GRADUATE EDUCATION

Online Simulated Cases Assess Retention of Virtual Neighborhood Tour Curriculum

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Abstract

Background Learning to identify and address social determinants of health (SDH) is a crucial component of pediatric residency training. A virtual tour of an impoverished neighborhood previously demonstrated efficacy in increasing residents' self-assessed knowledge and competence, but its impact on performance has not yet been reported. Online simulated cases are emerging as feasible assessment tools to measure trainees' skills across various healthcare settings. We developed online simulated cases to evaluate residents' retention of the virtual tour's key SDH-related learning objectives 1 month after completing this curriculum. *Methods* Three online simulated cases with interpolated open-ended questions were created to assess residents' ability to identify SDH, recommend appropriate resources, and display empathy. Scoring rubrics to objectively evaluate responses were developed and borderline scores were decided by a team of educators. *Results* 19 residents participated. Mean scores for all cases exceeded pre-established borderline scores (statistically significant in two of the three cases). More than 90% of residents identified relevant SDH in the primary care and emergency department cases. Ninety-five percent of residents recommended appropriate resources in all cases, and 89% displayed empathy. *Discussion* Residents' performance in online simulated cases demonstrated retention and application of the virtual tour's learning objectives, including recognizing SDH, offering appropriate resources, and displaying empathy, which supports the long-term effectiveness of the virtual tour curriculum to train pediatricians about SDH. Online simulated cases provided a standardized and cost-effective way to measure residents' skills related to curricular uptake, suggesting that this assessment approach may be adapted to evaluate other educational interventions.

Keywords Assessment tool · Technology for education · Online simulated cases · Social determinants of health · Neighborhood · Community resources · Empathy

The authors Francis Real and Melissa Klein have both completed the work typical of senior authorship.

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Significance

What is already known on this subject?

A virtual tour of a local impoverished neighborhood was previously implemented at our institution and increased residents' self-assessed knowledge and competence regarding social determinants of health (SDH), but the impact of this educational intervention on clinical performance has not been reported.

What this study adds?

We developed three interactive online simulated cases with interpolated open-ended questions to assess residents' retention of key learning objectives from the virtual tour curriculum. Online simulated cases offered a standardized and cost-effective way to measure curricular uptake, suggesting this assessment approach may be adapted to evaluate other educational interventions. Residents' performance

demonstrated retention and application of skills gained from the virtual tour, including identifying SDH, recommending appropriate community resources, and displaying empathy.

Introduction

Training pediatricians to identify and address social determinants of health (SDH) is critical to meet the healthcare needs of all children. Education about SDH, including how to empathetically tailor care based on neighborhood context, requires understanding the assets and barriers of patients' neighborhoods. Conditions associated with impoverished neighborhoods, including food insecurity, housing instability, parental unemployment, and educational barriers, negatively impact child health (Alaimo et al. 2001; Cutts et al. 2011; Ma et al. 2008). However, interventions targeting these social risk factors can significantly improve child health outcomes (Black et al. 2004; Frank et al. 2006). Learning to effectively assess and manage SDH is a crucial component of pediatric residency training as well as a requirement of the Accreditation Council on Graduate Medical Education's Pediatric Milestones Project (necessitating that residents be able to "communicate effectively with patients, families, and the public…across a broad range of socioeconomic and cultural backgrounds" Milestone ICS1; ACGME, ABP 2017). Furthermore, emerging evidence suggests that meaningful community pediatrics education and exposure during residency, including a focus on SDH, can increase pediatricians' future engagement in community health and advocacy following training (Lichtenstein et al. 2017; Minkovitz et al. 2013).

