Effectiveness of Digital Multimedia Educational Aids Produced by Intensive Care Unit Providers

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J Pediatr Intensive Care 2018;7:182–187.

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Abstract

Multimedia improves understanding of information. Professionally developed digital multimedia educational modules are expensive. We tested educational modules developed by a medical student without extensive multimedia production training. The modules were developed with neonatologist collaboration, uploaded to YouTube, and presented via iPad to neonatal intensive care unit family members who were ≥ 18 years, English literate, and unexposed to topic they were reviewing. Thirty-six participants viewed the modules once and then answered topic-specific key questions. Thirty of 36 (83%) of the participants answered 4/4 (100%) of questions correctly and 6/36 (17%) answered three-fourths (75%) correctly, demonstrating success of the educational modules. Health care workers can economically create effective digital multimedia educational materials without extensive training.

Keywords

- parent education
- handheld computer
- multimedia

Introduction

Family-centered medical care is recommended by the American Academy of Pediatrics, and evaluation of this approach show that family involvement decreases health care costs and improves health outcomes.¹ To involve families, a large focus is on education aimed to empower and inform parents about their necessary role as advocates and caregivers.² Providing relevant education to families anticipating a pediatric intensive care hospitalization presents unique challenges as parents are often overwhelmed and the intense parental feelings associated with the hospitalization limits their capacity to comprehend new information.^{2,3} Additionally, these hospitalizations can often be prolonged and regular parent visitation can be hampered due to distance, work, and sibling care. Ideally, parent educational materials must meet the informational needs of all families, the information must be easy to understand, and accessible outside the hospital for review and sharing.^{4–8}

Cognition science evidence shows that the combination of graphics and narration facilitates greater understanding of concepts and the visuals help with the neural storage and retrieval of information.⁹ An added benefit in using multimedia

is for low-literate adults, who focus on word-for-word reading in written text rather than comprehending key concepts. Learners need to form a mental image and connect it with words when presented without visuals, which can be difficult for those with low literacy. Thus, multimedia allows low-literate adults to learn key information by presenting visuals with step-by-step teaching to create an action sequence, which is more interactive than textual explanations.⁹

Digital audiovisual information in a physical form, such as a digital video disc (DVD), limits its accessibility outside the hospital. This can be overcome by providing audiovisual information via the Internet that can be easily viewed and shared regardless of setting.^{10,11} The extant literature recommends digital multimedia as an ideal mode of parent education. Digital multimedia educational materials are more effective than verbal and print materials, diminish barriers imposed by poor health literacy, and can be distributed electronically.^{12,13} Parents prefer videos and the Internet for learning resources.^{14,15} Pediatric parent teaching practices need to be updated to enhance understanding and reflect today's digital society.

It is costly to have multimedia production professionals develop parent educational materials. Our study's hypothesis

received

December 23, 2017

accepted after revision

February 13, 2018

published online

March 15, 2018

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Verlag KG, Stuttgart · New York

DOI <https://doi.org/10.1055/s-0038-1637747>.
ISSN 2146-4618.

is that health care providers who lack extensive multimedia production training can develop effective, low-cost digital multimedia educational materials for parents.

Methods

Study Setting

We tested the hypothesis in a level 4 tertiary neonatal intensive care unit (NICU) setting. After Institutional Review Board approval, family members of NICU patients who were ≥ 18 years old, English literate, and available in the NICU were approached for study participation. The purpose of the study was explained to the family members and they were asked if they had prior knowledge of any of the six topics. If they had never received any information on one of the study topics, they were recruited to test that particular module. Participation was voluntary and anonymous.

Development of Educational Modules

Topics for parent education were identified by six parents who had experienced extreme premature birth. Study limitations of time limited the number of educational modules to be developed for this study. Six prematurity-related core topics were selected by institutional neonatologist for digital multimedia educational module development. Some of the topics recommended by parents but which were not included due to study logistic limitations included: arterial lines, peripherally inserted central catheters (PICCs), breast feeding in the NICU, necrotizing enterocolitis, developmental delays, and cerebral palsy. The six topics selected for the study included (1) intraventricular hemorrhage (IVH), (2) lungs and breathing, (3) feeding and nutrition, (4) retinopathy of prematurity (ROP), (5) patent ductus arteriosus (PDA), and (6) NICU discharge criteria. During the creation process, institutional neonatologists screened each educational module and suggested revisions.

Doceri produced by SP Controls Inc. was identified as a feasible tool to create the digital multimedia educational modules. The Doceri app allows users to hand-draw their own illustrations on the iPad screen and these illustrations play in real-time to show as each pen stroke is created. Using the iPad's built-in microphone, it is possible to record a voiceover to explain the illustrations. Doceri can be used with the iPad alone or through a computer and it is free to

download from the Apple App Store. The Doceri app also allows the product to be uploaded to YouTube, which is easily accessed through all smartphones and shared through email.

