Comprehensive Neonatal Resuscitation Course: Integrating High-Fidelity Simulation and Novapp for Enhanced Performance Evaluation

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Abstract

This paper presents a course on neonatal resuscitation training, focusing on the use of high-fidelity simulations to enhance the practical skills of healthcare professionals in managing critical newborn emergencies. The course emphasizes improving technical/non abilities, decision-making, and team working through realistic scenarios, helping participants build confidence and competence. Additionally, the course integrates the mobile app Novapp, which is used to evaluate pediatric residents' performance during the simulation sessions. The app provides real-time feedback and assessments, contributing to continuous improvement in neonatal resuscitation skills and overall patient outcomes.

Keywords

Education AI in healthcare, Personalized learning, Neonatal Simulation course

1. Introduction and Motivations

Neonatal resuscitation is a critical intervention requiring precise, timely actions from healthcare providers to prevent severe complications, including brain damage or death, in newborns experiencing life-threatening conditions. Given the high-stakes environment, effective training for neonatal resuscitation is essential to ensure that medical personnel are well-prepared to respond efficiently under pressure. Simulation-based training has emerged as a cornerstone in medical education, offering a safe, controlled environment where healthcare professionals can practice and refine their skills [1, 2, 3]. Among the various forms of simulation, high-fidelity simulation stands out due to its ability to replicate realistic clinical scenarios with advanced technology that mimics real-world physiological responses.

High-fidelity simulations allow medical teams to engage in neonatal resuscitation in a manner that closely mirrors actual clinical challenges, improving technical skills, decision-making, and teamwork—all critical to successful neonatal care. These simulations also allow for repeated practice of rare but high-risk scenarios, which are often difficult to encounter in clinical settings [4].

To further enhance the effectiveness of the course, this training incorporates the use of the mobile app Novapp, designed to evaluate and provide real-time feedback on the performance of medical students during simulation sessions. Novapp offers detailed assessments of critical tasks, decision-making processes, and team interactions, enabling learners to identify areas for improvement and track their progress over time. By integrating technology-driven evaluation into high-fidelity simulation, the

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course provides a comprehensive learning experience that not only strengthens clinical skills but also ensures continuous development through personalized feedback.

This paper describes the neonatal resuscitation simulation course, highlighting the use of high-fidelity simulation and the Novapp mobile app for evaluation. Together, these tools offer a robust framework for medical personnel to gain the hands-on experience and confidence needed to improve neonatal resuscitation outcomes.

2. Course structure summary

The course begins with an overview of the principles of neonatal resuscitation according to the latest American Heart Association guidelines [5], followed by a pre-simulation briefing to familiarize participants with protocols and the use of the Novapp mobile app for performance evaluation. High-fidelity simulation sessions are conducted in realistic delivery room scenarios, focusing on technical/non technical skills, decision-making, communication, and teamwork. After each session, participants receive immediate feedback through debriefing and Novapp assessments. The course includes repeat simulations to refine technical/non-skills and concludes with a final evaluation, offering certification upon successful completion. This structure ensures continuous learning and improvement in neonatal care.

3. Case-Scenario: an Overview

During one of the simulation sessions, a critical scenario is presented: the newborn is apnoic immediately after birth, requiring immediate resuscitation. The residents, divided into small groups, must manage the situation under time pressure, performing tasks such as airway clearance, positive pressure ventilation, chest compressions, administration of medications (such as adrenaline) and fluids. They are expected to demonstrate teamwork, communication, and quick decision-making.

Patient Information:

- **Background:** the trainees are called to attend an emergency cesarean delivery due to umbilical cord prolapse. Cardiotocographic tracing showed fetal bradycardia.
- **Gestational age:** 40 weeks
- **Weight:** 3 kg
- **Apgar score at 1 minute:** 1 (Appearance: cianotic, Pulse: <60 bpm, Grimace: no response to stimulation, Muscle tone: none, Respiration: apnoic)

Despite starting positive pressure ventilation, performing corrective ventilation and placing an advanced airway, the heart rate does not improve. Therefore, residents should continue the neonatal resuscitation algorithm with cardiac massage, adrenaline administration, and fluids. Only after the administration of a fluid bolus, if the previous actions have been performed correctly, does the newborn improve permanently.