"Windshield" tours of local neighborhoods have been incorporated into a variety of residency curricula to enhance awareness of community resources and hardships (Kruger et al. 2013; Lichtenstein et al. 2018; Real et al. 2015), yet standardization and sustainability of these in-person experiences have been limited due to availability of community partners and safety concerns (Wilson et al. 2004). To overcome these barriers, an interactive virtual tour of a local impoverished neighborhood, which combined 360° footage of neighborhood sites with community member interviews, was implemented in the residency advocacy curriculum at our institution. The virtual tour demonstrated non-inferiority to a prior in-person experience in increasing residents' self-assessed competence identifying resources, recognizing neighborhood-related barriers to healthy outcomes, and providing tailored anticipatory guidance—highlighting the role of technology in expanding SDH training (Lazow et al. 2018).

SDH-focused educational interventions are often assessed through measurement of participants' knowledge and attitudes, but as their goal is application to patient care,

performance tests may provide a higher-level and more accurate marker of curriculum uptake (Lichtenstein et al. 2017; Miller 1990). Direct observation is a key performance-based evaluation strategy, but the required time commitment limits its feasibility. Computer-based case simulations and interactive clinical vignettes represent promising alternative approaches, offer advantages of standardization and efficiency, and have been utilized to assess trainees' skills in various medical specialties (Hawkins et al. 2004; Peabody et al. 2000). Furthermore, electronic educational platforms that enable production and dissemination of interactive online videos with interpolated questions are emerging as tools to teach and evaluate learners in different healthcare settings (Rose et al. 2016; Zhou et al. 2018).

Although improvements were described in residents' self-assessed knowledge and competence immediately following the virtual tour (Lazow et al. 2018), its impact on future clinical performance has not been reported. In this study, we developed online simulated cases as an innovative evaluation tool to measure curriculum uptake and application of skills learned during the virtual tour, including recognizing SDH, recommending appropriate resources, and displaying empathy. Our aim was to utilize online simulated cases to assess residents' performance and retention of key SDH-related learning objectives 1 month after completing the virtual tour.

Methods

Setting and Study Population

This descriptive study, conducted at Cincinnati Children's Hospital Medical Center (CCHMC), utilized a new evaluation tool to assess outcomes of an educational intervention. Participants included post-graduate year one (PGY1) pediatric residents who completed the virtual tour during their advocacy rotation (October 2017 to May 2018) and had continuity clinic at the Pediatric Primary Care Center (PPCC). The PPCC is a large, urban, academic pediatric clinic that serves as the continuity clinic site for approximately half of CCHMC residents (i.e., ~ 25 PGY1 residual annually). Residents who attend the PPCC were purposefully chosen as the intervention group because this clinic provides primary care for predominantly underserved patients (~ 90% with Medicaid), is located within the neighborhood highlighted in the virtual tour, and serves as the medical home for approximately 50% of children from this neighborhood. The virtual tour was approximately 4 h (one half-day) in duration and was completed during the required advocacy rotation, which for most residents is scheduled during intern year. The virtual tour is a critical component of our longitudinal spiral curriculum on SDH, in which SDH topics are purposefully revisited throughout residency to deepen

learners' understanding at each educational time point (Real et al. 2017). In addition to informal, hands-on exposure to SDH gained through patient encounters, PGY1 residents learn to screen for and address SDH as part of an interdisciplinary team during the advocacy course. For upper level residents, this education is supplemented with two to three 1-h long noon conferences and several brief pre-clinic teaching sessions.

The Institutional Review Board at our institution approved this study. Residents were consented prior to enrollment.

Development and Dissemination of Online Simulated Cases

Three online simulated cases were created de novo utilizing the online educational platform Vizia (https://vizia.co/). Scripts were iteratively developed and piloted by a team of educators, pediatricians, upper-level residents, and nurses with the goal of simulating realistic patient encounters to assess and compare retention of virtual tour curricular objectives across three different clinical settings [primary care, emergency department, subspecialty clinic (hematology/oncology); Table 1]. Simulated encounters were video-recorded (all under 3 min) and uploaded onto the Vizia platform. Two to four interpolated open-ended questions were integrated into each video at designated time-points during which the video paused and required a typed response (Fig. 1). After response submission, the video resumed with correct responses demonstrated by actors, reinforcing the virtual tour's learning points and providing near-immediate feedback. Participants were not allowed to change responses.

