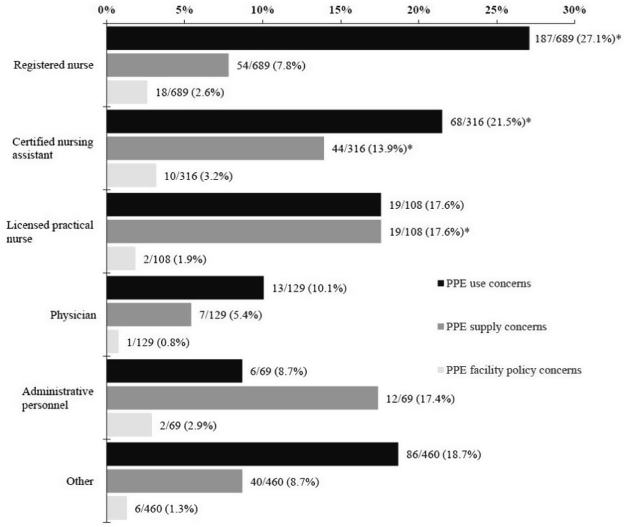
Figure 2. Personal protective equipment (PPE) concerns reported by HCP cases with close contact with COVID-19 patients, stratified by healthcare role, April 2020–January 2021



* p<0.05 using mid-P or Fisher exact test when compared with the percentage of physician cases reporting the same PPE concern type

Conclusions: Although lower percentages of HCP cases overall reported PPE concerns after the first US peak, our results highlight the importance of developing capacity to produce and distribute PPE during times of increased demand. The difference we observed among selected groups of cases may indicate that PPE access and use were more challenging for some, such as nonphysicians and nursing home HCP. These findings underscore the need to ensure that PPE is accessible and used correctly by HCP for whom use is recommended.

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Improved assay for detecting SARS-CoV-2 from nonporous hospital surfaces using surrogate human coronavirus OC43

Lisa Tran; William Furin; Geun Woo Park; Martinique Edwards and Carrie Whitworth

Background: Understanding SARS-CoV-2 persistence on surfaces can help inform transmission risk from surfaces in healthcare and community settings. A sensitive viral infectivity assay is crucial for the detection of infective virus in environmental investigations. The conventional cell culture-based infectivity assay is limited by the time dependence, subjectivity, and insensitivity of cytopathic effect (CPE) scoring. We validated an integrated cell-culture and reverse-transcription quantitative RT-PCR method (cc-RT-qPCR) to improve SARS-CoV-2 detection and reduce detection time. We compared cc-RT-qPCR with CPE-scored cell culture to evaluate assay sensitivity of recovered virus from stainless-steel coupons simulating nonporous healthcare surfaces. **Method:** Human ß-coronavirus OC43, a model strain for SARS-CoV-2, was propagated on HRT-18G cells in growth medium at 33°C in a 5% CO_2 incubator. The OC43 infectivity was determined by cell culture with a 10-fold dilution series of viral samples in 96-well plates, and incubation for 7 days at 33°C to confirm CPE. Plates were CPE-scored and TCID50 was calculated using the Reed-Muench method. For the cc-RT-qPCR assay, CPE-negative wells were interrogated for viral intracellular replication using RT-PCR; infectivity was based on a titer increase of ≥ 2 logs 7 days after inoculation using RT-qPCR. CPE-positive or replicative virus-harboring cells were enumerated to determine $TCID_{50}$. The sensitivity of both CPE-scored cell culture and cc-RT-qPCR assays were evaluated by inoculating 105 $TCID_{50}$/mL OC43 in infection media and artificial saliva matrices onto coupons and dried in an environmental chamber at 26°C and 57% relative humidity for 6 hours. Viral eluates from coupons served as test samples. **Results:** Low-titer infectious OC43 (0.75 log10) was detected by both methods 7 days after incubation; however, infectivity confirmation required 4 and 6 days after incubation, respectively, for cc-RT-qPCR and CPE-scored cell culture methods. When cells were inoculated with OC43 at titer range 1.75–4.75 log_{10}, CPE presented at 4–5 days after incubation, while viral replication was already detected at 3 days after incubation via RT-PCR. Upon virus titration, cc-RT-qPCR demonstrated greater sensitivity, detecting up to 1 log_{10} higher of infectious OC43 than cell culture alone at 0 and 6 hours ($P \leq .05$) dried in infection medium and 0 hours ($P \leq .05$) in saliva. **Conclusions:** Our data demonstrated greater sensitivity and shorter times to detect viral replication by cc-RT-qPCR, minimizing potential for false-negative results with cell culture alone. This sensitive assay may provide investigators with quicker results for informing infection control practices to reduce risk of transmission from deposited bodily fluids on surfaces, eg, coughing and sneezing.

