Original Article

Virtual Teach-To-Goal™ Adaptive Learning of Inhaler Technique for Inpatients with Asthma or COPD

Valerie G. Press, MD, MPH[a], Colleen A. Kelly, BA[b], John J. Kim, BA[c], Steven R. White, MD[d], David O. Meltzer, MD, PhD[c], and Vineet M. Arora, MD, MAPP[a] *Chicago, Ill*

What is already known about this topic? Patients frequently misuse their rescue and controller devices that provide needed medications. In-person teach-to-goal sessions improve patients' inhaler technique, but skills wane within 30 days. A portable, effective learning strategy is needed to refresh skills.

What does this article add to our knowledge? This article demonstrates that virtual teach-to-goal™, a novel adaptive learning strategy, is effective at teaching patients inhaler skills and may help transform patient education by providing a portable, effective strategy for skill acquisition and retention.

How does this study impact current management guidelines? Current guidelines recommend assessing and teaching the inhaler technique at all health care encounters; however, lack of provider time and/or training is prohibitive. This virtual teach-to-goal™ strategy may be employed to achieve the guideline-recommended care.

BACKGROUND: Asthma and chronic obstructive pulmonary disease (COPD) result in more than 1 million hospitalizations annually. Most hospitalized patients misuse respiratory inhalers. This misuse can be corrected with in-person education; however, this strategy is resource intensive and skills wane quickly after discharge.

OBJECTIVE: The objective of this study was to develop and pilot a virtual teach-to-goal™ (V-TTG™) inhaler skill training module, using innovative adaptive learning technology.

METHODS: Eligible adults with asthma or COPD completed a V-TTG™ metered-dose inhaler session with tailored rounds of narrated demonstration and self-assessments. The primary outcome was the proportion of participants with inhaler misuse post- versus pre-V-TTG™; secondary analyses tested mastery, self-efficacy, and perceived versus actual inhaler skills. Analyses were tested with McNemar's χ^2 test ($P < .05$).

RESULTS: Among 90 enrolled participants, the majority were African American (94%), female (62%), and had asthma (68%), with a mean age of 48 years. Among those completing both pre- and post-V-TTG™ (n = 83), misuse was significantly lower post- versus pre-V-TTG™ (24% vs 83%, $P < .001$). Mastery and confidence both improved significantly (46% vs 7%, $P < 0.001$; 83% vs 67%, $P < .001$) post- versus pre-V-TTG™. After V-TTG™, there was greater congruence between perceived versus actual inhaler skills ($P < .01$). No differences were seen in subgroup analyses for age, health literacy level, or diagnosis.

CONCLUSIONS: This study is the first to demonstrate the efficacy of adaptive V-TTG™ learning to teach the inhaler technique. V-TTG™ improved most participants' technique to an acceptable level, reached mastery for half, and also increased self-efficacy and actualized skill. V-TTG™ has potential to improve health care across care transitions. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;■:■-■)

Key words: *Asthma; Chronic obstructive pulmonary disease; Pulmonary disease; Patient education; Inhalation devices; Technology; Adaptive learning; Virtual education; Video module education; Health care; Care transitions*

Asthma and chronic obstructive pulmonary disease (COPD) are 2 of the most common pulmonary disorders, and together result in over a million hospitalizations annually.[1-4] Current national financial penalties for COPD readmissions emphasize the growing urgency to reduce preventable readmissions.[5-8]

[a]Section of General Internal Medicine, Department of Medicine, University of Chicago, Chicago, Ill
[b]Pritzker School of Medicine, University of Chicago, Chicago, Ill
[c]Section of Hospital Medicine, Department of Medicine, University of Chicago, Chicago, Ill
[d]Section of Pulmonary and Critical Care Medicine, Department of Medicine, University of Chicago, Chicago, Ill

This study was funded by the National Heart Lung and Blood Institute (NHLBI) (K23 HL118151), American Thoracic Society Foundation, and the American Lung Association Social Behavioral Award.

Conflicts of interest: V. G. Press has received research support from the NHLBI (K23 HL118151), American Thoracic Society Foundation, the American Lung Association Social Behavioral Award, and Patient Centered Outcomes Research Initiative. C. A. Kelly has received research support from National Institutes of Health (NIH) via the National Institute on Aging (training grant 5T35AG029795-08). J. J. Kim declares no relevant conflicts of interest. S. R. White has received consultancy fees from Marathon Pharmaceuticals; has provided medical-legal consulting; and has received research support from National Institute of Allergy and Infectious Diseases and NHLBI. D. O. Meltzer has received research support from the NIH. V. M. Arora has received research support from NHLBI (5R25HL116372).

Received for publication August 31, 2016; revised October 28, 2016; accepted for publication November 21, 2016.

Available online ■■

Corresponding author: Valerie G. Press, MD, MPH, Section of General Internal Medicine, Department of Medicine, University of Chicago, 5841 S Maryland Ave, MC 2007, Chicago, IL 60637. E-mail: vpress@medicine.bsd.uchicago.edu.