Links to the online simulated cases were sent via email to PGY1 residents 1 month after completing the virtual tour. To avoid bias, this email was sent by a physician who was not part of the virtual tour team, without mention of the virtual tour. Three email reminders were sent.

The time commitment and financial cost required for the development and dissemination of three online simulated cases were minimal. Videos were recorded on personal cellular phones, subsequently edited utilizing iMovie (Apple, Inc.), a free movie-editing software program that is easily-downloadable on Mac computers, and then uploaded onto the Vizia platform, which is free and intuitive to use. Production of three online simulated cases was accomplished in approximately 12 h total, including the time needed for video recording, editing, upload, and question insertion, and was completed by two team members who had not previously received specialized training in video-recording/editing.

Scoring Rubrics and Analysis

Scoring rubrics to evaluate responses were developed in an iterative fashion by a team of educators and pediatricians

familiar with SDH. Potential responses were divided into three performance levels based on demonstrating no retention (level 1), partial and/or general retention (level 2), or full and specific retention (level 3) of the virtual tour's curricular objectives, with points weighted accordingly (Table 2). A published assessment of empathetic communication (Bylund and Makoul 2002) provided a basis for evaluating empathy. The scoring rubrics were piloted with three upper-level residents prior to utilization.

Borderline (i.e., minimally competent) scores were decided a priori by four physicians with educational expertise using the Extended Angoff Method for standard setting (Hambleton and Plake 1995). The four raters (ML, DD, FR, MK) independently assigned scores to each question that they believed a 'borderline' candidate would need to earn to demonstrate a minimally acceptable competence level; scores were then averaged together. In order to understand variation in the assessment tool, 24 new PGY1 residents who have continuity clinic at the PPCC completed the online simulated cases during their PPCC orientation (July 2018). Since this group had not yet participated in the virtual tour, their scores were not included for statistical analysis, but were reviewed for descriptive purposes and provided additional reasoning to help inform the borderline score decisions. Specifically, the new PGY1 residents' responses were scored before the borderline cut-offs were finalized, in order to ensure the borderline scores assigned by the four physician raters were fair and appropriate (e.g., that only a minority of new PGY1 residents achieved scores at/above borderline).

Two authors (FR, DD) independently scored residents' responses. Prior to reviewing actual responses, these investigators practiced and discussed scoring sample cases until a consensus was consistently reached. Intraclass correlation coefficients (ICCs; Shrout and Fleiss ICC[2, 1] Shrout and Fleiss 1979) were used to test inter-rater reliability. One-sample t-tests were used to test whether resident scores differed from borderline. Data were de-identified and coded prior to analysis.

Results

Of 24 PGY1 residents who attended continuity clinic at the PPCC and participated in the advocacy rotation during the 2017–2018 academic year, 22 (92%) completed the virtual tour curriculum (the other 2 residents were unable to attend the virtual tour session due to coinciding clinic responsibilities). Nineteen (86%) of these 22 eligible PGY1 residents participated in the online simulated cases (mean age 27 ± 1.8 years; 79% female; 74% white, 21% Asian, 5% African-American). ICC results demonstrated good to excellent reliability between raters (case 1: 0.78, 95% confidence

Table 1 Descriptions of the content and the virtual tour curricular objectives assessed throughout the three online simulated cases

