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REVIEW ARTICLE

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Video recording in the delivery room: current status, implications and implementation

B. Simma[1]✉, M. den Boer[2,3], B. Nakstad[4,5], H. Küster[6], H. M. Herrick[7], M. Rüdiger[8,9], H. Aichner[1] and M. Kaufmann[8,9]

Many factors determine the performance and success of delivery room management of newborn babies. Improving the quality of care in this challenging surrounding has an important impact on patient safety and on perinatal morbidity and mortality. Video recording (VR) offers the advantage to record and store work as done rather than work as recalled. It provides information about adherence to algorithms and guidelines, and technical, cognitive and behavioural skills. VR is feasible for education and training, improves team performance and results of research led to changes of international guidelines. However, studies thus far have not provided data regarding whether delivery room video recording affects long-term team performance or clinical outcomes. Privacy is a concern because data can be stored and individuals can be identified. We describe the current state of clinical practice in high- and low-resource settings, discuss ethical and medical–legal issues and give recommendations for implementation with the aim of improving the quality of care and outcome of vulnerable babies.

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IMPACT:

- VR improves performance by health caregivers providing neonatal resuscitation, teaching and research related to delivery room management, both in high as well low resource settings.
- VR enables information about adherence to guidelines, technical, behavioural and communication skills within the resuscitation team.
- VR has ethical and medical–legal implications for healthcare, especially recommendations for implementation of VR in routine clinical care in the delivery room.
- VR will increase the awareness that short- and long-term outcomes of babies depend on the quality of care in the delivery room.

INTRODUCTION

Delivery room (DR) management of newly born infants is challenging. While most term neonates transition from in utero to ex utero without special help, up to 10% of (near) term neonates and almost all extremely preterm neonates require support in the DR.[1,2] For the majority, support consists of simple interventions. However, up to 3% of all neonates require intensive interventions, including assisted ventilation, or even endotracheal intubation or cardiac resuscitation.[3] Unfortunately, the need for extensive resuscitation is not anticipated in one-third of cases[2] and unnecessary measures are sometimes instituted prior to ensuring adequate ventilation.[4]

Established algorithms outline the recommended steps of DR care.[1,5–7] This standardised approach to DR care may have a positive influence on morbidity and mortality, especially in preterm infants.[8] However, the complex DR environment involves more than adherence to algorithms in order to be successful:[9] it demands a combination of technical, cognitive and behavioural skills within a well-trained and effective team. Many additional factors may influence success rate and performance in the DR such as the presence and preparation of equipment to be used, and team communication.[10] However, analysis of what happened is difficult and thus impedes the opportunity to learn from the past in order to improve for the future.

This has been substantially changed by video recording (VR), which has become an increasingly popular tool in the DR, allowing analysis of work as done rather than work as recalled. VR allows comprehensive evaluation of care and enables in-depth feedback and debriefings with members of the team. VR of DR care has now been performed for more than 25 years.[11,12] In that time, it has been used to describe, analyse and compare standard procedures, team communication, interaction and their immediate influence

[1]Department of Paediatrics, Academic Teaching Hospital, Landeskrankenhaus Feldkirch, Feldkirch, Austria. [2]Division of Neonatology, Leiden University Medical Center, Leiden, The Netherlands. [3]Department of Medical Ethics and Health Law, Leiden University Medical Center, Leiden, The Netherlands. [4]Department of Paediatrics and Adolescent Health, University of Botswana, Gaborone, Botswana. [5]Division of Paediatrics and Adolescent Medicine, Institute for Clinical Medicine, University of Oslo, Oslo, Norway. [6]Clinic for Paediatric Cardiology, Intensive Care and Neonatology, University Medical Centre Göttingen, Göttingen, Germany. [7]Division of Neonatology, Department of Pediatrics, Children's Hospital of Philadelphia, Philadelphia, PA, USA. [8]Division of Neonatology and Paediatric Intensive Care Medicine, Department of Paediatrics, Faculty of Medicine, Technische Universität Dresden, Dresden, Germany. [9]Saxony Center for Feto-Neonatal Health, Faculty of Medicine, Technische Universität Dresden, Dresden, Germany. ✉email: Burkhard.simma@lkhf.at

