

Task Analysis of In-Home SARS-CoV-2 Rapid Antigen Testing by Families

Hanna J. Barton, MS,^a Nicole E. Werner, PhD,^a Makenzie Morgen, BS,^b Gregory P. DeMuri, MD,^b Michelle M. Kelly, MD, MS,^b Ellen R. Wald, MD,^b Gemma Warner, MSSW,^b Barbara Katz,^c Ryan J. Collier, MD, MPH^b



^aDepartment of Industrial and Systems Engineering, and
^bDepartment of Pediatrics, University of Wisconsin-Madison, Madison, Wisconsin; and ^cFamily Voices of Wisconsin

Ideal severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing platforms must be simple, accessible, and timely to ensure that symptomatic and exposed individuals are tested, positive results are identified, and isolation, quarantine, and contact tracing begin as soon as possible. Many children remain unvaccinated and, as other respiratory viruses surge, families have a pressing need for reliable and practical SARS-CoV-2 testing options.

Point-of-care rapid antigen SARS-CoV-2 tests address many of the challenges associated with real-time reverse transcription-polymerase chain reaction by offering the convenience of in-home testing for individuals (including parents), tolerability (anterior nasal swab), and rapid results (within 15 minutes).¹ SARS-CoV-2 antigen test performance data suggest lower sensitivity when performed by nonhealth care professionals²; however, limited information exists on specific testing barriers parents face.

Identifying in-home testing pitfalls and strategies that facilitate high-quality testing is essential to inform test kit design and result follow-up. We applied hierarchical task analysis (HTA) to (1) model the task of in-home rapid antigen testing by parents, (2) identify potential failure modes, and (3) identify and categorize strategies used to address potential failure modes.

METHODS

Participants were enrolled as part of a larger study aimed at increasing safe return to school for children with complex medical conditions.³ Participants were parents/caregivers of children enrolled in the University of Wisconsin's Pediatric Complex Care Program (cohort average of 5 affected organ systems, 7 subspecialists, 10 scheduled medications, and 3 medical devices).⁴

The BinaxNOW Antigen Self-Test (Abbott) is a point-of-care, lateral flow immunoassay intended for the qualitative detection of the SARS-CoV-2 nucleocapsid protein antigen in direct anterior nasal swabs (symptomatic testing sensitivity range; 57%–74%; specificity range = 99.0%–100%).^{2,5,6}

We conducted a contextual inquiry over video conferencing software to observe parents testing their children in their home environment. Contextual inquiry is a design research method that pairs observation with opportunistic questioning with the goal of uncovering details implicit in how people approach and conduct tasks.⁷ Sessions were recorded, transcribed, then analyzed by using team-based content analysis.^{8,9} HTA is a Human Factors method used to decompose a task into actions that are required to meet the overall objective of the task. By combining Human Factors expertise and protocol comparison, the resultant HTA informs task redesign by pointing to potential failure modes. We applied HTA to

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Address correspondence to Ryan Collier, MD, MPH, 600 Highland Ave, H4/410, Madison, WI 53792. E-mail: rcoller@pediatrics.wisc.edu

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TABLE 1 Potential Failure Modes With Associated Strategies Used by Families to Overcome Them

Potential Failure Modes	Strategies Used by Families to Overcome Failure Mode
A. Remember to conduct the test	Plan to do test as part of a preestablished routine Set alarm or reminder
B. Remember in which order to do the steps of the test	Leave testing materials in line of sight (eg, on the kitchen table)
C. Cannot locate testing materials	Refer to instructions while conducting the test Keep all materials in original box Keep all materials in a designated location (eg, kitchen cabinet, desk drawer, supply drawer in child's room, etc)
D. Perforation on testing card package is small and hard to see/find	Keep scissors with materials and use those to open testing card package
E. Child or pet knocks testing card off surface	Set up testing card in a carefully selected location (eg, out of the child's reach, on a high countertop, within eyesight, etc)
F. Cannot tell if there were 6 drops administered	—
G. Cannot remember how many drops to use	Write "6" on the bottle to cue use of 6 drops
H. Cannot tell which end is the swab end versus the handle end when opening, potential for contamination	—
I. Child does not like swabbing	Do swab while child is sleeping Explain testing steps to the child verbally Have child do swab themselves (while coaching them, eg, "swirl it like you're swirling your French fries in ketchup") Keep child in a comfortable/distracting setting (eg, watching TV, counting, singing, etc) Have child in a chair that supports child's head and neck to prevent bucking Ask child which nostril to swab first Have another caregiver help restrain the child during swabbing Model test swabbing on oneself first Distinguish the test explicitly from a deep nasal swab Do more circles in each nostril Observe swab to see if it looks wet
J. Fear of not getting enough sample	Peel sticker tab off before swabbing (so that both hands are free)
K. Sticker can be hard to peel off	Set timer (eg, using smart home system, stand-alone timer, or phone)
L. Remember to go back to read results after 15 min and before 30 min	Sit and wait 15 min in front of the card Place the test card in a location to cue reading it in 15 min (eg, next to them at their desk) Write time of test administration onto the testing card Read results before 15 min pass
M. Confuse testing cards (if conducting test on >1 person)	Write name on the testing card
N. Read the lines because of poor vision	Use zoom feature on phone camera to observe results
O. Remember to record the results	Record test date and details while waiting and place the recording sheet next to the test card to cue recording results

The many steps, potential failure modes, and strategies involved with in-home rapid antigen SARS-CoV-2 testing by families may influence test performance. Given growing direct-to-consumer test availability, similar studies are needed to quantify failure rates and ensure appropriate conclusions are drawn from reported results.

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ABBREVIATIONS

HTA: hierarchical task analysis
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

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