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Heesters, V.; Zanten, H.A. van; Heijstek, V.; Pas, A.B. te; Witlox, R.S.G.M.

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QUALITY IMPROVEMENT ARTICLE

Record, reflect and refine: using video review as an initiative to improve neonatal care

Veerle Heesters[1]✉, Henriette A. van Zanten[1], Veerle Heijstek[1], Arjan B. te Pas[1] and Ruben S.G.M. Witlox[1]

BACKGROUND: The goal of every medical team is to provide optimal care for their patients. We aimed to use video review (VR) sessions to identify and address areas for improvement in neonatal care.
METHODS: For nine months, neonatal procedures (stabilization at birth, intubations and sterile line insertions) were video recorded and reviewed with the neonatal care providers. Action research was used to identify and address areas for improvement which were categorized as (1) protocol/equipment adjustments, (2) input for research, (3) aspects of variety, or (4) development of educational material or training programs.
RESULTS: Eighteen VR sessions were organized with a mean(SD) of 17(5) staff members participating. In total, 120 areas for improvement were identified and addressed, of which 84/120 (70%) were categorized as aspects of variety, 20/120 (17%) as development of educational material or training programs, 10/120 (8%) as protocol/equipment adjustments, and 6/120 (5%) as input for research. The areas for improvement were grouped in themes per category, including sterility, technique, equipment, communication, teamwork, parents' perspective and ventilation.
CONCLUSION: Our study showed that regularly organized VR empowered healthcare providers to identify and address a large variety of areas for improvement, contributing to continuous learning and improvement processes.

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IMPACT:

- Video review empowered healthcare providers to identify areas for improvement in neonatal care
- Video review gave providers the opportunity to address identified areas for improvement, either by enhancing the application of external evidence (i.e. guidelines), learning from individual clinical expertise or strengthening resilience and teamwork
- Embedding regularly organized video review sessions allowed for continuous monitoring of care by providers, which can be beneficial for creating ongoing learning and improvement processes
- The structured pathways, supporting implementation of changes that were proposed based on the video review sessions, could help other centers make use of the potential video review has to offer

INTRODUCTION

Video recording of medical procedures in emergency or intensive care has been used as a tool for training, research and quality improvement. It has proven to be beneficial for guideline compliance and team performance[1–6]. Video recordings show how clinical practice unfolds over time in a concrete situation[6]. Reviewing a recording, therefore, gives an extra dimension to discussing a performed intervention, whereas regular debriefing or auditing can be hindered by recall bias[7–9]. However, the lessons learned by the healthcare providers during video review (VR) sessions should be structured to drive change aimed at improving care, otherwise it becomes a mundane task and valuable information will get lost[10–13].

Optimal care in the Neonatal Intensive Care Unit (NICU) can be defined by more than just guideline adherence. Although guidelines are important to guide healthcare providers in making the right clinical decisions, and should be applied correctly, there will always be a gray zone where guidelines are lacking[14]. Here, providers use their individual clinical expertise to perform procedures in the best possible way, fitting to the individual patient, context and setting, resulting in a variety in practice[15]. This presents an opportunity for healthcare providers to learn from best practices of variety in care from their colleagues and use it to discuss and improve their own practice. Moreover, within the context of (neonatal) intensive care, medical teams have to be resilient to perform a procedure while being able to navigate complexity and adapt to variable conditions. This requires proficient application of effective teamwork and communication skills[16–19].

Action research is an approach that has been used in healthcare to address a particular problem by engaging in a process of cyclical reflection and evaluation with the involved stakeholders[20,21]. It has the potential to integrate guidelines and theory with clinical practice. Staff involvement on all levels is

[1]Division of Neonatology, Department of Paediatrics, Willem-Alexander Children's Hospital, Leiden University Medical Center, Leiden, the Netherlands.
✉email: v.heesters@lumc.nl