Description of each case's patient, visit focus, and clinical setting	Curricular objectives from the virtual tour that were assessed throughout each online simulated case, including example correct response		
	(A) Asking about and identifying relevant SDH	(B) Recommending specific, appropriate community resources	(C) Displaying empathy
Case 1 12 y/o female with leukemia in maintenance therapy presents to the oncology outpatient clinic, struggling with missed oral chemotherapy doses due to transportation barriers (unable to get to a pharmacy) as well as her single parent's busy work schedule	✓ • Access to a pharmacy • Transportation barriers • Financial issues • Barriers to med administration	✓ • Home-delivery of prescriptions • Transportation assistance • Care management	✓
Case 2 11 y/o obese male presents for an ill visit at the PPCC, which also involves tailored counseling about healthy diet and exercise for weight loss; the patient's family experiences food insecurity, is financially strained, and lives in a neighborhood where it is not safe to play outside	✓ • Food insecurity (access to and ability to afford fruits/vegetables) • Access to safe play/exercise	✓ • Community garden and marketplace • Food pantries • Federal food assistance • Affordable local rec center	✓
Case 3 9 y/o healthy male presents to the emergency department with a head laceration due to unsafe housing conditions in the family's rented apartment and an unresponsive landlord	✓ • Neighborhood/housing conditions • Relationship with landlord	✓ • Medical–legal partnership within the PPCC • Health department	N/A (this case did not specifically assess empathy as it was shorter with more focused questions)

A team of educators, pediatricians, upper-level residents, and nurses collaborated to develop scripts for these cases in an iterative fashion to ensure that their content accurately reflected patient encounters in which identifying and addressing SDH was critical. Three different clinical locations/specialties were intentionally selected [a primary care office, emergency department, and subspecialty clinic (hematology/oncology)] to enable comparison of resident performance and retention across distinct clinical settings
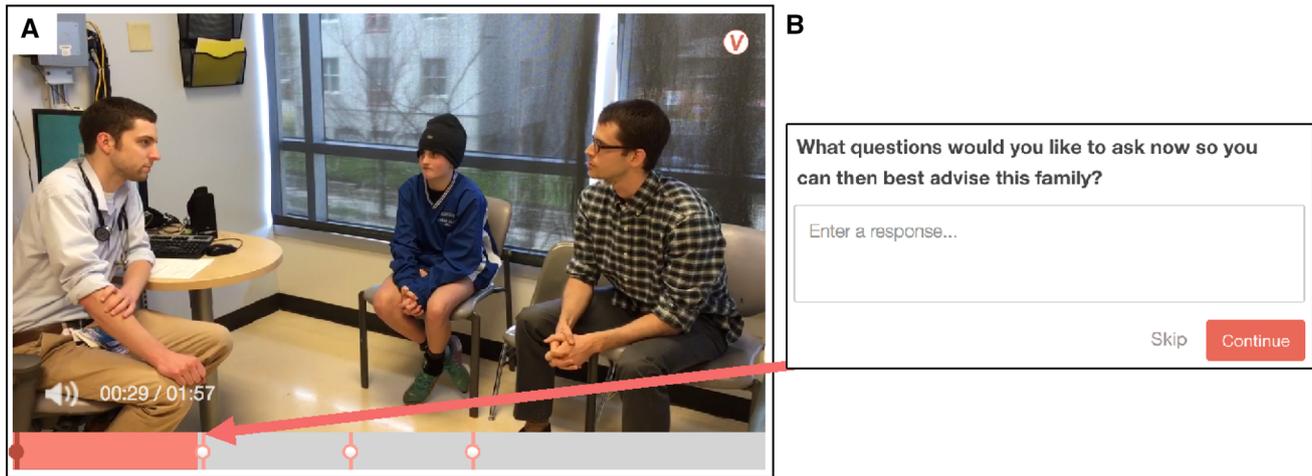
Fig. 1 Online simulated case snapshot. **a** Snapshot of one of the online simulated cases' user interface [included for publication with permission from the online educational platform, Vizia (https://vizia.co/)]. Each encounter took place between a resident physician (on left) and a pediatric patient and his/her parent (on right). All three online simulated cases were between 1 and 3 min in length, with 2 to 4 interpolated open-ended questions at designated time points throughout (**b**), such as "What questions would you like to ask now so you can then best advise this family?", "What would you like to say next?", and "What resources would you recommend to this family?". The video would pause with each question, allowing the user time to submit a free-text response in the response box (**b**). The video then resumed after the user submitted a response, with the subsequent conversation in the encounter demonstrating correct responses in near-real time, but did not allow users to go back and change their responses (provided below are links to view and/or participate in each of the three online simulated cases: case 1: https://vizia.co/videos/0e3bd2958c55631baeb8cc/share, case 2: https://vizia.co/videos/a979dfb38b867dd56ae86e/share, case 3: https://vizia.co/videos/d496ade23dda0cd8eae673/share)

