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Evaluation of a Virtual Training to Enhance Public Health Capacity for COVID-19 Infection Prevention and Control in Nursing Homes

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ABSTRACT

Context: Between April 2020 and May 2021, the Centers for Disease Control and Prevention (CDC) awarded more than $40 billion to health departments nationwide for COVID-19 prevention and response activities. One of the identified priorities for this investment was improving infection prevention and control (IPC) in nursing homes.

Program: CDC developed a virtual course to train new and less experienced public health staff in core healthcare IPC principles and in the application of CDC COVID-19 healthcare IPC guidance for nursing homes.

Implementation: From October 2020 to August 2021, the CDC led training sessions for 12 cohorts of public health staff using pretraining reading materials, case-based scenarios, didactic presentations, peer-learning opportunities, and subject matter expert–led discussions. Multiple electronic assessments were distributed to learners over time to measure changes in self-reported knowledge and confidence and to collect feedback on the course. Participating public health programs were also assessed to measure overall course impact.

Evaluation: Among 182 enrolled learners, 94% completed the training. Most learners were infection preventionists (42%) or epidemiologists (38%), had less than 1 year of experience in their health department role (75%), and had less than 1 year of subject matter experience (54%). After training, learners reported increased knowledge and confidence in applying the CDC COVID-19 healthcare IPC guidance for nursing homes (≥81%) with the greatest increase in performing COVID-19 IPC consultations and assessments (87%). The majority of participating programs agreed that the course provided an overall benefit (88%) and reduced training burden (72%).

Discussion: The CDC's virtual course was effective in increasing public health capacity for COVID-19 healthcare IPC in nursing homes and provides a possible model to increase IPC capacity for other infectious diseases and other healthcare settings. Future virtual healthcare IPC courses could be enhanced by tailoring materials to health department needs, reinforcing training through applied learning experiences, and supporting mechanisms to retain trained staff.

KEY WORDS: capacity, infection prevention, nursing homes, public health, training

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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The Coronavirus Disease 2019 (COVID-19) pandemic created an unprecedented demand for public health staff with infection prevention and control (IPC) expertise[1-3] to respond to COVID-19 outbreaks across the United States. This includes outbreaks in high-risk healthcare settings such as nursing homes, which were severely impacted by SARS-CoV-2 transmission.[4,5] To increase US public health capacity for COVID-19 prevention and response, between April 2020 and May 2021, the Centers for Disease Control and Prevention (CDC) awarded more than $40 billion to 64 state, territorial, and local health department recipients through the Epidemiology and Laboratory Capacity Cooperative Agreement.[6] This emergency funding was a significant investment, especially given the decline in the US public health workforce in the years preceding the COVID-19 pandemic.[7] It also contributed to increased hiring across health departments, including within the CDC-funded Healthcare-Associated Infections and Antibiotic Resistance (HAI/AR) Programs in all 50 states, 5 local jurisdictions (Chicago, Houston, Los Angeles County, New York City, and Philadelphia), and the District of Columbia.[6]

As HAI/AR Programs form the cornerstone of public health prevention and response activities for HAIs and AR pathogens in healthcare settings, newly hired staff require knowledge and expertise in healthcare IPC to provide effective guidance and technical consultation.[8,9] Developing healthcare IPC expertise to prevent and respond to COVID-19 in nursing homes was a priority for HAI/AR Programs due to the vulnerable patient population and burden of infections.[4,5] However, despite the influx of emergency funding to support hiring for COVID-19 activities, descriptions of methods to effectively scale up capacity among the public health workforce were limited at the onset of pandemic and did not include methods for specialty areas such as healthcare IPC.[10-13] As the COVID-19 pandemic progressed, scaling up healthcare IPC capacity became even more challenging as public health resources were overextended across different response activities.[1,2] Capacity-building initiatives were also complicated by the variability in education, professional training, experience, and job roles among the public health workforce[1,2,14,15] and by other limitations such as organizational support, time, funding, competing priorities, location of staff, and staff turnover.[1,10,11] In combination, these factors limited in-person training opportunities and created an opportunity to address the needs of the HAI/AR Program workforce using a virtual training approach.

