



Impact of 4 Components of Instructional Design Video on Medical Student Medical Decision Making During the Inpatient Rounding Experience

Alex Friedman Peahl, MD,* Elizabeth E. Tarr, BA,[†] Phinnara Has, MS,[‡] and B. Star Hampton, MD[‡]

*Department of Obstetrics and Gynecology, University of Michigan, Institute for Healthcare Policy and Innovation, National Clinical Scholar, Ann Arbor, Michigan; [†]Warren Alpert Medical School of Brown University, Providence, Rhode Island; and [‡]Department of Obstetrics and Gynecology, Warren Alpert Medical School of Brown University/Women and Infants Hospital, Providence, Rhode Island

INTRODUCTION: The Four Components of Instructional Design (4C-ID) Model has been used to teach Medical Decision Making (MDM), a core competency recognized by the Liaison Committee for Medical Education. 4 Components of Instructional Design (4C-ID) has been applied in general medical education, but not the inpatient clerkship setting. A 4C-ID video for inpatient rounding, like postpartum rounding in Ob/Gyn, could help improve MDM on busy services.

METHODS: Students in the third year Ob/Gyn clerkship were randomized by clerkship group to receive a 20-minute postpartum rounding video, based on 4C-ID principles, or usual teaching. MDM and knowledge were assessed pre-/postintervention with the Diagnostic Thinking Inventory and a case-based evaluation. Satisfaction was assessed with Likert style questions.

RESULTS: Seventy-eight students were randomized (36 control, 42 intervention). Both groups had equal baseline measures of MDM and knowledge, and similar postclerkship MDM. The intervention group demonstrated higher knowledge postclerkship (17.1, 22.6 $p < 0.001$). Students in the intervention felt prepared by the video, and would recommend it. Students in the control group reported higher satisfaction with their postpartum rounding experience (3.9, 3.5 $p = 0.04$).

DISCUSSION: Videos are easy to incorporate teaching platforms for medical students, however, the 4C-ID based video in this study did not increase student MDM. In addition, educators should use caution when integrating video into coursework as use of video may lead to decreased student satisfaction as it did in this study. (J Surg Ed 76:1286–1292. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Four components of instructional design, medical decision making, postpartum rounding, undergraduate medical education

COMPETENCIES: Practice-Based Learning and Improvement

INTRODUCTION

Medical Decision Making (MDM) requires the complex assimilation of medical knowledge and critical thinking, taking knowledge learned in the classroom and applying it to real life clinical scenarios. The Liaison Committee for Medical Education now includes MDM amongst the core competencies for student mastery, emphasizing the importance of this skill.¹ MDM has been taught in a variety of contexts and points of clinical training, from the first year of medical school to postgraduate training, from formal classroom lectures to impromptu learning on the wards.²⁻⁴ More recently, the 4 Components of Instructional Design (4C-ID) model has been adapted from other fields as a model for applying MDM in general medical education, but to date, has not been studied or described in the inpatient clerkship experience.^{5,6} The 4

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Correspondence: Inquiries to Alex Friedman Peahl, MD, 2800 Plymouth Rd, Building 14, Ann Arbor, MI 48109; e-mail: alexfrie@med.umich.edu

components include learning tasks, supportive information, procedural information, and directed practice.⁵ These methods help learners to both manage cognitive load and develop cognitive strategies for improvement.⁷ These strategies can be particularly important in rotations on surgical specialties, where trainees are required to quickly integrate a large amount of information during rushed activities like inpatient postoperative rounds. In fact, few studies have addressed how to improve MDM through inpatient rounding at all, a hallmark of the medical education experience.