interval [0.47, 0.92], case 2: 0.91 [0.78, 0.96], case 3: 0.94 [0.85, 0.98]; $p < 0.001$ for each). Residents' scores exceeded borderline scores in all cases; this was statistically significant for case 1 (residents: 7.0 ± 2.2 vs. borderline: 5.0; $p = 0.001$) and case 3 (6.6 ± 1.5 vs. 4.0; $p < 0.001$), though not case 2 (11.4 ± 3.3 vs. 10.0; $p = 0.099$) (Table 3). 80 to 90% of residents identified relevant SDH in cases 2 (primary care) and 3 (emergency medicine), but only 58% identified SDH in case 1 (hematology/oncology). Of the 11 residents who recognized relevant SDH in the hematology/oncology case (case 1), only one resident asked specifically about neighborhood, transportation, and/or financial barriers contributing to medication noncompliance, whereas the remaining 10 residents inquired about barriers to medication administration, including safe medication storage, understanding medication timing and dosing, and/or having an adequate support system to assist with this patient's complex medical care needs (Table 2). Conversely, in the primary care case (case 2), 71% of residents asked specifically about neighborhood, food insecurity, and/or financial barriers limiting access to fresh fruits/vegetables. At least 95% of residents recommended one or more appropriate resources in all cases, and 89% displayed empathy in at least one case.

A descriptive comparison with 24 new PGY1 residents (July 2018) revealed that residents who completed the virtual tour were more likely to correctly recommend resources for food and safe play (100% vs. 58%) and respond empathetically to families' hardships in case 2 (74% vs. 46%). While the majority of PGY1 residents who completed the virtual tour achieved scores at/above borderline in all cases, less than 30% of new PGY1 residents (who had not participated in the virtual tour curriculum) scored at/above borderline.

Discussion

Pediatric residents' performance in online simulated cases demonstrated retention and application of the virtual tour's curricular objectives, including identifying SDH, offering appropriate resources, and displaying empathy.

Online simulated cases provided an innovative, yet standardized approach to assess residents' skills and delayed retention of key curricular concepts. Since this technology is free and readily available, does not require specialized equipment or training, and can be completed asynchronously by learners, we believe it is convenient and efficient. Other investigators reported similar findings of cost-effectiveness, universal accessibility, and immediate feedback when using online simulated cases in education settings (Rose et al. 2016; Zhou et al. 2018). This study was novel in utilizing this emerging technology to measure retention and reinforce SDH training. Online simulated cases may be generalizable for use as assessment tools to evaluate future SDH-focused interventions and other curricula.

Recognizing and addressing poverty-related social risk factors with community resources and empathetic

Table 2 Sample scoring rubric (case 1)

	Level 1	Level 2	Level 3
	Responses not related to virtual tour's objectives	Responses demonstrate partial and/or general retention	Responses demonstrates full and specific retention of virtual tour's objectives
Question 1 [obj: identify relevant SDH (A)] "What questions would you like to ask now so you can then best advise this family?"	0 Points Not asking about specific or general barriers/obstacles the family faces	1 Point Asking in general about what barriers/obstacles the family faces	2 Point each (max 8 points) Asking about *neighborhood* • Asking about *transportation* barriers • Asking about *financial* barriers • Asking about *barriers to medication administration* at home, including at least 1 of the following: – Support system – Safe medication storage – Understanding medication schedule/dosing
Question 2 [obj: display empathy (C)] "What would you like to say next?"	0 Points • No display of empathy	1 Point • Recognizing difficulty family faces in general	2 Point each (max 8 points) • *Acknowledge* what is specifically difficult about the family's situation • *Validate* (Ex: "I understand how that would be challenging…", "That must be difficult") • *Normalize* (Ex: "A lot of our families also have difficulty with…") • *Explore*/pursue (Ex: "Would it be ok if we discuss some resources that could help?")
Question 3 [obj: recommend appropriate resources (B)] "What resources would you recommend to this family?"	0 Points • Not recommending any existing or relevant resources	1 Point • Involving social work	2 Point each (max 6 points) • *Transportation* assistance • *Home-delivery* of medications • Assistance with *care coordination*/care management