Simpler scenarios in which it is not necessary to perform the entire neonatal resuscitation algorithm are also available.

4. Novapp as a Learning Support Tool

The developed application is designed for Android devices, both smartphones and tablets, and is aimed at healthcare professionals for neonatal resuscitation simulation. It offers the possibility to access either as guests or through authentication with personal credentials. To facilitate learning in an educational context, users can choose between four simulation scenarios with increasing difficulty levels.

Each simulation records the timing and sequence of taken actions(this activity is shown in Figure 1), and through a specific algorithm, penalties are assigned based on the performed actions. This helps

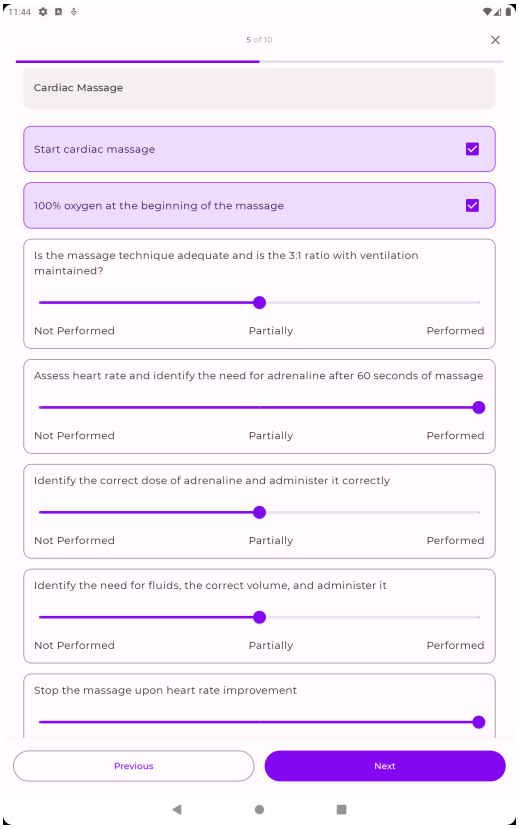

Figure 1: Cardiac Massage: Some key actions, such as the start of cardiac massage, the administration of adrenaline, and fluids, are carefully recorded and synchronized with the time of birth, allowing an analysis of the timing of critical interventions. These parameters are compared to ensure comprehensive monitoring of the simulation, visible in the report screen.

to identify the team's strengths and weaknesses during the simulation. It is also possible to navigate back and forth between different screens, offering great flexibility in use. At the end of each session, a detailed report is generated, assigning a score based on the operations that were carried out. The report (shown in Figure 3) includes two types of assessments: one is related to the technical operations performed during the simulation, and the other evaluates non-technical skills (Figure 2)). During the debriefing phase, participants can compare the results across the various groups that took part in the simulation, encouraging reflection on performance and areas for improvement.

Simulation Room

An immersive room is used, i.e. an advanced simulation room (shown in Figure 4) with an audio and video system for recording and streaming, which reproduces the hospital room where neonatal resuscitation is performed. The instructors and control technicians observe the simulation from the control room behind a one-way glass (Figure 4-left), without being seen by the trainees, where they manage the simulator's actions. The SimNewB high-fidelity neonatal manikin [7] (Figure 4-right), manufactured by Laerdal[1] and designed in collaboration with the American Academy of Pediatrics, is used as a neonatal simulator. SimNewB is a neonatal manikin with realistic features and complete feedback; it is equipped with an airway that allows the use of positive pressure ventilation devices and the placement of endotracheal tubes and a laryngeal mask, a lung compliance that can be modified by the instructor with a realistic variable chest lift, a pervious umbilicus with realistic pulsations that can be catheterised for the insertion of an umbilical catheter, and the possibility of inserting an intraosseous access in both legs. The room is equipped with a neonatal island, ventilation devices (T-piece, flow-dependent balloon, self-expanding balloon), a monitor with cables and electrodes for ECG and saturation