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Work system factors affecting COVID-19 PPE use: A human factors approach to analysis of video recordings of emergency department clinical work

Esosa Nosakhare; Shawna Perry; Susan Peterson; Frankie Catalfumo; Kelly Osei, Kelly Williams; Maia Bradley; Marium Sultan; Oluseyi Daodu; Nivedha Prabhu and Ayse Gurses

Background: The effectiveness of PPE in preventing self-contamination of healthcare workers (HCWs) and transmission of pathogens (airborne and contact) in the emergency department (ED) is highly dependent on consistent, appropriate use of and other interactions (eg, storing, cleaning, etc) with the PPE. Pre–COVID-19 studies focused primarily on individual HCW contributions to incorrect or suboptimal PPE use. We conducted an analysis of ED video recordings using a human-factors engineering framework (ie, The Systems Engineering Initiative for Patient Safety, SEIPS), to identify work-system–level contributions to inappropriate PPE usage by HCWs while they provide care in their actual clinical care environment. **Methods:** In total, 47 video sessions (each ~15 minute) were recorded between June 2020 and May 2021 using a GoPro camera in an 8-bed pod area, designated for persons under investigation (PUI) and confirmed COVID-19–positive patients, in an ED of a large, tertiary-care, academic medical center. These recordings captured a 'landscape view': 2 video cameras were set up to capture the entire ED pod area and HCWs as they provided care. A team with hemorrhagic fever expertise, infection prevention and control expertise, and ED expertise reviewed each video together and extracted data using a semistructured form. **Results:** Guided by the 5 components of the SEIPS work system model, (ie, task, physical environment, person, organization, tools and technology), multiple work system failure points influencing HCWs appropriate use of PPE were identified. For example, under the task component, HCWs were observed not doffing and donning in recommended sequence. Also, inconsistencies with COVID-19 status signage on a patient's door and ambiguous labelling of work areas designated as clean (donning) and dirty (doffing) sites acted as a barrier to appropriate PPE use under the physical

environment section. **Conclusions:** Human factors–based analysis of video recordings of actual ED work identified a variety of work system factors that impede appropriate or correct use of PPE by HCWs. Future efforts to improve appropriate PPE use should focus on eliminating or mitigating the effects of these work system factors.

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Work system barriers to & resilience strategies for COVID-19 PPE use in the emergency department: A qualitative interview study

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Background: Emergency departments (EDs) are complex, sociotechnical, high-paced, safety-critical work systems that have been disproportionately affected by the COVID-19 pandemic. Despite training, consistent compliance with recommended PPE use during COVID-19 pandemic has been challenging. Healthcare workers (HCWs) have had adapt to overcome these challenges to ensure their own safety and patient safety. We sought to identify barriers in the work system that impede the recommended COVID-19 PPE use in EDs. **Methods:** We conducted semistructured, in-depth interviews over ZoomTM from August 2020–May 2021 with 45 HCWs from the ED (ie, physicians, nurses, ancillary support staff, etc) affiliated with a large, tertiary-care, academic medical center. These audio-recorded interviews were transcribed and analyzed using a hybrid (inductive and deductive) qualitative coding approach in NVivo software. The deductive portion was guided by the SEIPS work system model, a well-known human-factors conceptual framework. **Results:** We identified multiple work-system factors in the ED that impede compliance with the recommended COVID-19 PPE use. In addition, ED HCWs have reported making a variety of adaptations or developing strategies to overcome these barriers. Some of these adaptations were made to the PPE physically (eg, trimming portions of PPE), and others were related to the tasks and/or processes associated with PPE, such as filming their own training video demonstrating PPE donning and doffing techniques, and environment services staff checking a patient's status with nurses prior to entering the patient's room when there was no COVID-19 signage on the door. **Conclusions:** Consistent compliance with COVID-19 PPE use in ED clinical practice is challenging and can be negatively affected by a variety of work system factors. Resilience strategies developed by HCWs can provide critical information with regards to HCW needs and potential directions for innovation. Future efforts should focus on not only changing individual HCW behavior through training but also on improving the PPE and ED work system design.