To enhance public health capacity to support COVID-19 healthcare IPC in nursing homes, CDC developed a virtual course to train HAI/AR Program staff in core healthcare IPC principles and in the application of the CDC COVID-19 healthcare IPC guidance for nursing homes. In this report, we describe the development and implementation of the COVID-19 IPC 101 for HAI/AR Programs (COVID IPC 101) course, its impact on learners and participating HAI/AR Programs, and the potential for application of lessons learned to other healthcare IPC capacity-building initiatives for the public health workforce.

Methods

Virtual training development and implementation

To inform the delivery of training content to support HAI/AR Programs in providing healthcare IPC guidance and technical consultation to nursing homes for COVID-19, in July 2020, the CDC conducted 7 key informant interviews with HAI/AR Programs in Florida, Kansas, Maryland, Missouri, Montana, Oregon, and Vermont. Based on these programs' feedback, the CDC identified new and less experienced HAI/AR Program staff as the target audience for training and developed the virtual COVID IPC 101 course using small- to medium-sized cohorts to maximize discussion opportunities among learners. Sessions were designed to focus on the application of interim CDC COVID-19 healthcare IPC guidance for nursing homes[16] using pretraining reading materials, case-based scenarios, didactic presentations, peer-learning opportunities, and subject matter expert (SME)-led discussion. Prior to implementation, the course curriculum was reviewed by the CDC SMEs and HAI/AR Program reviewers to ensure that the training content was appropriate for the target audience.

Between October 2020 and May 2021, learners in cohorts 1 to 6 were trained using a 5-week curriculum (Table 1). To meet the demand to rapidly train additional HAI/AR Program staff, feedback from these learners was used to condense the curriculum from 5 to 3 weeks. Learners in cohorts 7 to 12 were then trained using a condensed curriculum between June 2021 and August 2021. All training sessions were led by 1 or more CDC SMEs and conducted using videoconferencing software to facilitate group discussion. Across cohorts 1 to 12, learners were required to attend all live virtual training sessions and to review self-study materials, including pretraining reading materials summarizing relevant healthcare IPC guidance for nursing homes. Learners were also encouraged to perform 2 on-site and 2 remote COVID-19 IPC assessments[17] in nursing homes within 4 weeks of course completion.

TABLE 1
CDC COVID IPC 101 5-wk Virtual Public Health Training Curriculum

COVID IPC 101 Session Descriptions and COVID-19 Healthcare IPC topics[a,b]					
Week	**Session Title**	**Session Description**	**COVID-19 Healthcare IPC Topics**	**Hours**	**Self-Study Materials**
1	COVID-19 Nursing Home Case-Based Learning Part I	Learners practice application of healthcare IPC principles and CDC COVID-19 healthcare IPC guidance in realistic nursing home case-based scenarios.	• Hand hygiene • Environmental cleaning and disinfection • PPE optimization strategies • Discontinuation of transmission-based precautions • Healthcare personnel return-to-work criteria	1.5	Pretraining reading materials: • Fundamental healthcare IPC guidance concepts • Interim CDC IPC recommendations for healthcare personnel during the COVID-19 pandemic
2	COVID-19 Nursing Home Case-Based Learning Part II	Learners practice application of healthcare IPC principles and CDC COVID-19 healthcare IPC guidance in realistic nursing home case-based scenarios.	• Using COVID-19 data for action • Viral testing strategies during outbreaks • Point-of-care antigen testing • Resident cohorting strategies	1.5	Pretraining reading materials: • CDC IPC guidance for preparing for and responding to COVID-19 in nursing homes
3	Conducting Remote COVID-19 IPC Assessments in Nursing Homes	CDC SMEs review fundamentals of conducting prevention-based, remote IPC assessments in nursing homes.	• Introduction to remote COVID-19 IPC assessments • Remote IPC assessment process • Documenting IPC observations • Providing IPC feedback to nursing home staff • Tips and tricks for performing remote IPC assessments	1.5	Pretraining reading materials: • CDC Infection Prevention and Control Assessment Tool for Nursing Homes Preparing for COVID-19 Prerecording[c]: Training video on conducting remote COVID-19 IPC assessments in nursing homes