Interventions to improve the inpatient rounding experience have included checklists, adding additional team members to focus on education, reciprocal teaching between residents and students, and focusing on specific physical exam skills at the bedside.⁸⁻¹⁰ In our review, no study specifically addressed MDM in the inpatient rounding experience. Additionally, to our knowledge, no studies to date have examined how postpartum rounding could be used as an opportunity to build students' MDM. Modern methods of teaching are increasingly needed as a new generation of learners rises through the medical education system. A recent survey of Ob/Gyn residents found the most common sources of information were UptoDate, Google, and Practice Bulletins, with over 75% reporting they would use podcasts for learning.¹¹ Previous studies have shown that videos are effective teaching tools for both medical students and residents, and can also be used to engage trainees.¹²⁻¹⁴

We believe inpatient rounding, and specifically for Ob/Gyn, postpartum rounding is a valuable opportunity for new learners to develop MDM skills through directed education and skills practice. The primary objective of this study was to understand the effect of an educational video intervention grounded in 4C-ID principles on third year medical student MDM during the OB/GYN core clerkship. Secondary objectives were to understand the effect of the intervention on student knowledge and satisfaction. We hypothesized that the video intervention would improve MDM, knowledge, and overall clerkship satisfaction.

METHODS

We conducted a prospective, randomized controlled trial of third year medical students at Warren Alpert Medical School of Brown University who were rotating through their 6-week Ob/Gyn core clerkship at Women & Infants Hospital from May 4, 2015 to January 29, 2016. By nature of the intervention, students could not be blinded to their randomization. Clerkship groups range in size from 11 to 15 students. All students rotating through the core clerkship were eligible. The study was approved by the

Institutional Review Board of Women & Infants Hospital of Rhode Island (Providence, Rhode Island).

A detailed description of the study was provided to the students on the first day of each clerkship and consent was obtained from interested students. Students were randomized by clerkship group to receive the intervention, a postpartum rounding video based in 4C-ID principles plus usual teaching or usual teaching only. Group randomization was used to avoid social interaction threats within the clerkship group, such as *diffusion*, which may occur if students in the intervention group discuss the video with students in the control group on the same rotation; *compensatory rivalry and reactivity* among students in the same rotation; and *resentful demoralization* which would be detrimental to students in the control group. These effects not only threaten the internal validity of our study, but potentially create significant anxiety among students which could adversely affect the learning environment.¹⁵ Clerkships 1, 3, and 5 were randomized by the principle investigator (AFP) using a random group assignment device through "Sealed Envelope."¹⁶ Clerkships 2, 4, and 6 were assigned based on the results of the prior randomization (i.e., if clerkship 1 was assigned intervention, clerkship 2 was assigned to the control group) to ensure equal distribution of students in the intervention and over time. Students completed questionnaires at the time of consent and 6 weeks later, following their clerkship examination. Usual teaching at our institution includes informal discussions of postpartum rounding during the labor and delivery portion of the rotation, as well as postpartum note review with residents. The participants were not masked to the intervention by nature of the study design.

Intervention

The intervention was a 20-minute video with narrated PowerPoint slides, designed using 4C-ID principles.

The learning task was defined as understanding postpartum complications. The supporting details included key points about postpartum complications, including definitions of the disorder, diagnostic criteria, usual risk factors and historical information, physical exam findings and relevant laboratory, and imaging information. Procedural steps included how to find relevant details in the patient chart and elicit information on history and exam. Finally, the video provided directed practice through several case examples with an emphasis on MDM.

The video content included basic principles of postpartum rounding, including normal postpartum course and complications: febrile illness, hypertensive disorders, and postpartum hemorrhage. The video was shown to all students in clerkships randomized to the

intervention during clerkship orientation, regardless of their participation in the study. The video was available in the hospital library for additional individual viewing during clerkships randomized to the intervention, and was not available during clerkships not randomized to the intervention.

The intervention and assessments were piloted with a group of 15 fourth year medical students before the study began to ensure materials were accessible to the study population and to make revisions as necessary. No changes were made following the initial pilot of the materials.

Outcome Measures

Knowledge and medical decision making were assessed at the beginning and end of each clerkship for all students. Participant satisfaction was assessed at the end of each clerkship for all students. The investigator grading outcomes was masked to group assignment.

