support role • Provide completed PPE audits to Senior nurse manager • Feedback to line managers about any compliance issues with individual staff or teams <p>Other</p> <ul style="list-style-type: none"> • Organise breaks early and taken them when you can

Fig. 1. PPE Marshal role. Abbreviations: Personal protective equipment (PPE), Registered nurse (RN), NUM (Nurse unit manager).

“Advised it was my role as PPE marshal to ensure safe PPE to MO [medical officer] with long sleeved cloth gown, beads around neck and no eye protection in hotzone. They asked “why should I?”. I explained mandatory NSW Health policy and safety. Refused again stating “when you talk to someone, you need to have a little bit of respect”.

Since the implementation of the strategy to improve PPE use in the ED, to date of manuscript submission, there has been one staff

member furloughed, because of not wearing the correct mask. The PPE Marshal role while supported in principle was not continued due to staff shortages.

Discussion

This study demonstrated the utility of behaviour change theory informed intervention can be applied rapidly to address time critical needs in the emergency care environment.

Auditor:		Date:		Observe for 15min period in COVID "hot zones" (where it is assumed patients are suspect or +ve COVID). Check off the PPE and processes per relevant patient interaction. AGP = Aerosol Generating Procedure	
Location (circle)	Staff type	AGP – Yes + what type?	AGP – No	PPE process (tick all correct +/- N/A)	Comments (describe errors, potential reasons (ie no stock) any action)
P = Paeds				<input type="checkbox"/> Bare	
T = Triage				<input type="checkbox"/> Below Elbows	
R = Resus				<input type="checkbox"/> Hand hygiene at all moments	
B = Acute B				<input type="checkbox"/> Apron / Long sleeved	
C = Acute C				<input type="checkbox"/> N95 / equiv	
				<input type="checkbox"/> Eye protection	
				<input type="checkbox"/> Gloves	
				<input type="checkbox"/> Buddy	
				<input type="checkbox"/> Don correct (N/A)	
				<input type="checkbox"/> Doff correct (N/A)	

Fig. 2. Personal protective equipment marshal monitoring audit form. Abbreviations: Corona Virus Disease (COVID), Aerosol Generating Procedure (AGP), Personal Protective Equipment (PPE).

Table 3

Location and classification of staff observed in 281 audits by PPE Marshal at WH ED.

	Number (%)
Location	
Hotzone	174 (61.9)
Resus	57 (20.3)
Triage	26 (9.3)
Paeds	16 (5.7)
Cold Zone	7 (2.5)
Staff tea room	1 (0.4)
Staff Type	
ED nurses	113 (40.4)
ED medical officers	69 (24.6)
Inpatient medical officers	44 (15.7)
ED radiographer	25 (8.9)
Ancillary staff	15 (5.4)
Paramedics	6 (2.1)
Medical students	5 (1.8)
Inpatient nurses	3 (1.1)
Seniority of staff	
Student	6 (2.1)
Junior Medical Officer	86 (30.7)
Paramedic	6 (2.1)
Radiology	24 (8.6)
Ancillary staff	15 (5.4)
ED Nurse	105 (37.6)
Nurse Management/Clinical Nurse Consultant	11 (3.9)
Consultant (medical)	27 (9.6)

Ongoing PPE compliance and competency requires regular and standardized auditing and provision of constructive feedback in order to identify barriers, facilitators, and gaps in the practice, and to ensure the correct use of PPE is applied consistently and rigorously [4,5]. Auditing can take several forms of observations and interactions (e.g., random vs. planned observation, or direct vs. indirect feedback) depending on the type of PPE and the clinical setting. A common arrangement is where a trained observer or supervisor (also known as 'dofficer') is introduced to watch both the donning and doffing processes to ensure the protocols are not breached and sufficient level of adherence to procedures are achieved [2,5]. This is like the PPE Marshal we introduced. Each method has inherent advantages and disadvantages. For instance, direct observation methods enable the identification of barriers to compliance, allow for real-time education and are adaptable to a variety of setting [24]. Other methods of auditing using video-based monitoring systems (VMS) and remote video auditing (RVA) are becoming more appealing, but have limited capability to render real-time education, and their applicability could be undermined by technical and methodological issues [25,26]. The ongoing intervention required by the PPE Marshal indicates that in times of crisis, and when staff are already at capacity, they require additional ongoing support, particularly in the ED which is acknowledged internationally [27]. As such additional resources to support safe staff practice should be part of any pandemic plan [28].