A second-year medical student (S.A.) who had no prior experience in creating digital multimedia educational materials used the Doceri app to create the six educational modules. On average, it took approximately 3 hours to write the script, create and draw the initial slides, and record the voiceover. Using the Flesch–Kincaid Grade Level formula, we aimed for the scripts to be written at a sixth-grade reading level or below, as it is most appropriate for general patient population.^{16–18} However, the scripts for NICU discharge criteria, feeding and nutrition, and ROP could only be written at a seventh to eighth grade reading level. However, audiovisual materials allow for flexibility with reading grade level comprehension as one study showed patients preferred an audiovisual tool despite a higher reading grade level compared with the lower reading grade level written material.¹⁴ To aid in comprehension of the written information presented, consistent word choices were made and the number of words on the slide were limited.¹⁷ If difficult medical words were mentioned, the term was displayed on the slide for a visual cue and a nontechnical explanation was given. Health literacy research shows that simple symbols, graphics, and minimal use of color allow viewers to focus on relevant details.¹⁹ Besides limited use of medical jargon, attention to communication style was necessary to allow the dialogue to feel inclusive and conversational.¹⁷ Therefore, plain language and personal pronouns were used whenever possible. To improve comprehension, simplicity was preferred over accurate, anatomical figures.^{20–22} Select screenshots of the PDA module is shown in **Fig. 1**. Link to YouTube to view the educational modules is: <https://www.youtube.com/channel/UC5BijG31dXPomBnAycTgF3A>.

Analysis

After viewing the educational module once on an iPad, participants completed a written questionnaire with four open-response questions about the topic. These four questions were recommended by the institutional neonatologist to be the key information that parents need to know about the health topic. A survey item also assessed the ease of understanding the educational module based on Likert scale (1–5), 1 being most easy and 5 being most difficult. An optional survey item allowed

Fig. 1 PDA module. We wanted families to know that the ductus arteriosus is a blood vessel that is normal part of circulation in the womb and it naturally closes after birth. PDA can be problematic because blood can overload the lungs, which overworks the heart and lungs. If needed, treatment options include medication or surgery. PDA, patent ductus arteriosus.

participants to list comments or suggestions for improvement. Total count and percent were reported for categorical variables. Mean and standard deviation were reported for continuous variables. If participants could answer 75% of the questions regarding the topic correctly, the educational module was considered successful as a parent teaching tool because parents could comprehend the majority of the key points.

Results

Thirty-six participants (6 per topic) were consented and completed the study. ▶ **Table 1** provides participant demographic information. ▶ **Table 2** presents topic questions, participant responses, proportion of correct responses, and participant perception of ease of understanding for each module. Overall, 83% of the 36 participants answered 100% of the questions correctly and the remaining 17% answered 75% correctly, demonstrating basic understanding of the topic and success of the digital multimedia educational materials.

An optional question on the questionnaire asked participants to “List any suggestions to improve the video.” Twelve of the 36 participants chose not to answer this question. The 24 responses were overwhelmingly positive and these responses addressed two themes. Twenty-five percent of the comments related to the drawings and voice-overs created for the educational modules. One example: “Know eye is more complex, but like how simple it was to understand ROP.” One participant with a health care background wrote, “More anatomically appropriate visual aid depending on target audience background” for the PDA module. Therefore, the simplicity of the drawings might be too basic for some viewers who want a more in-depth explanation. Participants particularly liked how the topic was presented in the audiovisual format. For example: “Great job explaining the topic, very clear. I appreciated the visuals and how slowly you spoke.” The remainder of the comments related to how the information was provided in the modules and ease of com-

prehension due to key terms and explanations. For example, “I like the way everything is shown in the video while they explain,” and “I like demos used and how it’s written out as it’s spoken.” Another family member commented “very easy to understand and follow.” Some of the feedback highlights the goals we wanted to achieve for the modules. For example, “Appreciate glossary of terms, hard when lots of medical terms thrown around and even with Master’s degree, afraid to ask and be concerned with child’s health” and “Good tool to ask more questions.”

Discussions

This pilot study demonstrates that health workers who lack extensive training in multimedia development can produce effective multimedia family education materials on a small budget. Family members who had not received any prior information regarding the educational topic were able to correctly answer relevant questions about the topic after viewing the modules once on an iPad. In addition, the vast majority of family members provided very positive feedback regarding the educational materials. Barriers to this production method include access to an iPad and the need for basic drawing skills. Time is a large barrier for health care workers; however, in following this simple and straightforward method, a video module can be completed within a few hours.