Medical Decision Making

MDM was evaluated using the Diagnostic Thinking Inventory (DTI), a validated measure of both learner stage and change in diagnostic skill with intervention.¹⁷⁻¹⁹ The DTI measures 2 main components: (1) knowledge and structure in memory, and (2) flexibility in thinking. Knowledge and structure in memory refers to the ability to store, organize, access and apply information, and is in part dependent on experience. Flexibility in thinking refers to the ability to think fluidly, utilizing multiple strategies, adapting to new information, and processing even without clear guiding factors. The scale includes 41 items, each with a question stem and a 6-point response scale, for a maximum total score of 246 points. Higher numbers indicate better levels of medical decision making. Questions left blank by participants were not assigned point value.¹⁷

Knowledge Assessment

Students were presented with a typical hand-off sheet, including a brief patient history, vital signs, and current medications. A scenario-based assessment was designed for this study to query 5 knowledge domains of the postpartum period: Students were asked to (1) evaluate historical information and vitals (6 points), (2) propose a differential diagnosis (6 points), (3) elicit general information about the postpartum period (6 points), (4) elicit complication specific information (6 points), and (5) identify appropriate exam maneuvers (8 points) to clarify the patient's condition. Total scores were out of 32 points. The pretest scenario was a febrile patient with likely endometritis, and the post-test scenario was a patient with tachycardia following a postpartum hemorrhage. Students received a point for correct answers. Incorrect

answers and unanswered questions were not assigned a point value.

Satisfaction Survey

A 10-item satisfaction survey was created to assess student experience with postpartum rounding and the OB/GYN core clerkship. Three additional questions about experience with the video were given to the intervention group. Questions were based on a 5-point Likert Scale, with higher scores indicating higher satisfaction.

Data Analysis

Pre- and postclerkship MDM and knowledge scores, and postclerkship satisfaction scores were compared between the intervention and control group. Continuous variables were compared using *t*-test or nonparametric Wilcoxon rank-sum test. *p* Values were 2-sided, with $p < 0.05$ considered statistically significant. Imputed means were used for missing variables encountered in the DTI.

The sample size of this study was set based on the available students rotating on the OB/GYN clerkship over 6 rotations. As no standard deviations for the selected measures were available, effect size of the DTI was used to determine power. With a sample size of at least 36 per arm, this study was powered to >80% to detect a moderate to large effect size; Cohen's $D = 0.7$. Data analysis was performed with Stata 13.1 (College Station, Texas).

RESULTS

A total of 79 third-year medical school students were eligible to participate in this study, and 78 agreed to participate. One student in the intervention group declined due to a scheduling conflict during the clerkship orientation. Three clerkship groups (43 students) were randomized to the intervention group and 3 clerkship groups (36 students) were randomized to the control group. The discrepancy in group size was the result of usual variation in clerkship group size.

Beginning of Clerkship

At the start of the clerkship, there was no statistically significant difference between control and intervention group scores for medical decision making or overall knowledge scores.

Medical Decision Making

Scores on the DTI for control and intervention groups showed no statistical difference in any domain: flexibility in thinking (82.6, 81.5 $p = 0.58$), structure in memory (77.3, 78.4 $p = 0.59$), or total score (160.1, 160.5 $p = 0.92$).

Knowledge

For knowledge, there was no statistically significant difference between control and intervention group for the first four domains: (1) evaluating historical information and vitals (2.4, 2.5 $p = 0.71$), (2) proposing a differential diagnosis (1.4, 1.7 $p = 0.16$), (3) eliciting general information about the postpartum period (3.9, 3.7 $p = 0.58$), and (4) eliciting complication specific information (0.75, 1.1 $p = 0.59$). Control and intervention groups differed in the fifth domain: identifying appropriate physical exam maneuvers (4.1, 4.8, $p = 0.05$). There was no difference between control and intervention group for total score (12.6, 13.8, $p = 0.20$) (Table 1).