(*continues*)

TABLE 1
CDC COVID IPC 101 5-wk Virtual Public Health Training Curriculum (*Continued*)

COVID IPC 101 Session Descriptions and COVID-19 Healthcare IPC topics[a,b]

Week	Session Title	Session Description	COVID-19 Healthcare IPC Topics	Hours	Self-Study Materials
4	Conducting On-site COVID-19 IPC Assessments in Nursing Homes	CDC SMEs review fundamentals of conducting response-based, on-site IPC assessments in nursing homes.	• Introduction to on-site COVID-19 IPC assessments • On-site IPC assessment process • Documenting IPC observations • Providing IPC feedback to nursing home staff • Tips and tricks for performing on-site IPC assessments	1.5	Pretraining reading materials: • Conducting on-site COVID-19 IPC assessments in nursing homes
5	COVID-19 Nursing Home Tabletop Exercise	Learners complete a culminating exercise covering the fundamentals of COVID-19 prevention and response in nursing homes.	• Prioritizing COVID-19 prevention and response activities • Communicating with nursing home leadership and healthcare personnel • Conducting remote and on-site COVID-19 IPC assessments • Providing technical assistance to ensure COVID-19 IPC gap mitigation	2.0	None

Abbreviations: CDC, Centers for Disease Control and Prevention; IPC, infection prevention and control; PPE, personal protective equipment; SMEs, subject matter experts.

[a] *The 5-week training curriculum was implemented for cohorts 1 to 6 from October 2020 to May 2021. From June 2021 to August 2021, a condensed 3-week curriculum was utilized for cohorts 7 to 12. Weeks 1 and 2 and weeks 3 and 4, respectively, were combined into 2 separate, 2-hour sessions in the 3-week curriculum.*

[b] *All learners were encouraged to conduct 2 remote and 2 on-site IPC assessments in nursing homes within 4 weeks of course completion.*

[c] *A prerecorded training video on conducting remote COVID-19 IPC assessments in nursing homes was provided for cohorts 3 to 12.*

Learner enrollment

During initial enrollment, the CDC requested contact information for 2 training nominees from each of the 50 state and 6 local CDC-funded HAI/AR Programs (including District of Columbia). An electronic registration survey was then distributed to collect information on the healthcare IPC experience level of each nominee. Nominees with a self-rated experience level of "none" to "approaching proficiency" and a high likelihood of performing COVID-19 IPC consultations and assessments in nursing homes within the next 3 to 6 months were prioritized for enrollment in cohorts 1 to 6. Nominees not meeting these criteria were subsequently enrolled in cohorts 7 to 12. Throughout implementation, the maximum cohort size (10 to 17 learners) and number of eligible training nominees from each CDC-funded HAI/AR Program were adjusted to meet evolving HAI/AR Program training needs. Select enrollment opportunities were also offered to staff in local health departments without CDC-funded HAI/AR Programs based on state HAI/AR Program input and cohort space availability. Participation in training was voluntary and subject to HAI/AR Program manager or other supervisory approval.

Evaluation framework

An evaluation framework was established prior to implementation to measure the impact of the training at 2 levels: (1) individual learners and (2) HAI/AR Programs. For learners, we assessed self-reported knowledge and confidence in key COVID-19 healthcare IPC metrics and collected quantitative and qualitative feedback on the course curriculum and format. This included the use of a single precourse assessment distributed the week before the launch of each cohort and 2 postcourse assessments, 1 distributed immediately and 1 distributed 6 months following course completion, using REDCap.[18] Learners received up to 3 separate email reminder notifications for each assessment type to request assessment completion. The HAI/AR Program managers of enrolled learners also received an assessment 1 year following training inception to measure the overall impact of the course on their programs. This activity was reviewed at the CDC and was conducted consistent with applicable federal law and CDC policy (45 CFR part 46, 21 CFR part 56; 42 USC §241(d); 5 USC§552a; 44 USC §3501 et seq). This activity was deemed not to be research, and institutional review board review was not required.