[1] https://laerdal.com/it/products/simulation-training/obstetrics--paediatrics/simnewb/

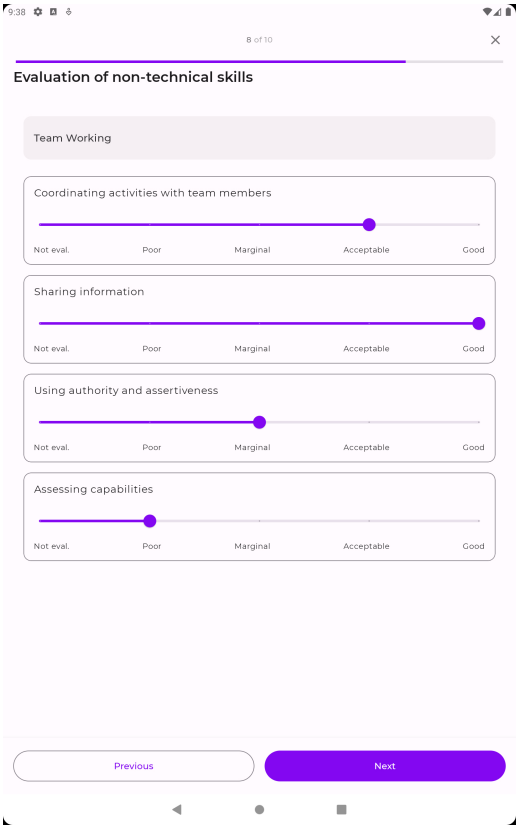

Figure 2: ANTS Scale: Evaluation of non-technical skills using the ANTS (Anaesthetists' Non-Technical Skills) scale [6] as a reference tool. This scale allows for the assessment of skills such as communication, teamwork, stress management, and critical decision-making. Performance is classified on five levels, with ratings ranging from "Not assessable" to "Excellent," corresponding to a score within the [0-4] range. This evaluation system provides structured feedback to improve essential behavioral competencies in resuscitation contexts.

tracing, advanced airway management equipment such as laryngoscopes, endotracheal tubes, laryngeal mask, peripheral venous access, umbilical and intraosseous access equipment, emergency medicines such as adrenaline and fluids, stethoscope.

4.1. Debriefing Session and Personalized Learning Plan

At the end of the simulation, we move to a room where the debriefing takes place. The debriefing provides a method of reflection on the practical part and is the crucial moment in the learning process in the simulation. It is generally conducted using the 'facilitator-guided post-event debriefing' method: the debriefing conversation takes place after the simulation scenario and is led by the instructor who acts as the facilitator of the debriefing [8]. The strengths and weaknesses of the group in the simulation are discussed together with the instructor. The trainees reflect on what they did correctly and what they would change in the future in a similar scenario.

Discussion Points

- Critical Factors in the Scenario
- Key Learning Objectives
- Outcome and Prognosis
- Technical/Non-technical Skills
- Teamwork and Communication

Thanks to the use of Novapp, a performance report is available immediately to provide objective feedback to course participants. Novapp provides data on the timing at which maneuvers were performed