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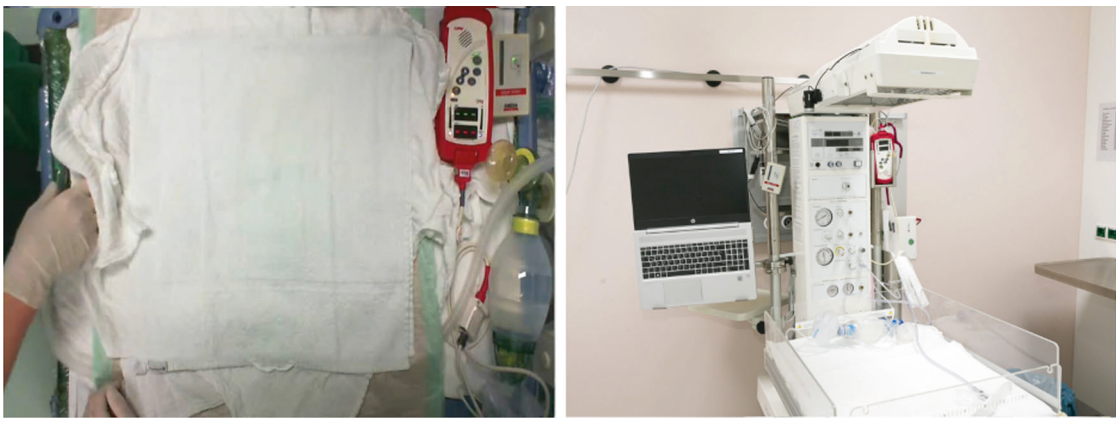

Fig. 1 Resusciation table. Visual field of the resuscitation table (**a**) recorded by a commercially available fixed web camera connected to the overhead warmer (**b**).

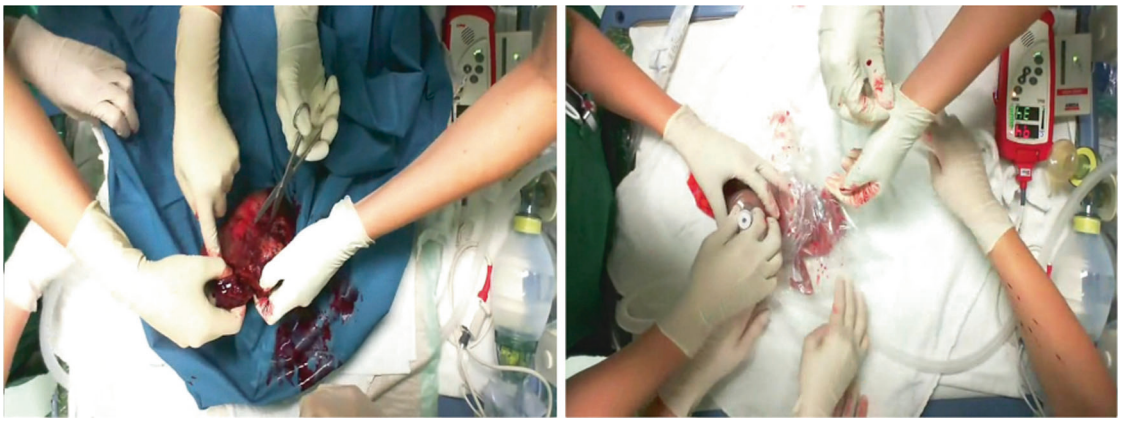

Fig. 2 A preterm infant is transferred to the resuscitation area in the intact amniotic sac including the placenta. The sac is opened on the resuscitation table (**a**), where the umbilical cord is milked and clamped ("En caul delivery),[84] the infant is ventilated and routine care by heat protection in a transparent plastic wrap and monitoring (SpO_2) started (**b**).

on physiological parameters in order to improve quality and patient safety.[9,13–17] Besides quality improvement and research purposes, VR is commonly used as a teaching and training tool as it provides objective data on the postnatal condition of the infant and allows for quality improvement of care.[13,18–21]

In this article, we describe the current state of clinical practice with VR in the DR in both high- and low-resource settings, explore technical settings and review the results of research in simulation and clinical practice. We also describe the ethical and medical–legal implications of VR and give recommendations for implementation in routine clinical care.