Data analysis

The number of learners enrolled and who completed training were calculated and described by cohort, health department representation (ie, CDC-funded state or local, including District of Columbia, HAI/AR Program), and select demographics. The proportion of learners who completed the precourse assessment, immediate postcourse assessment, and 6-month postcourse assessment was calculated, and course evaluation metrics were presented for learners who completed the immediate postcourse assessment and the 6-month postcourse assessment. Where appropriate, open-ended responses in these assessments were qualitatively coded into major themes and tabulated. The proportions of learners reporting increased knowledge and confidence in CDC COVID-19 healthcare IPC guidance and confidence in performing COVID-19 IPC consultations and assessments in nursing homes from precourse assessment to immediate postcourse assessment were calculated. Finally, course impact measures reported by participating HAI/AR Programs were summarized. All data were analyzed using SAS statistical software, Version 9.4 (SAS Institute Inc, Cary, North Carolina).

Results

Course enrollment and training completion

A total of 182 learners were enrolled: 165 (91%) from 40 state and 4 local CDC-funded HAI/AR Programs and 17 (9%) from 16 local health departments without HAI/AR Programs. Overall, 81 (45%) learners were enrolled in the 5-week curriculum (cohorts 1 to 6) and 101 (55%) in the condensed 3-week curriculum (cohorts 7 to 12). Of those enrolled, 171 (94%) completed training, 80 in cohorts 1 to 6 and 91 in cohorts 7 to 12.

Characteristics of learners who completed training and the precourse assessment

Demographic data were available for 170 of 171 (99%) learners who completed training and the precourse assessment. Eighty percent of learners represented state CDC-funded HAI/AR Programs, 10% represented local CDC-funded HAI/AR Programs, and 10% represented local health departments without CDC-funded HAI/AR Programs. Most learners were infection preventionists (42%) or epidemiologists (38%), had less than 1 year of experience in their health department roles (75%), and had less than 1 year of experience in HAI or IPC subject matter (54%). Seventy-seven percent of learners self-rated their healthcare IPC experience in nursing homes as "none" to "approaching proficiency," and only 35% had independently led at least 1 on-site or remote COVID-19 IPC assessment prior to training

(see Supplemental Digital Content Table, available at http://links.lww.com/JPHMP/B25, which describes characteristics of learners who completed training).

Immediate postcourse assessment and 6-month postcourse assessment findings

Of the 171 learners who completed training, 149 (87%) completed the immediate postcourse assessment, and 73 (43%) completed the 6-month postcourse assessment. In the immediate postcourse assessment (N = 149), 91% of learners reported that the course consisted of the "right amount of lecture and interaction," 88% found the pretraining reading materials to be "very" or "extremely helpful," 89% found the course content to be "very" or "extremely relevant," and 88% reported that they "definitely will use" the course content. However, a small proportion of learners (5%) suggested the inclusion of more case-based learning scenarios that were focused on jurisdiction-specific needs and the required, instead of encouraged, participation in a remote or on-site COVID-19 IPC assessment (5%) by the end of the course. In the 6-month postcourse assessment (N = 73), more than 90% of learners found the course content to be "very" or "extremely relevant" (Table 2).

A small number of learners in both the immediate and 6-month postcourse assessments (7% and 3%) reported needing further training in the subject matter, and some learners also reported not being provided opportunities to implement what they learned (eg, to perform remote or on-site COVID-19 IPC assessments in nursing homes) (7% and 18%). In open-ended feedback, case-based learning and peer-learning were reported as the most helpful aspects of the course in both the immediate postcourse assessment (19% and 14%) and the 6-month postcourse assessment (14% and 14%) (Table 2).

Change in self-reported knowledge and confidence from precourse assessment to immediate postcourse assessment

Learners who completed both the precourse assessment and the immediate postcourse assessment (N = 149) reported increased knowledge and confidence in applying the CDC COVID-19 healthcare IPC guidance for nursing homes immediately following course completion (≥81%), with the greatest increase in performing COVID-19 IPC consultations and assessments (87%) (Table 3). The number of learners who had led at least 1 on-site or remote COVID-19 IPC assessment also increased by 32% (60-79) from precourse assessment to immediate postcourse assessment.