The total possible score for this case was 25 points and the pre-established borderline or minimally competent score was 5 points

Table 3 Summary of residents' scores (N = 19), in comparison to borderline (i.e., minimally competent) scores, and percent of responses demonstrating full and specific (level 3) retention of the virtual tour's curricular objectives in each of the three online simulated video cases

	Total possible score	Border-line score	Residents' total score mean (SD)	p-value[a]	% Residents who scored at or above borderline	% Residents whose responses showed full and specific (level 3) retention of the following curricular objectives		
						(A) Asking about and identifying relevant SDH	(B) Recommending specific, appropriate community resources	(C) Displaying empathy[b]
Case 1	25	5	7.0 (2.2)	0.001	95	58	95	89
Case 2	39	10	11.4 (3.3)	0.099	63	79	100	74
Case 3	14	4	6.6 (1.5)	< 0.001	100	89	95	(N/A)

[a]p-value from one-sample *t* test of no difference between resident total mean and pre-established borderline scores

[b]Displaying empathy consisted of demonstrating the empathic communication skills of specifically acknowledging, validating, normalizing, and/or exploring in response to the patient/family's poverty-related hardships, as seen in question 2 in the scoring rubric above (Table 2). For example, in case 1, one resident responded to learning about the family's struggles with medication adherence with: "That makes a lot of sense. I can see how it would be really difficult to get to the pharmacy under those circumstances. Is there anything we could do to make it easier?"

communication are important skills for all pediatricians, both in primary care and pediatric subspecialties. In our study, residents were more likely to identify relevant SDH during simulated primary care appointments (case 2) or emergency department visits (case 3), rather than with medically complex patients in hematology/oncology clinic (case 1). Although this difference may be partially explained by the latter being displayed first (i.e., residents may be 'primed' to recognize SDH in subsequent online simulated cases after SDH-specific learning points are reinforced in the first case), it is also possible residents are less likely to appropriately assess SDH during subspecialty encounters with medically complex patients. Given evidence that children with chronic and/or complex medical illnesses are more vulnerable to health disparities (e.g., often on public insurance, higher prevalence of financial difficulties [Kuo et al. 2014]), it is critical to address SDH among this population. Our findings suggest additional resident education about SDH in subspecialty settings may be necessary.

Our study has limitations. First, it included a small sample size from a single site, potentially reducing generalizability and limiting study power to detect differences between resident and borderline scores. Second, our study lacked a matched control group for statistical comparison. Third, we did not measure residents' performance prior to the virtual tour, so were unable to quantify behavior changes. Lastly, the video cases are simulations, so translation to patient care is unclear.

Despite these limitations, our results are promising in demonstrating residents' retention of SDH-related curricular content at least 1 month following the virtual tour through the use of online simulated cases as a performance-based evaluation tool. Given the importance of integrating a robust child poverty curriculum across the educational continuum as emphasized by the Academic Pediatric Association's Child Poverty Education Subcommittee (Chamberlain et al.

2016), our next steps include scaling the virtual tour to clinicians at all levels of training and measuring impact on clinical practice in this diverse group of learners. Technological innovations—from the virtual tour's 360° immersion to the online simulated cases utilized here to assess its effectiveness—provide exciting opportunities to continually evaluate, improve, and expand SDH training.

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