CURRENT CLINICAL APPROACH

Two principal approaches can be used for VR in the DR: fixed versus hand-held cameras. Fixed cameras are integrated into the resuscitation equipment or the DR (Fig. 1). A pulse oximeter[16] or respiratory function monitor[2,4,15,16,22] visible in the video may be a useful option. Often the camera is connected directly to the resuscitation table, giving a single bird's-eye view of the neonate and the hands of the care providers[4,17,23–26] (Fig. 2). In other instances, several cameras are in the resuscitation room and offer multiple views of resuscitation and the monitors.[9,15,16] This integrated set-up has the advantage of always being available, even in emergencies. Hand-held cameras may allow more flexibility in recording surroundings and monitors in order to emphasise more relevant events. This approach may make healthcare workers more identifiable and requires additional personnel for filming.[4,22] Both fixed and hand-held cameras can be implemented or a mobile phone can be used to allow live stream recording enabling providers not present in the DR to view DR management in real-time.[4]

The ways in which these videos are stored and later accessed vary greatly. Some centres store videos anonymously with regard to date, location and staff identity, and allow access to only a limited number of healthcare givers or researchers who have access to the videos.[24,26] At other centres, the video is part of the medical record, and parents are invited to watch it.[4,27] Some centres delete the recording immediately after review, often as instructed by ethical approval, while others store the videos temporary before deleting them.[4,12,28]

The frequency and structure of video reviews also vary significantly,[29,30] either taking place on an ad hoc or regular basis ranging from a few times per year to weekly. Video review is performed on an individual basis or as a team approach. The reviews may be structured and used for training purposes by all or only new team members to maintain a certain standard of care.[29]

At some centres, VR in the DR is considered the standard of care for all deliveries.[27,31] Other centres only apply VR for a predefined population[9,17] or perform VR solely for research purposes.[4,17] At some centres, no consent is obtained or an official opt-out is provided because VR is considered routine care and part of regular

quality assurance.[17] At other centres, informed consent is preferably obtained before delivery with the option for deferred consent after birth.[17,25] Most of the variations related to consent are not due to different practices with the implementation of VR, quality improvement versus research, but rather due to different standards and formalities of local or national ethic committees.

VR FOR QUALITY IMPROVEMENT

Analysis of procedures seen with VR has led to neonatal resuscitation guidelines being questioned and ultimately revised. Already in 2004 Lane et al.,[32] after studying intubation, recommended 30 s as a reasonable time for neonatal intubation attempts. In 2006 O'Donnell et al.[33] demonstrated that the time for successful intubation often exceeded the 20 s recommended in guidelines. These studies led to revised guidelines allowing up to 30 s to complete intubation.[34] In a recent multicentre study, the lower interquartile range at all centres was still above these 30 s, further questioning the feasibility of this time limit.[17] In the same study, all centres experienced difficulties acquiring a SpO_2 signal within the recommended time and significant variations were seen in cord clamping, type and duration of stimulation, the extent of monitoring, placement of a gastric tube and venous access, or administration of surfactant.[17] VR studies have also shown that carbon dioxide detectors improve respiratory support[35] and that many distractions occur frequently (median 3.7/min) in the first 3 min of life that are not related to the ongoing resuscitation.[9] Based on the currently available evidence,[36–39] no statements can be made regarding optimal stimulation management, although repetitive stimulation and stimulation at the trunk may be more effective. Used as a quality improvement tool, VR helps to identify suboptimal processes and techniques. Data provided by VR can be used to assess and improve local practices, as well as nationally to develop and improve DR guidelines, as described here for intubation.[17] VR may lead to issues, which should be discussed with parents regarding the DR management of their child.[40–43] Parental review of DR videos is another topic of increasing interest.[28] A planned study protocol will investigate parenteral VR review: In addition to parental viewing of the video, VR will be used to evaluate communication between medical staff and parents in the DR. In this research project, if issues are noted during post debrief or video review, they will be directly addressed with the team (M. den Boer, personal communication). All these discussions will be blame-free and aimed at quality improvement, not at punishment.

VR FOR EDUCATION AND TRAINING

DR management has become increasingly non-invasive. As a consequence, practical training and expertise in invasive procedures are more difficult to gain, e.g. endotracheal intubation. To overcome these limitations and improve team performance and patient safety,[44] many centres have introduced new approaches to training and education that are mandatory in some countries. For example, in all Austrian hospitals, regular training in newborn resuscitation is required by law for all team members attending newborn deliveries, including midwives.[45] These approaches are regular clinical or simulation practice, advanced life courses, or team and leadership training. Common to them is the core issue of feedback by a briefing before and debriefing after the event using different means like verbal comments, the manikin itself,[46] checklists,[47,48] respiratory function monitoring[15,16] or digital recordings (video and/or audio).[28,48,49]

VR is a method that offers an important advantage being a feasible tool for delivering information across different educational levels[29] while allowing in-depth and repetitive review. Implementation of video-assisted debriefings like the Neonatal Resuscitation Program of the American Academy of Pediatrics[7] improves adherence to existing guidelines and team performance.[50,51] By reviewing video-based simulations, resuscitation procedures can be discussed in more detail, thus leading to improved effectiveness, better knowledge and enhanced teamwork.[18,52–54] It is important to emphasise that VR not only provides information about technical and cognitive skills but also about behaviour, teamwork and communication.