Impact on participating HAI/AR Programs

Among 39 CDC-funded HAI/AR Program managers assessed 1 year following training inception, responses were received from 32 (82%), including 29 state and 3 local managers. Eighty-eight percent of these managers agreed that the course provided an overall benefit to their programs, with the most agreement for increasing the number of staff who were knowledgeable in the CDC COVID-19 healthcare IPC guidance for nursing homes (94%). Seventy-two percent also agreed that the course provided relief to existing personnel due to reduced training burden (Table 4). These managers also represented 120 of 171 (70%) learners who completed training, and they reported that 112 (93%) learners were still working in the health department 1 year following training inception.

Discussion

Challenges in scaling up workforce capacity among state and local public health department staff were common prior to the COVID-19 pandemic and have been noted during previous public health emergencies.[1,10,13] Identifying methods to increase the number of public health professionals capable of responding to emerging health threats is also included as part of national public health objectives,[19] and the COVID-19 pandemic only reinforced its importance. In particular, methods to enhance healthcare IPC capacity among the public health workforce were needed to ensure that health department staff were prepared to support nursing homes in preventing and responding to the high incidence of COVID-19,[4,5] as nursing homes commonly experience high healthcare personnel turnover and lack time and other resources for IPC training.[20] Evaluation findings suggest that the CDC's virtual *COVID IPC 101* course was effective in increasing knowledge and confidence among new or less-experienced HAI/AR Program staff in supporting COVID-19 healthcare IPC for nursing homes.

Although most learners who participated in *COVID IPC 101* were new to their current health department roles or had less than 1 year of HAI or IPC experience, they were serving in roles providing healthcare IPC guidance and technical consultation to nursing homes. In addition, few learners had led on-site or remote IPC assessments prior to training, reflecting how education, experience, and role can fail to align with public health job responsibilities, particularly for specialized subject areas.[1,2,14,15] Although nearly all learners were from state or local CDC-funded HAI/AR Programs, we were also able to enroll a small proportion of learners from local

TABLE 2
CDC COVID IPC 101 Course Evaluation Feedback Reported by Learners Who Completed Training (N = 171)

Course Evaluation Metric	Immediate Postcourse Assessment[a] (149, 87%) n (%)	Six-Month Postcourse Assessment[b] (73, 43%) n (%)
How would you describe the balance of lecture and interaction in the course?		
Right amount of lecture and interaction	136 (91)	. . .
Too much lecture and not enough interaction	7 (5)	. . .
Too much interaction and not enough lecture	6 (4)	. . .
Do you plan to use the course content in your current work?		
Definitely not	0 (0)	. . .
Probably not	0 (0)	. . .
Possibly	3 (2)	. . .
Probably will	15 (10)	. . .
Definitely will	131 (88)	. . .
How helpful were the course pretraining reading materials?[c]		
Not helpful	0 (0)	. . .
Slightly helpful	3 (2)	. . .
Moderately helpful	14 (9)	. . .
Very helpful	75 (50)	. . .
Extremely helpful	57 (38)	. . .
How relevant was the course content to your current work?[c]		
Not relevant	0 (0)	0 (0)
Slightly relevant	1 (1)	3 (4)
Moderately relevant	14 (9)	4 (5)
Very relevant	29 (19)	23 (32)
Extremely relevant	105 (70)	43 (59)
Top 3 recommendations to improve the effectiveness of the course content[d,e]		
No response	44 (30)	. . .
No improvements needed	25 (17)	. . .
More case-based scenarios focused on state/local health department needs	8 (5)	. . .
Required participation in a remote or on-site IPC assessment as part of course	8 (5)	. . .
Have any barrier(s) prevented you from applying the course content to your current work?[d]		
No reported barriers	106 (71)	47 (64)
I need additional training in the subject matter	11 (7)	2 (3)
I will not be provided opportunities to use what I learned (eg, to perform remote/on-site COVID-19 IPC assessments in nursing homes)	10 (7)	13 (18)
Other reasons will keep me from using what I learned	9 (6)	7 (10)
I will not have the time to use what I learned	5 (3)	6 (8)
I will not have the resources I need	3 (2)	1 (1)
My state/local policies will not support me in using what I learned	2 (1)	0 (0)
My supervisor will not support me in using what I learned	2 (1)	1 (1)
Which aspect(s) of the course were most helpful to your learning?[d,e]		
No response	43 (29)	39 (53)
Case-based learning	29 (19)	10 (14)
Peer learning	21 (14)	10 (14)
Level of interactivity	19 (13)	2 (3)
Focus on CDC COVID-19 healthcare IPC guidance	12 (8)	7 (10)
SME-led discussion	11 (7)	5 (7)

