Differential Diagnosis

An Interactive Course for Health Care Providers to Practice the Diagnostic Process of Young Children

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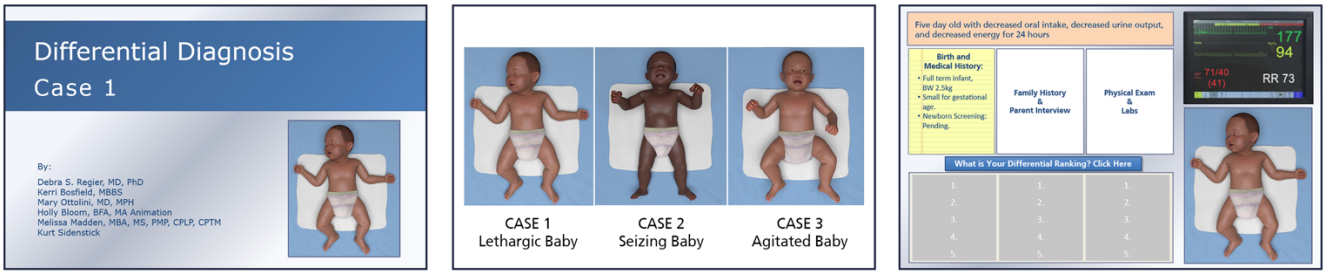

Figure 1: (left) Case 1 module title page (middle) The three case studies (right) Case 1 Introduction

ABSTRACT

Children's National Hospital is a leading pediatric teaching hospital with medical students, residency programs, fellowships, and research initiatives. Children's National uses online e-learning in its training, including interactive courses with 3D animated virtual simulations.Infants and young children can be hard to diagnose since they cannot easily tell doctors where it hurts or what they are feeling. Thorough diagnosing is important because diseases may often resemble other issues. Medical trainees of all levels require practice in the process of forming a diagnosis through organized steps in information gathering via medical history, lab results, and physical exam findings.The creation of educational videos of ill infants pose unique problems since children cannot self-consent, have rapid decompensations from minute to minute, and video capture can put the infant at risk. For example, a videographer would need to be in close proximity to a small child and could lead to increased exposures or prevent the care team from giving timely care. In addition, children often present with only one or two findings and these expand with time. As we work to ensure diversity in education and learning, the ability to create cases with diverse patient populations is important. While in a clinic setting, it is unethical to "allow" disease progression. Using 3D virtual simulation, the diagnostic process can be taught without risk to the patient.

CCS CONCEPTS

• **Applied computing**; • **Life and medical sciences**; • **Computing methodologies**; • **Modeling and simulation**;

KEYWORDS

Interactive Design, Virtual Simulation, E-Learning, Medical Training

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1 INTRODUCTION

The purpose of this study is to test the efficacy of an online multimedia immersive learning simulation to understand the knowledge, disease progression, and physical exam findings of acutely ill infants.

This course includes three case studies with differing symptoms, health states, and ethnicities. Students must examine patient history, family history, parent interviews, physical exams and labs, and

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virtual simulations of the patients while narrowing down their diagnosis using differential ranking. Interviews with the parents are recreated as videos using actors. Summary slides feature videos of Dr. Regier presenting real case studies and revealing the true diagnoses.

2 STUDY POPULATION

This course is designed for learners at multiple levels, from medical students and pediatric residents to medical genetics residents.

3 DESIGNS AND METHODS

3.1 Study Design

This interactive course was developed in Articulate Storyline and published as a Shareable Content Object Reference Model (SCORM) compliant package, for tracking the learner's decisions and performance throughout the simulation using a Learning Management System (LMS). Custom 3D baby models and animation were created in Autodesk Maya and timed to supporting infant sounds and cries where appropriate.

The 3D simulations were vetted with physician specialists (i.e. infant neurologists for seizures, metabolic physicians for Kusmal breathing changes, and pediatric hospitalists for encephalopathic infant) to ensure accuracy of the simulation. This was essential to the process due to the paucity of videos available that accurately represent these clinical states in infants available on the internet. Thus, the underlying reason for the creation of these modules led to recruiting physician specialists to vet the 3D simulations. Each video was vetted by at least 3 pediatric specialty physicians before incorporating into the final course modules.

3.2 Platform

The courseware training is available on a Children's National Hospital internal Portal, http://childrensmedicaleducation.org/learnrd/, and published on a Moodle-based Learning Management System (LMS). Student responses are tracked and utilized to ascertain their strengths and weaknesses in diagnosing patients.

3.3 Study Group

The first group of trainees to use the program were asked to participate in a survey on their opinion about the three modules, determine the time to complete the modules, and identify the best time in the learning process to participate in the modules. This group of 14 individuals were used to modify the first iteration and make changes that led to the current modules.

3.4 Ranking Process

Students are given a chance to rank their diagnoses from a list provided after each stage of information is revealed. By the end of the course, they have had three opportunities to adjust their rankings, and are given one more chance to submit a final result.

4 BABY MODEL MECHANICS

The 3D baby models in this course are animated using multiple custom-made blend shapes for the facial, inside mouth and tongue expressions, and an underlying skeletal joint structure for the body. The model has additional blend shapes for the cheeks, ears, and body thickness, making it possible to represent a nearly newborn to toddler aged child. Set-driven expressions connect the inside mouth geometry deformations to the facial movements. A variety of skin

Figure 2: Case 3 Ranking (left) Screen Round Two Selections (right) Round Two Results

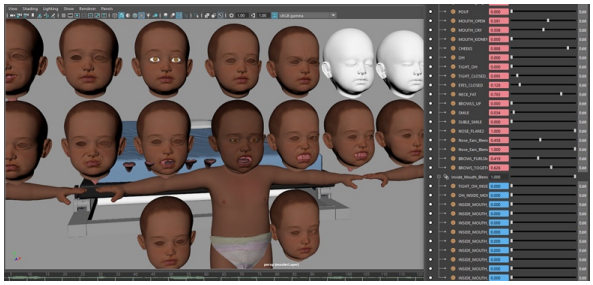

Figure 3: Blend Shapes and Facial Controls in Maya

textures are used depending on the ethnicity being portrayed. Pre-rendered movies of the baby's actions are triggered depending on the case study and screen the student is viewing.

5 CONCLUSION AND NEXT STEPS

Through the use of this course, students were given the opportunity to practice in a simulated environment without real-life risks to patients. The average completion time per student was 29 minutes to complete all three modules. Students reported they preferred learning about clinical cases using this interactive course over a traditional lecture format.

Future plans to expand this course include increasing access to more providers, including the broader metabolic and pediatric communities. The goal is to create additional modules that would then constitute an hour of training material, thus making the training CME (physician) and CE (nurses) eligible.

Using this format, additional courses can be created with a host of recent disorders coming to light. For example, an infant with COVID-19 could be represented with findings such as a rash or respiratory distress. As new information becomes available, we can "recreate" the most accurate example cases for emerging infectious diseases.

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