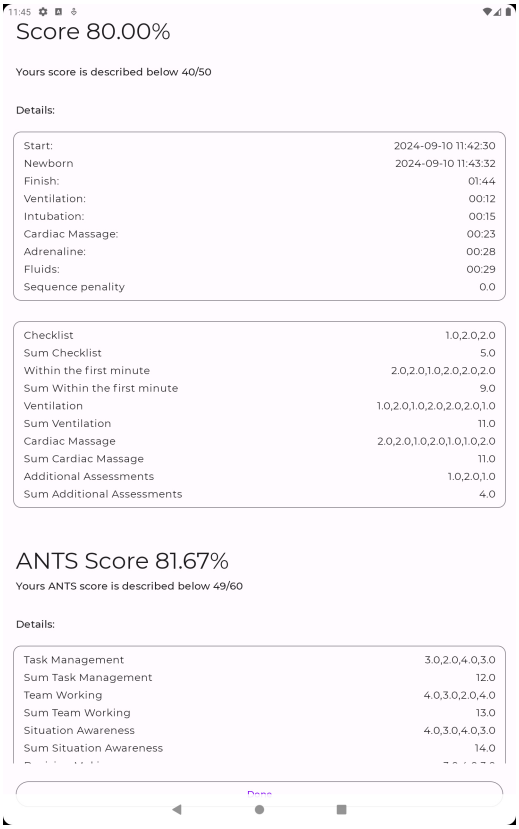

Figure 3: The report screen shows in detail the two different types of evaluation. Specific timings of the performed actions are shown, from the time of birth registration to the administration of drugs and fluids, including the presence or absence of penalties for the sequence of actions. The overall score is calculated based on the sum of actions correctly completed during the simulation and is divided into two main assessments. The first evaluates the correctness of clinical procedures, such as ventilation and cardiac massage, while the second (ANTS Score) focuses on non-technical skills such as task management, teamwork, and situational awareness. This detailed visualization allows users to thoroughly analyze the team's performance, highlighting strengths and areas for improvement, making the simulation an extremely useful learning tool.

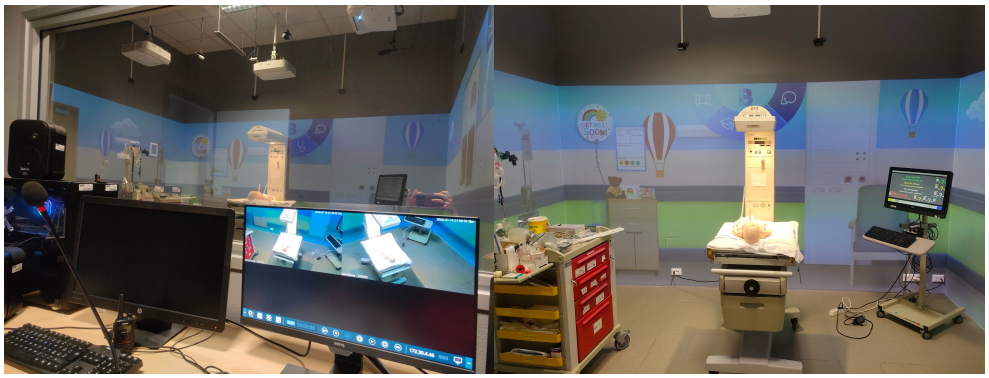

Figure 4: The advanced simulation room

and the agreement with the algorithm. Having this data limits the personal bias of the instructor's subjective perception. A further strength of Novapp is the assessment part on non-technical skills, which are assessed using the validated ANTS scale (Figure 2). To our knowledge, Novapp is the first system that integrates assessment of technical and non-technical skills in neonatal resuscitation. Because of the extreme importance of non-technical skills in ensuring better neonatal outcomes, it is of great benefit to the instructor to have a tool that allows for a systematic and standardised assessment of non-technical

skills, so that they can be discussed accurately in the debriefing and identify strengths and weaknesses of the team that need more work.