(*continues*)

TABLE 2
CDC COVID IPC 101 Course Evaluation Feedback Reported by Learners Who Completed Training (N = 171) (*Continued*)

Course Evaluation Metric	Immediate Postcourse Assessment[a] (149, 87%) n (%)	Six-Month Postcourse Assessment[b] (73, 43%) n (%)
Remote COVID-19 IPC assessment tips/tricks	10 (7)	2 (3)
Pretraining reading materials	9 (6)	1 (1)
Everything was helpful	9 (6)	7 (10)
On-site COVID-19 IPC assessment tips/tricks	8 (5)	1 (1)
Prerecorded materials	2 (1)	0 (0)

Abbreviations: CDC, Centers for Disease Control and Prevention; IPC, infection prevention and control; SME, subject matter expert.

[a] Immediate postcourse assessments were distributed on a rolling basis to learners immediately following course completion (December 2020 to August 2021).

[b] Six-month postcourse assessments were distributed on a rolling basis to learners 6 months following course completion (May 2021 to February 2022).

[c] Percentages for some responses may not add to 100% due to rounding.

[d] Completion of this question was not required. Learner responses were not mutually exclusive, and therefore percentages will not add to 100%.

[e] Open-ended responses were qualitatively coded into major themes and tabulated.

TABLE 3
Change in Self-Reported COVID-19 Healthcare IPC Knowledge and Confidence for Nursing Homes From Precourse Assessment to Immediate Postcourse Assessment by Cohort and Overall

COVID-19 Healthcare IPC Knowledge and Confidence Metrics	Cohorts 1-6[a] (N = 74, 50%) n (%)	Cohorts 7-12[b] (N = 75, 50%) n (%)	Overall (N = 149, 100%) n (%)
Increased knowledge in CDC COVID-19 healthcare IPC guidance for nursing homes	54 (73)	69 (92)	123 (83)
Increased confidence in applying CDC COVID-19 healthcare IPC guidance for nursing homes	55 (74)	66 (88)	121 (81)
Increased confidence in performing COVID-19 IPC consultations and assessments in nursing homes	67 (91)	62 (83)	129 (87)

Abbreviations: CDC, Centers for Disease Control and Prevention; IPC, infection prevention and control.

[a] Cohorts 1 to 6 were trained using a 5-week curriculum.

[b] Cohorts 7 to 12 were trained using a 3-week curriculum.

TABLE 4
CDC COVID IPC 101 Impact Measures Reported by HAI/AR Program Managers 1 Year Following Training Inception (N = 32)[a]

HAI/AR Program Impact Measures "The CDC COVID IPC 101 Course . . . "	HAI/AR Program Manager Responses[b] Agree n (%)	Disagree n (%)	Unable to Answer n (%)
Increased the number of staff who were knowledgeable in CDC COVID-19 healthcare IPC guidance for nursing homes	30 (94)	1 (3)	1 (3)
Contributed to increasing the number of staff who could independently perform COVID-19 IPC consultations and assessments in nursing homes	27 (84)	3 (9)	2 (6)
Contributed to reduced time training staff to perform COVID-19 IPC assessments and consultations in nursing homes	25 (78)	4 (13)	3 (9)
Provided relief to existing personnel due to reduced training burden	23 (72)	7 (22)	2 (6)
Did not provide an overall benefit to my HAI/AR program	3 (9)	28 (88)	1 (3)

Abbreviations: CDC, Centers for Disease Control and Prevention; HAI/AR, Healthcare-Associated Infections and Antibiotic Resistance; IPC, infection prevention and control.