Once completed, the videos provide a platform for future parent–provider discussions. A study by Markman et al, looking at the feasibility of medical students utilizing six different medical education apps on their personal smart phones or iPads for in-patient bedside teaching, demonstrates the value of audiovisual tools for patient teaching.²³ Students thought their “impromptu teaching” was “enhanced” by “illustrations” and the “ability to annotate and modify images and subsequently email to patients was an extraordinary improvement in provider–patient communication.”²³ One could argue it might be easier to direct parents to one of the innumerable Web site sources for information; however, focused information that is verified by the health care team is irreplaceable and personal. Family education on the Internet is suitable to give families a general background on NICU topics. However, the investment into creating an audiovisual tool provided by the health care team initiates conversation and directed information about a specific topic. Therefore, health workers would benefit in using our method to create personalized audiovisual modules because of the ability to provide long-lasting and reproducible teaching for patients. In addition, health workers do not have to be present when the modules are viewed; they can be discussed and viewed whenever convenient. A randomized study showed that parents who watched a DVD intervention compared with paper handout intervention reported higher confidence in recognizing congestion and in bathing their baby, and had fewer additional office visits. Therefore, there might be long-term benefits to incorporate audiovisual materials into practice for parent education because it may lead to better usage of health care resources.²⁴

The experience of seeking voluntary family participation in the NICU was extremely positive; most families were

Table 1 Participant demographics, *n* = 36

Variable		%
Gender	Male	17
	Female	83
Age (y)	18–25	28
	26–35	53
	36–45	11
	> 45	8
Education	High school	42
	Associate degree	17
	Bachelor degree	19
	Graduate degree	22
Previous preterm delivery	No	89
	Yes	11
Works in medical field	No	92
	Yes	08

Table 2 Topic-specific assessment of effectiveness of educational modules

Topic	Correct answers	Ease of understanding, median (range) ^a
IVH, $n = 6$	4 scored 100%	1 (1–1)
<u>Duration of module:</u> 4 min 10 s <u>Questions:</u>	2 scored 75%	
1. Why are premature babies at risk for IVH? <i>Correct answer: "Blood vessels are immature," "Blood vessels are prone to bleeding"</i> <i>Incorrect answer: "Blood tissue sensitive and not developed," "Brain not fully developed"</i>		
2. How is IVH diagnosed? <i>Correct answers: "Head ultrasound," "Through an ultrasound"</i>		
3. How many grades are there in IVH? <i>Correct answer: "4," "Grades 1–4"</i>		
4. What are the complications from IVH? <i>Correct answer: "Brain damage," "Bleeding in the brain (tissue) & fluid in the brain"</i>		
Lungs and breathing, $n = 6$	4 scored 100%	1 (1–3)
<u>Duration of module:</u> 3 min 20 s <u>Questions:</u>	2 scored 75%	
1. What does surfactant do? <i>Correct answers: "Helps the baby breathe easier," "Helps the lung's airways to open"</i> <i>Incorrect answer: "Give baby more oxygen"</i>		
2. What is the least intense intervention to help the baby breathe? <i>Correct answers: "Oxygen through the nose," "oxygen"</i> <i>Incorrect answer: "surfactant or artificial surfactant steroids"</i>		
3. What is the next intense intervention to help the baby breathe? <i>Correct answers: "CPAP," "Oxygen and pressure"</i>		
4. What is the most intense intervention to help the baby breathe? <i>Correct answer: "Ventilator"</i>		
Feeding and nutrition, $n = 6$	4 scored 100%	
<u>Duration of module:</u> 5 min 58 s <u>Questions:</u>	2 scored 75%	1 (1–1)
1. What is the first step to feeding in the NICU? <i>Correct answers: "TPN," "Total parenteral nutrition"</i> <i>Incorrect answer: "Through the belly button," No answer given</i>		
2. What is the second step to feeding in the NICU? <i>Correct answers: "Tube in the nose," "NG tube"</i>		
3. What is the final step to feeding in the NICU? <i>Correct answers: "Feeding by mouth," "Bottle/breast"</i>		
4. When does the baby develop the skills to feed by mouth? <i>Correct answer: "34–36 weeks"</i>		
Retinopathy of prematurity, $n = 6$ <u>Duration of module:</u> 5 min 56 s <u>Questions:</u>	All 6 scored 100%	1 (1–3)
1. What is retinopathy of prematurity (ROP)? <i>Correct answers: "When blood vessels grow abnormally in the eye," "Blood vessels grow weirdly and retina detaches"</i>		
2. What happens when the retina becomes removed or detached? <i>Correct answers: "It can cause blindness," "Blindness"</i>		
3. How is ROP diagnosed? <i>Correct answers: "By special eye doctor," "Eye doctor diagnoses it before baby goes home"</i>		
4. How many stages are there in ROP? <i>Correct answers 5 or 6 (As ROP is staged 0 to 6)</i>		

(Continued)

Table 2 (Continued)