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Disclosures: The authors gratefully acknowledge the US CDC for funding this work. This material is based upon work supported by the Naval Sea Systems Command (under contract no. N00024-13-D-6400, task order NH076). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Naval Sea Systems Command (NAVSEA) or the US CDC.

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Analysis of Universal admission laboratory screening for SARS-CoV-2 asymptomatic infection across a large health system

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Background: Admission laboratory screening for asymptomatic COVID-19 has been utilized to mitigate healthcare-associated SARS-CoV-2 transmission. A better understanding of the impact of such testing across a variety of patient populations is needed. **Methods:** Beginning April 2020, every patient admitted within an academic healthcare system underwent SARS-CoV-2 PCR testing upon admission. Between April 20, 2020 through June 14, 2021, results were analyzed in asymptomatic patients across 4 inpatient facilities: a tertiary-care adult hospital, a free-standing pediatric hospital, a community-based hospital, and a behavioral health hospital. Positivity rates and the number needed to test (NNT) to identify 1 asymptomatic infected patient were calculated overall, by hospital type, by patient vaccination status, and by CDC-defined levels of community transmission. Weekly community incidence rates of COVID-19 for the system's metropolitan service area (8 central Tennessee counties) were obtained from Tennessee Department of Health records. Weekly COVID-19 incidence rates per 100,000 people were calculated using US Census Bureau data. Using a national survey of hospital epidemiologists, a clinically meaningful NNT was identified (ie, 1 positive patient per 100 patients tested). A crude admission testing cost (covering testing supplies, reagents, and lab personnel costs) was obtained from operational data ($50 per test) to assess testing utility. **Results:** In total, 51,187 tests were collected during the study period with a positivity rate of 1.8%. No periods of low transmission were observed (Table 1). During high transmission periods, the NNT met the clinically relevant threshold in all populations. In addition, the NNT approached or met the 1:100 threshold for most locations during periods of less transmission, suggesting continued benefit even as infection rates decline. In all transmission periods, the NNT for non–fully vaccinated patients met the clinically meaningful threshold, in contrast to testing of fully vaccinated patients (Table 2). **Discussion:** Implementing an asymptomatic patient admission testing program can provide clinically relevant

Table 1. Admission Testing for SARS-Cov-2 Infection in Hospitalized Patients at a Large Health System, Overall and by Specific Patient Populations Tested

		All Transmission Periods (n=60 weeks)	Moderate Transmission Periods (n=7 weeks)	Substantial Transmission Periods (n=13 weeks)	High Transmission Periods (n= 40 weeks)
All Hospitals Combined	Total # Tests Collected	51,187	5,173	10,978	35,036
	# Positive (%)	946 (1.8%)	52 (1.0%)	99 (0.9%)	795 (2.3%)
	NNT	54	99	111	44
	Total Test Costs	$2,559,350	$258,650	$548,900	$1,751,800
	Cost to Detect 1 Positive Patient	$2,700	$4,950	$5,550	$2,200
Tertiary Care Adult Hospital	Total # Tests Collected	35,962	3,740	7,888	24,334
	# Positives (%)	684 (1.9%)	36 (1.0%)	79 (1.0%)	569 (2.3%)
	NNT	53	104	100	43
	Total Test Costs	$1,798,100	$187,000	$394,400	$1,216,700
	Cost to Detect 1 Positive Patient	$2,650	$5,200	$5,000	$2,150
Pediatric Hospital	Total # Tests Collected	7,892	692	1,654	5,546
	# Positives (%)	113 (1.4%)	9 (1.3%)	10 (0.6%)	94 (1.7%)
	NNT	70	77	165	59
	Total Test Costs	$394,600	$34,600	$82,700	$277,300
	Cost to Detect 1 Positive Patient	$3,500	$3,850	$8,250	$2,950
Behavioral Health Hospital	Total # Tests Collected	2,505	239	466	1,800
	# Positives (%)	23 (0.9%)	2 (0.8%)	0	21 (1.2%)
	NNT	109	120	n/a	86
	Total Test Costs	$125,250	$11,950	$23,300	$90,000
	Cost to Detect 1 Positive Patient	$5,450	$6,000	n/a	$4,300
Community Hospital	Total # Tests Collected	4,828	502	970	3,356
	# Positives (%)	126 (2.6%)	5 (1.0%)	10 (1.0%)	111 (3.3%)
	NNT	38	100	97	30
	Total Test Costs	$241,400	$25,100	$48,500	$167,800
	Cost to Detect 1 Positive Patient	$1,900	$5,000	$4,850	$1,500

NNT: number needed to test to identify 1 positive patient