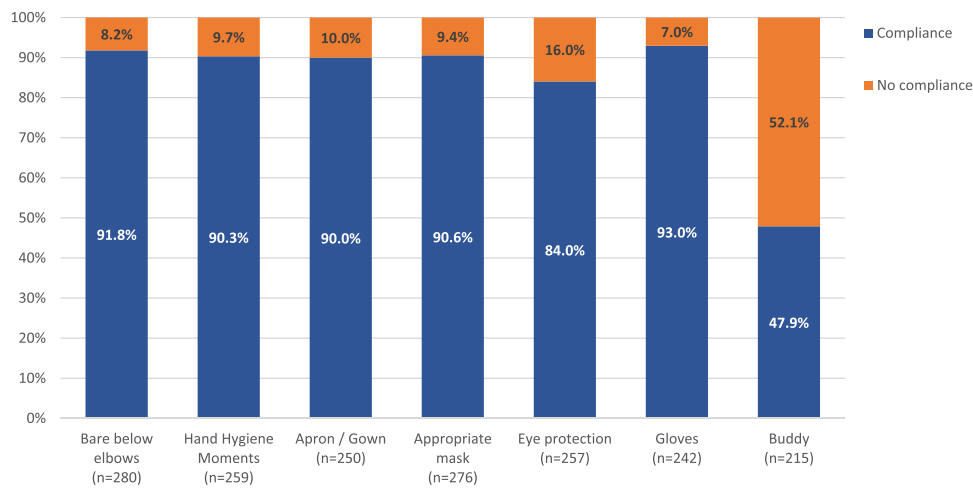


Fig. 3. Proportion of PPE Compliance observed by the PPE Marshal by type of PPE.