End of Clerkship

Medical Decision Making

There was no significant difference in DTI scores for control and intervention groups in flexibility in thinking (84.6, 85.8 $p = 0.56$), structure in memory (80.9, 82.9 $p = 0.31$), and total score (165.2, 168.7 $p = 0.33$). Both the control and intervention group demonstrated an increase in total score over the course of the clerkship, however, the increase was not statistically significant between groups (5.1, 8.2 $p = 0.32$).

Knowledge

Postclerkship, the intervention group scores were significantly higher than the control group for total knowledge score (17.1, 22.6 $p < 0.001$), and in 3 components of the knowledge assessment: evaluating historical information and vitals (2.3, 3.8 $p = 0.002$), eliciting complication specific information (1.5, 3.7 $p < 0.001$), and

appropriate physical exam maneuvers (5.2, 6.5 $p = 0.001$). There was no statistically significant difference between the control and intervention groups' scores in proposing a differential diagnosis (2.8, 2.9 $p = 0.43$) or eliciting general information about the postpartum period (5.4, 5.7 $p = 0.37$) (Table 1).

Satisfaction

Students receiving the intervention reported the video was helpful for preparing for postpartum rounding (mean 3.3, SD 1.1), and that they would recommend other students use the video (mean 3.7, SD 0.98) (Table 2).

Students in the control group demonstrated a significantly higher satisfaction score with the clerkship experience than the intervention group (3.9, 3.5 $p = 0.04$). Compared with the control group, students in the intervention group reported lower scores for their interaction with residents (3.6, 2.9 $p = 0.02$), and the importance of rounding to the clerkship (3.9, 3.3 $p = 0.01$).

There were no between group differences in students' perceptions of how prepared they felt for postpartum rounding (3.7, 3.8 $p = 0.71$) or their perceptions of how postpartum rounding contributed to learning about postpartum milestones (3.7, 3.5 $p = 0.38$), postpartum complications (3.3, 3.2 $p = 0.49$), or postoperative complications (3.5, 3.2 $p = 0.36$). The control group and the intervention group both reported postpartum rounding contributed to improvement of their clinical reasoning (3.4, 3.1 $p = 0.18$). Of students in the intervention group, 23% reported viewing the video at least one additional time in the library after orientation.

TABLE 1. Student Pre- and Post-Test Scores on Knowledge Assessment of Postpartum Care

| | All (n = 78) mean (SD) | Control (n = 36) mean (SD) | Intervention (n = 42) mean (SD) | p Value* |
|------------------------|------------------------------|----------------------------------|---------------------------------------|---------------------|
| Pre-test score | | | | |
| Rounding sheet | 2.4 (1.9) | 2.4 (1.9) | 2.5 (2.0) | 0.71 [‡] |
| Differential diagnosis | 1.6 (0.9) | 1.4 (0.9) | 1.7 (0.9) | 0.16 [†] |
| Ask all patients | 3.8 (1.8) | 3.9 (1.9) | 3.7 (1.8) | 0.58 [†] |
| Complications | 0.9 (1.3) | 0.8 (1.0) | 1.1 (1.5) | 0.59 [‡] |
| Physical exam | 4.5 (1.5) | 4.1 (1.8) | 4.8 (1.1) | 0.05 [†] |
| Total | 13.2 (4.1) | 12.6 (4.4) | 13.8 (3.7) | 0.20 [†] |
| Post-test score | | | | |
| Rounding sheet | 3.1 (2.3) | 2.3 (2.2) | 3.8 (2.1) | 0.002 [‡] |
| Differential diagnosis | 2.8 (1.0) | 2.8 (1.0) | 2.9 (1.0) | 0.43 [†] |
| Ask all patients | 5.6 (1.8) | 5.4 (2.0) | 5.7 (1.5) | 0.37 [†] |
| Complications | 2.7 (2.2) | 1.5 (1.7) | 3.7 (2.1) | <0.001 [‡] |
| Physical exam | 5.9 (1.8) | 5.2 (1.8) | 6.5 (1.5) | 0.001 [†] |
| Total | 20.1 (5.6) | 17.1 (5.2) | 22.6 (4.6) | <0.001 [†] |

* p Values are for Control vs. Intervention.