VR FOR RESEARCH PURPOSES

Besides being a useful tool for quality assurance and training, VR is frequently used in research.[16,17,38,55,56] This objective method allows very accurate data collection and analysis. VR is more accurate in documenting vital sign assessments than paper-based documentation even when done in real-time.[57,58] In addition, it offers the opportunity to objectively analyse the impact of interventions on physiological measures such as heart rate, skin colour or breathing effort.[31,37,39,55,58] Thus, VR is an invaluable tool for improving knowledge on neonatal transition and the effect of interventions during DR care.

VR also demonstrates significant inter-observer variability when using clinical scores[59,60] and poor reliability for assessing clinical signs like skin colour as part of the Apgar score.[60,61] It also demonstrates the amount of variability within and between neonatal units in Europe and the fact that it is difficult to adhere to the published guidelines.[12,15,17,51,62,63]

VR IN LOW-RESOURCE SETTINGS

While most VR-based studies are conducted in high-income countries with well-equipped hospitals, several have been performed in low-resource settings. There the number of newborns with complications like perinatal asphyxia is high and relevant effects can be accomplished with simple interventions[64–68] without more sophisticated and expensive technologies.[69] In addition, adding VR to DR practice is a feasible and powerful tool for improving and maintaining technical and procedural skills.[23,30] It is useful for quality improvement[24,26,68] and can be performed even in randomised trials.[25] Progress in DR management is essential in low-resource countries as most babies are born there, having a mortality rate of 28 deaths per 1000 live births and a rate of nearly 15% in preterm infants.[70]

ETHICAL CONSIDERATIONS

As with every new technology, VR raises new ethical and legal questions[71,72] and its effects are limited. Considerations include the impact of VR on providers and parents, the method of obtaining consent, data storage and access to the videos as well as medico-legal consequences. Multiple stakeholders are involved in VR of DR management, including the neonate, parents and medical care providers, as well as impacts on future neonates.[72] VR may benefit one stakeholder while adding risks for others. For example, future neonates may benefit from improved quality of care through the use of VR. However, VR per se does not improve the quality of care for the individual neonate actively being cared for. It may instead distract or otherwise negatively affect providers, leading to lower quality of care provided to the individual neonate. Adding vital physiological parameters may result in improved documentation, but does not permit conclusions about the interpretation or diagnosis.[17,59,60]

Privacy is another concern because individuals can be identified, even when only the hands and arms of the healthcare providers are visible. The way VR is implemented affects what ethical considerations are faced. For instance, using a fixed camera raises other ethical concerns than using a hand-held camera showing all healthcare providers in the DR. A feeling of being exposed and unprotected may develop and lead to a climate of

mistrust and anxiety. These considerations have led some centres to stop VR in simulation scenarios and have resulted in a lack of VR approval by ethics committees. Other centres showed that providers forgot that VR was underway during scenarios and DR management.[73,74] Debriefing should be done first within the team that was filmed and only later should it be extended to other persons having a serious interest.[30] Plenary review sessions actually improved DR performance[29,53] and have no disadvantage as compared to an individual debriefing.[71]

LEGAL CONSIDERATIONS

The medical–legal implications are an important concern for VR in the DR.[27,71,72] The admissibility of videos and audio recordings as evidence in court proceedings varies by consent process, ethics approval and country. Because of this variability, general recommendations for use of VR when a baby is born and neonatal resuscitation is required cannot be given. In the research setting, VR is done with consent but de-identified, and the video is securely stored and cannot be re-identified in order to prevent recordings from being used in legal cases.[17] However, if VRs become part of the medical record, it may be compulsory to store them for several years. In such cases, they can be more easily used in court as evidence or for a forensic opinion.

Some may argue that sharing a VR of DR management with parents is similar to parental presence during cardiopulmonary resuscitation of their child.[75,76] In contrast to memory, a VR can be viewed many times and by different reviewers. Showing parents a VR may increase the risk of medico-legal consequences, especially if an audio track is also available, and permits persons and actions to be recognised that are not even seen in the VR. However, parents who watched a VR of their babies reported that being able to review the recording made them less likely to use the video for medical–legal purposes.[12,27] Issues noted during post briefing or later video review should be openly discussed with parents, even in the case of medical malpractice, and should always be noted in the chart.