Topic	Correct answers	Ease of understanding, median (range) ^a
Patent ductus arteriosus, <i>n</i> = 6 Duration of module: 5 min 7 s Questions:	All 6 scored 100%	1 (1–2)
2. What is a ductus arteriosus? Correct answers: “Blood vessel in womb,” “Connection between lungs and body” 3. What naturally happens to the ductus arteriosus after the baby is born? Correct answers: “Closes,” “It goes away” 4. Why can patent ductus arteriosus (PDA) be a problem for premature babies? Correct answers: “Makes heart and lungs work harder,” “Lungs fill with too much blood” 5. What are the treatment options for PDA? Correct answers: “Surgery,” “Meds or surgery”		
NICU discharge criteria, <i>n</i> = 6 Duration of module: 4 min 44 s Question: List at least 4 of 6 goals that need to be achieved in order for the baby to go home. (1) No illness that requires continuous care and NICU monitoring, (2) be able to keep a normal body temperature, (3) be feeding and growing, (4) breathe with no direct help needed, (5) have a doctor to continue care, like a pediatrician, (6) parent education and teaching completed	All 6 scored 100%	1 (1–1)

Abbreviations: CPAP, continuous positive airway pressure; IVH, intraventricular hemorrhage; NICU, neonatal intensive care unit; PDA, patent ductus arteriosus; ROP, retinopathy of prematurity;

^aLikert scale 1–5, 1 being most easy and 5 being most difficult.

happy to take time to watch an educational module and provide feedback, even if the topic was nonrelevant to their infant. Families were excited about the prospect of a teaching tool they could use independently in their free time. Since the modules can be uploaded to YouTube, a familiar and ubiquitous site, they are easily accessible. A barrier to usage might involve family hesitancy to use new technology or watch a module from an unfamiliar Web site source; however, such concern is eliminated if the educational materials are provided by their child's health care team.

Feedback demonstrated that the multimedia capability of the modules was beneficial for learning. The visuals were determined to be adequate and appropriately simple for most participants, demonstrating that noncomplex and non-anatomical drawings are sufficient to teach basics of medical topics.²¹ A review on methods and technology to promote developmental-behavioral promotion in pediatrics primary care emphasizes that verbal advice, which is most commonly used by providers, works the best when the information is straightforward and contains only a few main points. Therefore, a better solution for families in an intensive care setting is multimedia to facilitate discussion and teach complex topics.²⁵

One additional and key finding based on feedback was how appreciative families were for a platform to ask more questions and engage in learning about their infant's health. In a randomized study, parents who watched an educational video about cystic fibrosis prior to meeting with a genetic counselor to discuss positive newborn screening results scored higher on a

postmeeting knowledge-based questionnaire compared with nonvideo group.²⁶ Parents report high anxiety because they have to wait weeks before the genetic counseling appointment. Therefore, the researchers suggest that the alternative means for communicating outside the clinical setting may have allowed for better comprehension and retention. As infants can stay days or weeks in the NICU, the ability to communicate with families outside of the intensive care unit (ICU) might be beneficial. Overall, the modules are able to serve the family-centered care goal of involving families and making them feel more comfortable to ask questions and to communicate more freely with the health care workers.

Limitations for the study include lack of a control group to determine effectiveness of the modules as compared with the practice of parent teaching using verbal and/or printed information. However, our intention was not to compare methods, but to explore if participants were able to learn important information regarding each topic utilizing our low-cost digital multimedia information produced by health workers who are not trained in multimedia production. Participants were given the questionnaire immediately after viewing the module; therefore, short-term recall was best assessed. A delayed posttest to assess longer-term memory and understanding would be important to further test effectiveness.

Only one participant wrote feedback for less medical terms. This was for the IVH module, which contained medical terms we believed relevant for families affected by IVH condition, like “hydrocephalus” or “cerebrospinal fluid [CSF].” The basic

information for families to know about each medical topic can vary and attention to limit distracting information is important. If providers give too little information to families, it creates fear about the unknown and if providers give too much information or speak too much medical jargon, it creates confusion and more anxiety for families.^{27,28} Attention to the balance of information provided by health care providers is important in family-centered care.

Implications for Practice

All six modules were considered successful in teaching participants about the basic information of the medical topic. The success the medical student had in creating these modules on a low budget should encourage ICU health workers to leverage the power of digital multimedia to create educational materials specific to their patients' needs. Audiovisual modules handcrafted by providers empower families in their roles as advocates and caregivers and promote good communication with the perinatal team.

Acknowledgments

Ms. Amherdt was funded through the Drs. Elsa B. and Roger D. Cohen Summer Fellowship. Support for supplies was provided by Department of Pediatrics, Medical College of Wisconsin. The authors have no financial relationships relevant to this article to disclose. All authors have no conflict of interest relevant to this article to disclose.

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