[†]Hest.

[‡]Wilcoxon rank-sum.

TABLE 2. Student Scores on Postclerkship Satisfaction Survey for the Control and Intervention Groups

| | All (n = 78) Mean (SD) | Control (n = 36) Mean (SD) | Intervention (n = 42) Mean (SD) | p Value* |
|---|------------------------------|----------------------------------|---------------------------------------|-------------------|
| How would you rate your experience postpartum rounding overall? | 3.7 (0.9) | 3.9 (0.9) | 3.5 (0.8) | 0.04 [†] |
| How would you rate your preparation for postpartum rounding? | 3.8 (0.8) | 3.7 (0.9) | 3.8 (0.7) | 0.71 [†] |
| How would you rate your interactions with residents during postpartum rounding? | 3.3 (1.2) | 3.6 (1.2) | 2.9 (1.0) | 0.02 [†] |
| I think postpartum rounding was an important part of my OB-GYN clerkship. | 3.6 (1.0) | 3.9 (1.0) | 3.3 (0.9) | 0.01 [†] |
| I learned about normal postpartum milestones through postpartum rounding. | 3.6 (1.2) | 3.7 (1.1) | 3.5 (1.2) | 0.38 [†] |
| I learned about diagnosing postpartum complications through postpartum rounding. | 3.3 (1.1) | 3.3 (1.0) | 3.2 (1.2) | 0.49 [†] |
| I learned about diagnosing postoperative complications through postpartum rounding. | 3.3 (1.2) | 3.5 (1.1) | 3.2 (1.2) | 0.36 [†] |
| My clinical reasoning improved through postpartum rounding. | 3.3 (1.1) | 3.4 (1.1) | 3.1 (1.1) | 0.18 [†] |
| I felt confident about postpartum rounding. | 3.9 (0.8) | 3.9 (0.9) | 3.9 (0.7) | 0.75 [†] |
| I felt comfortable postpartum rounding. | 4.0 (0.8) | 4.1 (0.9) | 3.9 (0.7) | 0.29 [‡] |
| The video helped me feel prepared for postpartum rounding. | — | — | 3.3 (1.1) | — |
| I would recommend other students use the video to prepare for postpartum rounding. | — | — | 3.7 (1.0) | — |

* $p < 0.05$ is significant, the 1st, 3rd and 4th results are significant.

[†]t-test.

[‡]Wilcoxon rank-sum.

DISCUSSION

In this study, students participating in postpartum rounds on their Ob/Gyn clerkship randomized to receive a novel, 20-minute video based in 4C-ID principles failed to demonstrate improvement in their overall MDM and also reported overall lower satisfaction with the clerkship when compared to the usual teaching group. Students in the intervention group did improve medical knowledge by 30% when compared to usual teaching alone, and were specifically better able to evaluate historical information, elicit complication specific information, and identify appropriate exam maneuvers. These findings suggest that while video interventions can be easily integrated into clerkship curricula, this should be done with caution as they may negatively impact student experience.

The 4C-ID model has been used in other settings to improve task specific knowledge and reasoning.^{20,21} To our knowledge, this is the first application of 4C-ID to the inpatient rounding experience, and suggests this theoretical model could be helpful to student learning on busy inpatient rotations as medical student knowledge improved with this intervention. Theoretically, delivering content through a video model is important for millennial learners, who demand concise, clear educational tools, available on mobile platforms.¹¹ Videos, when well designed and based in educational principles like 4C-ID, have the potential to meet this need. The guided,

independent education afforded by video learning may be particularly relevant in busy clinical settings where videos targeted at relevant topics may provide opportunities for students to remain engaged in learning even when no resident or faculty member is available to teach them.