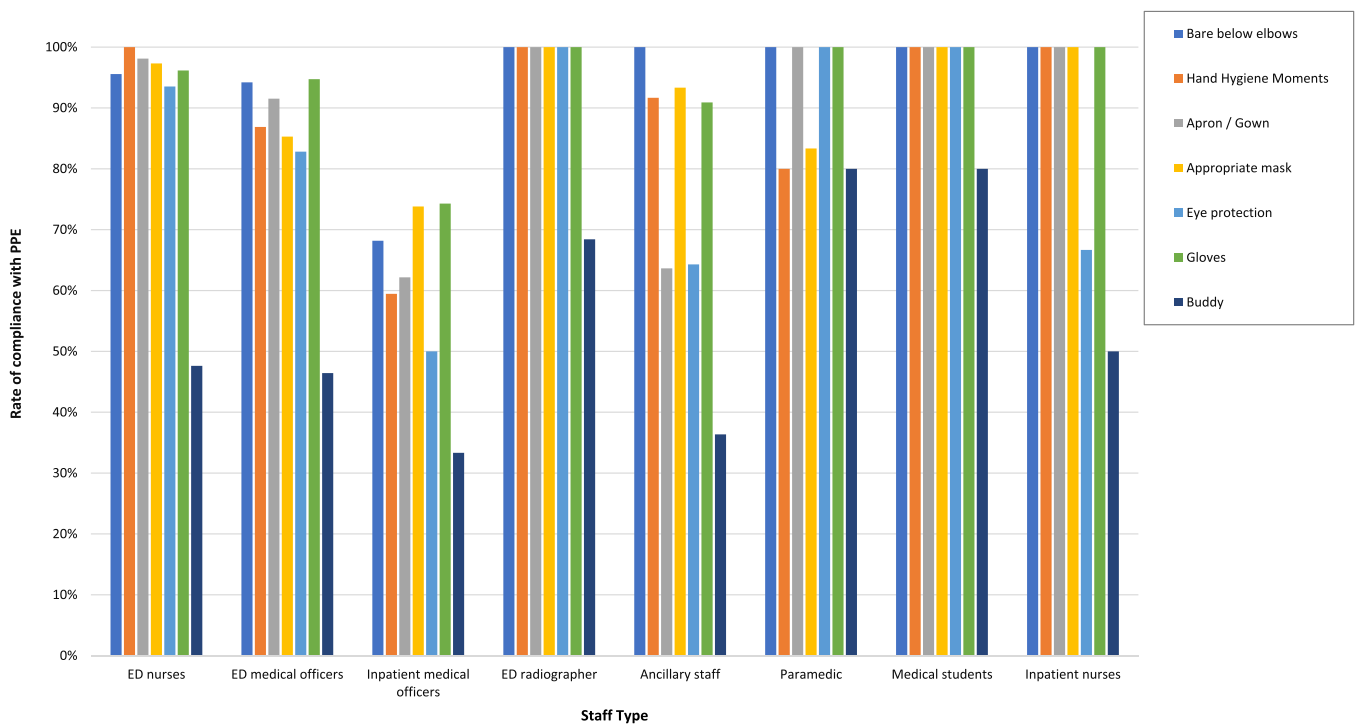


Fig. 4. Proportions of PPE Compliance observed by PPE Marshal per staff type.

Despite the completion of mandatory PPE eLearning modules supported by face-to-face training, and the existence of policy, compliance with PPE remained a problem during the study period, in particular doffing contaminated PPE. The problems we encountered are not new in COVID times [29] or routine infection control [14]. Each organization has an obligation to ensure staff have the capability, opportunity and motivation to use PPE appropriately to protect themselves, patients, other staff and their families. To meet this obligation, intervention must go beyond a policy release. An assessment of the needs of each department is recommended

and support provided to address these needs. We were able to achieve this to a large degree with the use of a PPE Marshal, supported by executive mandates. However human behaviour remained an issue on occasion. In these instances, the behaviour was escalated to management to be addressed.

There are limitations to the generalizability of study. Although the process used was systematic and evidence based, it was context specific. Interventions to improve compliance in other EDs would require conduct of a similar process to obtain relevant information and suitable strategy.

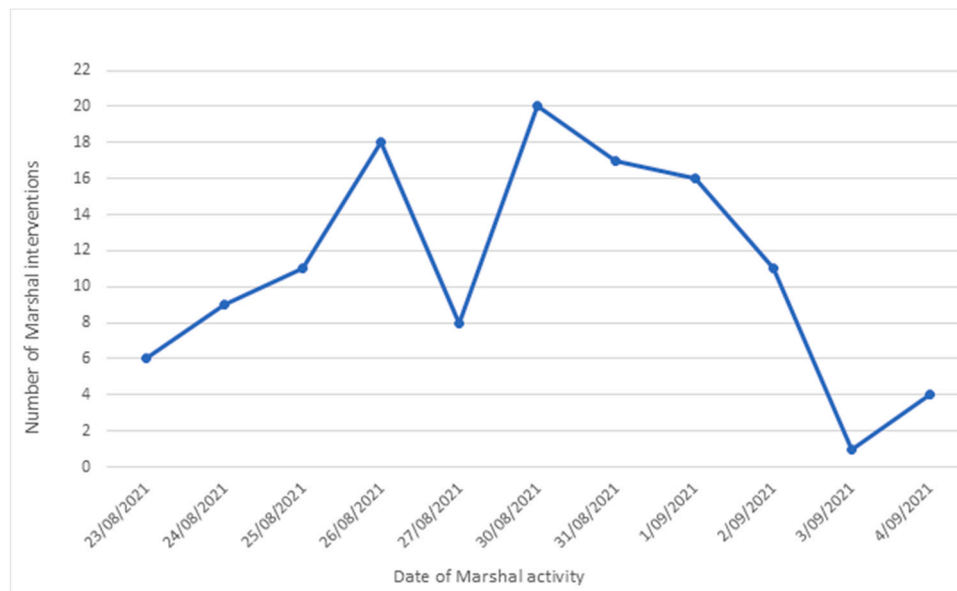


Fig. 5. The number of PPE marshal interventions over the two-week period.

Conclusion

Behaviour change theory and interventions can be applied and actioned efficient in time critical situations. The implementation of a PPE Marshal resulted improved PPE use and compliance for safe practice but was not without challenges. Staff require enabling, access to equipment and reinforcement to use PPE correctly.

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Provenance and Conflicts of Interest

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.auec.2022.01.004](https://doi.org/10.1016/j.auec.2022.01.004).

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