[a] HAI/AR Program managers who enrolled learners in the CDC COVID IPC 101 course were contacted for feedback using an electronic assessment in October 2021. HAI/AR Programs with recent program manager turnover (n = 5) were excluded from the assessment.

[b] Percentages for some responses may not add to 100% due to rounding.

health departments without CDC-funded HAI/AR Programs. Given the expanding role and capacity of local health departments to participate in and lead HAI/AR activities,[8,9] future healthcare IPC training initiatives could also be targeted toward the local health department workforce. A virtual approach, such as the one described in this report, could be used to achieve this goal and might also facilitate training of local health department staff in rural areas.[11,21]

These findings support the utility of the *COVID IPC 101* training model in building healthcare IPC capacity. Similar to other training evaluations, the use of a virtual course curriculum, case-based and peer-learning strategies, sessions focused on the application of knowledge to practice, and the organization of learners into smaller groups to aid discussion were instrumental in building capacity through shared learning among staff.[12,21-23] Learners responded positively to the course design, finding the curriculum both balanced and useful, and to the session-specific pretraining reading materials, which likely improved the ability of less-experienced learners to actively participate in course discussions and application exercises. The course also reinforced the CDC COVID-19 healthcare IPC guidance for nursing homes using multiple formats (ie, pretraining reading materials, case-based scenarios, didactic presentations, peer-learning opportunities, and SME-led discussion) simultaneously, an approach effective in improving learner knowledge and skill.[23] In addition, the use of multiple formats gave the CDC SMEs flexibility to introduce new or updated topics (eg, COVID-19 vaccination), which kept the course content relevant and engaging for learners and helped promote the application of knowledge to practice.[24,25] It also created a low-risk environment for learners to practice addressing realistic challenges while receiving immediate feedback from SMEs and peers, techniques supported in successful capacity-building initiatives.[11,12,22,23,25] Utilizing this approach, learners had access to different perspectives and levels of healthcare IPC and nursing home expertise, which is similar to what they would experience in real-world public health practice.[11,12]

Barriers to implementing the course content were not commonly reported in either the immediate postcourse assessment or the 6-month postcourse assessment; however, a small proportion of learners did report needing further training, perhaps reflecting a need for additional training as the CDC COVID-19 healthcare IPC guidance for nursing homes continued to evolve. In addition, a few learners recommended the inclusion of more case-based scenarios tailored to state or local health department needs, which likely reflects variation among health departments in terms of composition, resources, public health authority for response activities, and staff experiences.[1,11,12,26] Although the number of learners who had led an on-site or remote COVID-19 IPC assessment increased by the end of the course, some learners in both postcourse assessments reported not having the opportunity to implement what they learned. Some also suggested that required, instead of encouraged, participation in a remote or on-site COVID-19 IPC assessment by the end of the course would improve the effectiveness of the curriculum. Although we were unable to directly organize opportunities for learners to participate in IPC assessments as part of the course, these types of real-world, applied experiences are key to building public health capacity[22,27,28] and could accompany other case-based and peer-learning experiences. Although neither jurisdictional policies nor supervisors were commonly reported as barriers to the application of course content, other researchers have noted that a broader organizational, social, or political context may impact the application of training content.[26] When feasible, HAI/AR Programs and health departments could seek to organize additional opportunities for staff to perform IPC assessments as part of healthcare IPC training initiatives.