In contrast to other medical education interventions based in 4C-ID principles, our intervention did not show a statistically significant improvement in MDM as scored on the DTI. One explanation is our intervention may not have been robust enough to influence students' thinking. Other 4C-ID programs have included multiple components including in-person coaching with cognitive feedback to supplement initial content delivery.⁷ Students may have been unable to apply the video's principles to real clinical practice without these additional sessions. Viewing the video only once may also have limited its effectiveness: while 23% of students reported additional viewing of the video in the library at least once after orientation, perhaps further repetition was needed to improve cognitive skills. Making videos more accessible through mobile platforms, rather than simply available on an in-hospital desktop, may facilitate additional use. Still, the improvement in knowledge scores may represent a form of task-specific MDM that was not captured by the DTI.

Students who received the video intervention were significantly less satisfied with their postpartum rounding experience than their peers in the control group. These findings contrast with other studies of video

interventions, which suggest high satisfaction with this delivery model.¹³ Though contrary to what we expected, there are several potential explanations for this discrepancy. First, each clerkship includes different residents and attendings, and students bring unique perspectives based on prior experience to their rotation. The variation may lead to differing student experience and satisfaction. Additionally, as the study was not masked, clinical staff was aware of which students received video instruction. Residents may have gravitated to a more hands-off approach during postpartum rounding for intervention-group students prepared by video. This potential discrepancy in teaching styles may explain why students in the intervention group rated “interaction with residents” lower than the control group. It also may explain why the intervention group felt that postpartum rounding was less important to the overall clerkship. Alternatively, watching the video may have led the intervention group to set their expectations for postpartum rounding higher than the control group, resulting in more dissatisfaction at the end of the clerkship. Students who received the video intervention reported feeling prepared by the video and that they would recommend the video to other students, demonstrating overall acceptability. Still, we must interpret this stated satisfaction with caution, as medical students may feel obligated to demonstrate gratitude for any teaching source, regardless of its perceived utility. Uptake, as measured by additional use, rather than satisfaction, may be a more accurate measure of students’ perceptions of new resources.

We acknowledge several limitations in this study. First, we used a fixed sample size for over 6 clerkship groups. Randomization by group was used to prevent social interaction threats including diffusion of information between students, which could occur if students were individually randomized. This feature, while necessary, makes our satisfaction results more susceptible to the influence of a particular team of residents, attendings, and nurses. Second, while we were powered to detect moderate effect sizes, we lacked sufficient power to detect smaller, subtler influences on medical decision making. Third, though the clerkships were randomized, the intervention group had a higher baseline physical exam score than the control group. Additional analyses (not shown) were performed to confirm that the increase in scores across clerkships was higher in the intervention group, suggesting no impact of this initial difference. Other limitations include our study was performed at a single academic institution, limiting the generalizability of the results, and our use of a no-intervention control group limits our ability to make conclusions about which element of the intervention was most effective, the 4C-ID method, the video, or the

combination. Finally, we utilized a novel instrument for measuring knowledge. Though the instrument was trialed in a group of equivalent students prior to the study, it has not been validated in larger populations. Still, we believe this study provides an innovative approach to inpatient medical education and provides important pilot data for considering new theoretical (4C-ID) and delivery (video) models.

Based on our experience with implementing inpatient postpartum video education, we have several suggestions for improving student experience. First, combining video and face-to-face instruction not only reinforces concepts introduced in the video, but also demonstrates the value of material to students. Additionally, setting student expectations of their rounding experience may help prevent dissatisfaction. Finally, encouraging students to revisit the video may help solidify knowledge and help students feel supported while rounding. Though video may be a helpful educational adjunct, our study suggests that it should be used in conjunction with, not instead of, clinical teaching.

CONCLUSIONS

The 4C-ID platform for education administered through a video model was insufficient to demonstrate improvements in MDM on the Ob/Gyn clerkship. The decreased student satisfaction scores suggest video, while easily incorporated into clerkships, is not a panacea for all educational challenges and may have negative impact. Future work will be needed to better understand best practices in integrating video into the clerkship experience: standalone video interventions are likely insufficient to create meaningful change and should be explored as adjuncts, rather than replacements, to usual clinical teaching to help modern learners improve general knowledge and MDM across all fields efficiently and effectively.

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SUPPLEMENTARY INFORMATION

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