2213-2198

http://dx.doi.org/10.1016/j.jaip.2016.11.018

Abbreviations used
BI- Brief verbal instructions
COPD- Chronic obstructive pulmonary disease
MDI- Metered-dose inhaler
RA- Research assistant
TTG- Teach-to-goal
V-TTG™- Virtual teach-to-goal™
VME- Video module education

Many hospital (re)admissions are thought to be potentially preventable as effective treatments exist to treat and control patient symptoms related to asthma and COPD.[9-12] However, despite these treatments' efficacy, many patients suffer from exacerbations of their asthma or COPD requiring elevated levels of care.[13-16]

A critical component of reducing preventable readmissions is improving patients' self-management, through increased knowledge, skills, and self-efficacy.[17-28] For instance, teach-to-goal (TTG) is an in-person educational strategy that reduces inhaler misuse.[18,24,28,29] Previous studies demonstrate that TTG is associated with reduced acute care.[18,28] TTG's strengths include that it is patient-centered and tailored to the number of rounds of inhaler assessment and demonstration each patient requires. However, TTG requires provider time and training, may lack fidelity when attempting to implement through large-scale interventions, and lacks portability for at-home refresher education.[28] Furthermore, previous studies show that one TTG session is insufficient for long-term retention.[28] Effective self-management skills require repeated assessment and education,[7,25] yet health care professionals are often undertrained or lack time to provide this needed education.[30,31] Furthermore, patients need multiple sessions to learn and retain the skills.[28] Therefore, the use of self-directed adaptive learning technology to provide effective training for respiratory inhalers could improve standardization of, and access to, this critical education.

To address the existing barriers to access that clinicians and patients face for having access to effective, consistent, repeated patient training, we developed a virtual teach-to-goal™ (V-TTG™) learning session to teach one critical self-management skill, inhaler technique. V-TTG™ uses adaptive learning technology to provide patient-tailored learning sessions that are modeled after the in-person TTG sessions. V-TTG™ allows for standardization of the inhaler technique instruction, which enhances fidelity. V-TTG™ can be accessed on any desktop or hand-held device, which increases its reach to patients outside of the health care system. Importantly, like TTG, V-TTG™ provides a tailored learning session that includes assessments and demonstration, repeated as needed for optimal patient learning. Before implementing V-TTG™ on a large scale, though, it is necessary to test its initial efficacy and validate the V-TTG™ learning session's ability to improve knowledge, efficacy, and skill. Therefore, the primary hypothesis is that hospitalized adult patients with asthma or COPD would be significantly less likely to misuse their metered-dose inhaler (MDI) after completing the inpatient V-TTG™ session.

METHODS

This pre/post study evaluates the efficacy of an interactive virtual educational strategy, V-TTG™, that uses adaptive learning technology to customize the session to teach the correct MDI technique to hospitalized adult patients with asthma or COPD. The self-assessment items were validated through iterative testing to determine whether they provided learning and/or assessment value. Trained research staff screened the electronic medical records of hospitalized patients on weekdays to identify patients admitted to the inpatient medicine service with asthma or COPD. The study was approved by the University of Chicago Institutional Review Board (IRB12-1844).

Patients were eligible for enrollment if they were 18 years or older, hospitalized on the general medicine service, with a physician diagnosis of asthma or COPD, with planned use of MDI after discharge, inpatient primary team assent, and written informed consent. Patients were excluded from the study if they were unable to provide consent (eg, cognitive impairment or limited English proficiency), hospitalized in the intensive care unit, or previously enrolled in the study. A research assistant (RA) consented, enrolled, and completed the participant assessments before and after the V-TTG™ education.

Intervention: virtual TTG™ video module

Participants completed the interactive V-TTG™ session comprising cycles of demonstration and adaptive self-assessment (Figures 1 and 2) through short-answer questions (Figures E1 and E2, available in this article's Online Repository at www.jaci-inpractice.org). The V-TTG™ is a self-contained platform developed with videos produced by Click to Play Media (Berkeley, CA) presented on an adaptive learning platform developed in partnership with, and hosted by, Smart Sparrow (Sydney, NSW, Australia). V-TTG™ consists of a preassessment series of multiple choice and true/false questions about the proper inhaler technique, followed by a narrated video demonstration. Participants were then presented with a postassessment series of the same short-answer questions with the addition of an applied skill question using a video with the incorrect technique shown. If they failed to answer any of posteducation questions correctly, they were prompted to rewatch the narrated demonstration and repeat the postassessment up to 3 times to customize the learning session to participants' needs. On completion of the posteducation questions, additional information was provided on use of the MDI without a spacer.

Participants with incorrect answers on the final round were provided with the correct answer via written text on the screen.

Validation of V-TTG™ self-assessment items

The V-TTG™ pre- and postassessment item domains are supported by Bloom's learning theory and include cognitive (knowledge), psychomotor (applied skills, eg, identifying the incorrect technique on a video question), and affective (attitude: self-efficacy) domains.[32] The validation portion of the study consisted of 3 rounds, with 90 patients enrolled. Participants were enrolled in a round until a total of 30 had completed the study, and then the next round was open for enrollment, until 90 total participants had enrolled in total. Each round had ongoing midpoint evaluations to continuously assess the items for validity, clarity, and utility (Figure E2, available in this article's Online Repository at www.jaci-inpractice.org).

To test for the validity and utility of the self-assessment questions, we evaluated the proportion of participants who answered each question correctly on the pre- and postdemonstration assessments. Reasons for elimination or revision of any item included identification of results that indicated participant confusion of the item, overlapping content with another question, lack of significance, or questions that were determined to be too easy. For example, if the statistical