Increases in self-reported knowledge and confidence in applying CDC COVID-19 healthcare IPC guidance for nursing homes were high for both cohorts 1 to 6 and cohorts 7 to 12, indicating that learners perceived benefit from both the 5-week and 3-week curricula. Although we did not formally evaluate differences between these approaches, the 3-week curriculum allowed for learners to be trained more rapidly and reduced the time commitment and burden on both learners and SMEs. Anecdotally, learners also reported reduced redundancy in course content and better alignment across overlapping topics, such as performing on-site and remote COVID-19 IPC assessments. Potential limitations to the 3-week curriculum included reduced time for learners to ask questions, less time for interaction among peers and SMEs, and less time for learners to practice application of individual topics in case-based scenarios. However, state and local health departments seeking to reproduce the *COVID IPC 101* training model could consider whether the 5-week or 3-week curriculum would best fit their needs and available resources. Partnering with academic institutions in training implementation could also increase access to resources such as trainers with subject matter expertise and help in the delivery of either approach.[1,11,23]

As many capacity-building evaluations primarily focus on measuring individual-level outcomes,[29] we wanted to assess the larger impact of this training model on participating HAI/AR Programs. The

majority of HAI/AR Program managers agreed that the CDC's virtual *COVID IPC 101* course benefited their programs and reduced training burden among their staff. These managers also reported that retention of trained staff remained high for more than 1 year after training inception. Although it is unlikely that staff retention was entirely due to this course, it has been noted that outbreak response capacity can diminish after public health emergencies unless mechanisms are established to retain experienced staff.[1] As a significant portion of the state and local public health workforce is projected to leave or retire in the coming years,[30,31] continued investment in the capacity established through COVID-19 is needed to ensure that the public health workforce is prepared to respond to emerging health threats across healthcare settings. In addition, to replicate training models such as this course using a train-the-trainer approach (ie, learners replicate training for other individuals),[21,32] state and local health departments would need a sustained workforce with expertise.[11,12]

The findings in this report are subject to a few limitations. In terms of training design and implementation, we were unable to cover all aspects of COVID-19 healthcare IPC for nursing homes or to share reference copies of didactic course materials with HAI/AR Programs or the broader public health community due to evolving CDC COVID-19 healthcare IPC guidance. We were also unable to enroll all learners immediately upon on-boarding within their health departments as we aimed to keep cohorts as limited in size as feasible to foster participation and active discussion among learners. In terms of the course evaluation framework, data were self-reported and thus subject to individual biases. The response rate of the 6-month postcourse assessment was also low compared with the immediate postcourse assessment and may not be representative of all learners who completed training. In addition, we were unable to formally evaluate the change in course length between cohorts 1 to 6 and 7 to 12 as evaluation efforts were already underway. Finally, increases in healthcare IPC knowledge and confidence and in the number of learners performing COVID-19 IPC assessments could also be attributed to other factors such as more time spent in health department roles by the conclusion of training or by on-the-job training as part of regular COVID-19 response duties.

As public health and HAI/AR Program workforce capacity building needs continue to evolve in response to emerging threats such as COVID-19, methods to rapidly implement and scale up healthcare IPC training are critical to prevent and respond to the transmission of infectious pathogens in healthcare settings. The evaluation findings from the CDC's virtual *COVID IPC 101* course highlight strategies for increasing COVID-19 healthcare IPC capacity in nursing homes among a subset of the US public health workforce and provide a possible model to increase IPC capacity for other infectious diseases and other healthcare settings. To enhance the effectiveness of training activities and to support jurisdictional train-the-trainer initiatives, future virtual healthcare IPC course offerings could be tailored to meet state and local health department needs, reinforced through applied learning experiences such as on-site and remote IPC assessments, and supported by mechanisms to retain experienced staff over time.

Implications for Policy & Practice

- Virtual training models could be used by state and local health departments to increase healthcare IPC capacity among public health staff for nursing homes and other healthcare settings during public health emergencies.
- The use of multiple training formats (ie, pretraining reading materials, case-based scenarios, didactic presentations, peer-learning opportunities, and SME-led discussion) can promote the translation of healthcare IPC knowledge to practice.
- To enhance the effectiveness of training activities and to support jurisdictional train-the-trainer initiatives, future virtual healthcare IPC courses could be tailored to meet state and local health department needs, reinforced through applied learning experiences, and supported by mechanisms to retain experienced staff over time.

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