PATIENT OUTCOME ISSUES

A meta-analysis performed in low-income countries[69] showed that training like the Helping Babies Breathe program leads to a decreased stillbirth rate and increased and sustained first-day survival.[77–79] Using VR and debriefings increases the knowledge and skills in neonatal resuscitation,[30,68] but no data have been provided to prove whether this has an effect on clinical outcomes.

Research in high-income countries shows that briefing and debriefing with VR with[48] or without checklists[47,49] improve team communication, allows rapid identification of issues to be trained and increases adherence to best practice guidelines. However, again, long-term clinical and performance outcomes are uncertain.[1,5,14,80] Other studies are even more sceptical as they were not able to prove that reviewing a VR leads to improved clinical performance in resuscitations.[19,81,82] These studies are all small in number and thus are unlikely to show individual patient benefits. The major benefit of VR is to directly observe and see what is happening in the DR, in contrast to remembering the course of events. This allows an accurate analysis of work as done independent of the written record, the ability to assess interventions, team competence and to help prove the performance which is a benefit for any institution.

IMPLEMENTATION

For successful implementation of VR, we suggest that three major issues be discussed: consent, data acquisition and storage, and analysis.

All persons even remotely involved are to be informed in advance and given the reason for and the aim of VR. The uneasiness of the staff should be actively addressed. A written concept should be discussed and results documented. Parental consent can be prospective, in retrospect (deferral), by default (opt-out) or on admission to the hospital. Prospective informed consent excludes all emergency situations and may select a population that is not representative of those to whom the results will be applied.[83]

If VR is the standard of care, general consent signed at hospital admission is sufficient in some countries. The consent may specify the extent to which the video can be used for teaching and meetings.

The technique used for data acquisition depends on the resources available: a fixed web camera is often the easiest and cheapest way to make videos, even in emergency situations. Additional or hand-held cameras can be used to record and also to identify surroundings, monitors and people. While videos cannot be anonymized, they can be de-identified and should be stored in a password-protected hospital network or computer. If stored videos are immediately de-identified and not used for research, consent may not be necessary. They can be part of the medical record and are therefore accessible for a long time and to anyone who requests to see them.

Analysis and debriefing should be voluntary and first presented and discussed within the team present during the VR. Ideally, a fixed weekly time slot with a predefined end could be reserved for such assessments. Comments from all are welcomed and should always start with positive aspects. Education and training should focus on the sequence of activities, correct and timely assessment of essential vital signs and correct respiratory support, team function and communication.[30] It is important to first win over the staff for VR by reporting on successes early and often, and then to hold staff interest by emphasising long-term goals set by members of the team.

SUMMARY AND CONCLUSION

During the past 25 years, VR in DR management has evolved and is increasingly being implemented for quality improvement, teaching and education, as well as research. It is recognised as a tool for improving technical and cognitive skills as well as teamwork assessment, communication and behaviour. VR-based studies have shown that traditional paper documentation was less accurate than video for early vital signs and at the timing of procedures.[57] VR improves adherence to best practice guidelines and has led to changes in international resuscitation guidelines. These effects can be seen in simulation as well as real-life scenarios, both in high- and low-resource settings. Despite this success, the short- and long-term benefits to patients are still uncertain and require additional studies.

For successful implementation, we suggest that specific steps be taken for set-up, consent, storage, and analysis. All issues should be discussed openly and transparently prior to VR initiation and should involve all stakeholders. A blame-free, shame-free, safe and protected environment fostering a culture of openness is essential for achieving the goal of VR: to improve the quality of care for the babies in the DR.

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AUTHOR CONTRIBUTIONS

B.S.: conception, review of the literature, writing—original drafting, critical revisions and approval of the final manuscript. B.d.M.: conception, review of the literature, writing and editing, critical revisions and approval of the final manuscript. B.N.: a review of the literature, writing and editing, critical revisions and approval of the final manuscript. H.K.: a review of the literature, writing and editing, critical revisions and approval of the final manuscript. H.M.H.: a review of the literature, writing and editing, critical revisions and approval of the final manuscript. M.R.: editing, critical revisions and approval of the final manuscript. H.A.: editing, critical revisions and approval of the final manuscript. M.K.: conception, writing and editing, critical revisions and approval of the final manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to B. Simma.