After the debriefing session, a customized learning plan is drawn up for each student, adapted to the feedback received. This plan includes:

Targeted Exercises: Specific sessions are organized to teach technical skills (mask ventilation, intubation and advanced airway management, cardiac massage, how to find vascular access in an emergency, emergency drugs and fluids administration) in which trainees can learn the correct technique for performing these technical gestures and practice them repeatedly under the supervision of an instructor, using medium and high-fidelity manikins. After the drill, short simulations are practiced aimed at using the acquired skill. Depending on the outcome of the simulation, trainees are invited to participate in one or more specific simulation sessions to acquire the skills.

To improve teamwork, communication and other non-technical skills, group activities are organised under the guidance of a psychologist in which trainees are invited to participate.

Progress Tracking: Through the use of Novapp, the performance of the group over time in subsequent simulations is tracked, both in terms of overall assessment on the outcome of the patient in simulation and in terms of assessment of specific skills. It is possible to assess by how much time positive pressure ventilation was initiated, performance of corrective ventilation and administration of effective ventilation, proper placement of endotracheal tube or laryngeal mask, the correct execution of cardiac massage, and the correct administration of drugs and fluids over the course of the simulations. It is also possible to compare how group work, task management, situational awareness and decision making have improved over time within a group consisting of the same members. This assesses whether as a result of performing the target exercises, trainees have improved performance.

Video Replay The simulation is conducted in an immersive room equipped with an audio/video system for recording and streaming. In the next simulations we would like to show the video recording to the residents. This will allow them to review the simulation so that they can visually link their actions with the feedback they receive and better understand where they need to improve.

5. Discussion and Conclusion

The immersive environment used in this course, complete with audiovisual systems for recording and streaming, enhances the realism of the simulations. By replicating a Neonatal Intensive Care Unit (NICU) or delivery room with advanced manikins like SimNewB, participants experience a level of engagement that surpasses traditional classroom-based education. This setup also allows for video replay of simulation sessions, offering an invaluable tool for participants to revisit their performance during the debriefing process.

This real-time, immersive feedback loop - simulated practice, immediate evaluation through Novapp, structured debriefing, and targeted follow-up exercises - represents a powerful pedagogical model. It aligns with adult learning principles, which emphasize experiential learning, self-reflection, and practice-based improvement. The ability to link theory directly to practice within a highly realistic setting ensures that participants not only understand neonatal resuscitation protocols but can also apply them confidently in real-life emergencies. The Neonatal Resuscitation Course described in this paper, offers a forward-thinking model for improving both the technical and non-technical competencies of healthcare professionals. By integrating high-fidelity simulation with Novapp, the course provides a comprehensive learning experience that effectively prepares medical personnel to manage critical neonatal emergencies. The combination of realistic, high-pressure scenarios and the objective, real-time feedback from Novapp helps to ensure that participants develop both the procedural fluency and the decision-making skills necessary for optimal neonatal care. The structured feedback offered by Novapp, particularly its emphasis on technical and non-technical skills, is a critical innovation, providing

participants with a clear roadmap for continuous improvement. By standardizing the assessment process and offering personalized learning plans, this course addresses many of the limitations inherent in traditional medical training. The result is a highly effective, learner-centered approach that fosters both confidence and competence among neonatal care providers.

Moving forward, the potential applications of such integrated learning models are immense. Expanding the use of technology-driven assessment tools like Novapp across other medical disciplines could significantly improve training outcomes and, by extension, patient care. Additionally, the inclusion of video replay and other immersive elements in the simulation, could further enhance the reflective learning process, allowing for deeper insights into both individual and team performance.

Furthermore, the app's progress-tracking feature, allows participants to monitor their improvement over time. By reviewing their performance across multiple simulation sessions, participants can visualize their development in specific areas, such as performing positive pressure ventilation, intubation, or administering emergency drugs within the recommended timeframes. This longitudinal tracking of progress reinforces continuous learning and improvement, ensuring that participants refine their skills long after the course concludes.

Ultimately, this course contributes meaningfully to the field of medical education, offering a replicable framework for the next generation of healthcare professionals to deliver better care in the most critical moments of neonatal resuscitation.

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