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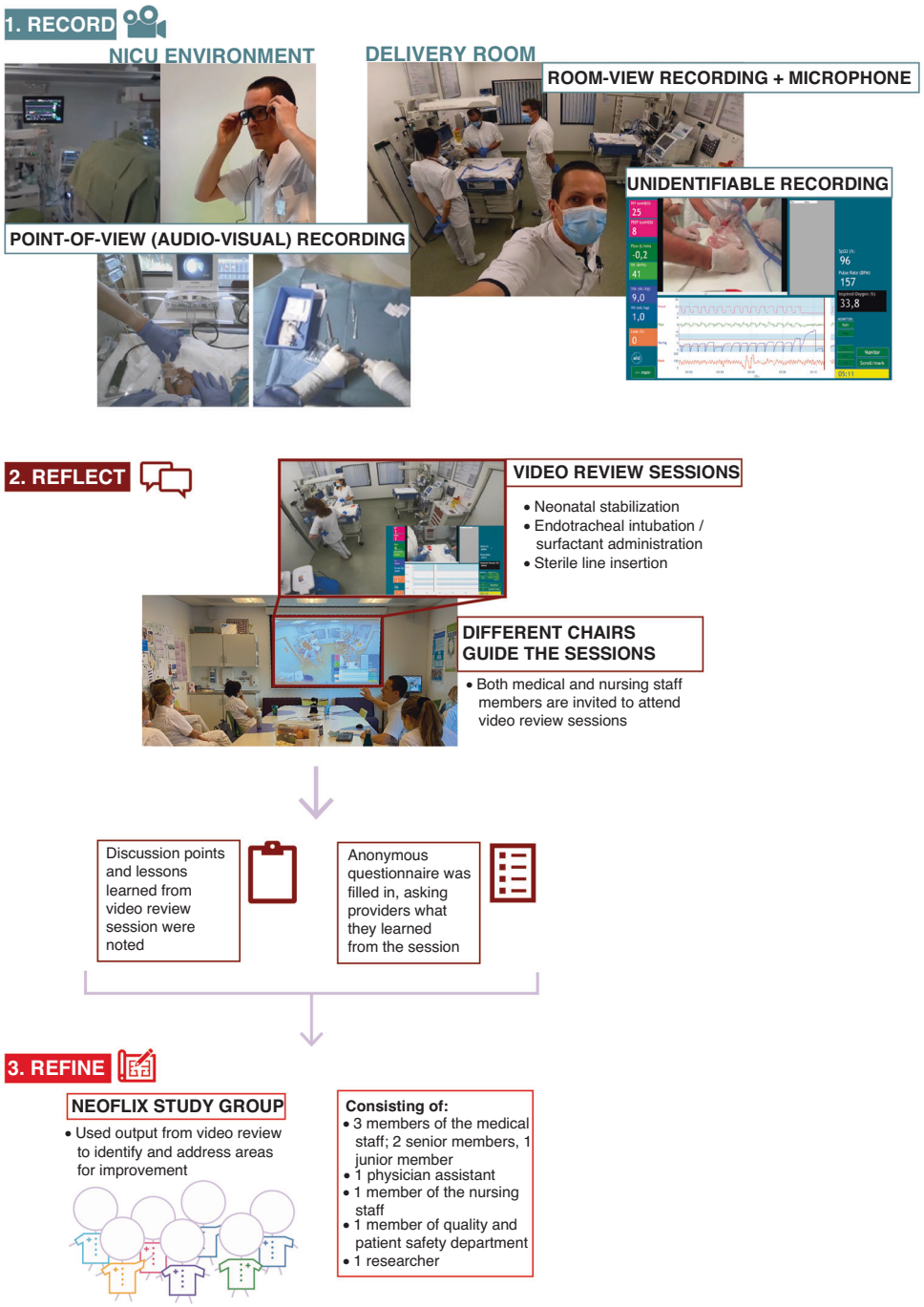

Fig. 1 Video review on the NICU of the LUMC. 1. Videos are recorded in the NICU environment and in the delivery room. 2. The recordings are reviewed during video review sessions. Different chairs guide the sessions. 3. The *Neoflix* study group uses the output from the video review sessions to identify and address areas for improvement.

necessary for improving quality of care[22]. Yet, in neonatal intensive care units this can be challenging due to the dynamic and emergent nature and workforce challenges. We speculated that VR is a suitable base for action research, and it can be used to initiate a continuous learning and improvement process. For one, VR can be performed in a multidisciplinary way, enabling front-line staff to provide valuable input. Through a recording extra dimensions of care such as time and context are visualized. We therefore hypothesized that action research, driven by VR, can potentially improve the practice of neonatal procedures by (i) enhancing right application of external evidence (i.e. use of guidelines and equipment), (ii) learning from individual clinical expertise and the variety in care and (iii) strengthening teamwork and resilience of the NICU team.

The goal of this study was to use VR to identify areas of improvement in different neonatal procedures and to give healthcare providers the opportunity to address those using an action research approach.

METHODS

Design and context

This action research study was performed from December 2021 until September 2022 at the NICU of the Leiden University Medical Center

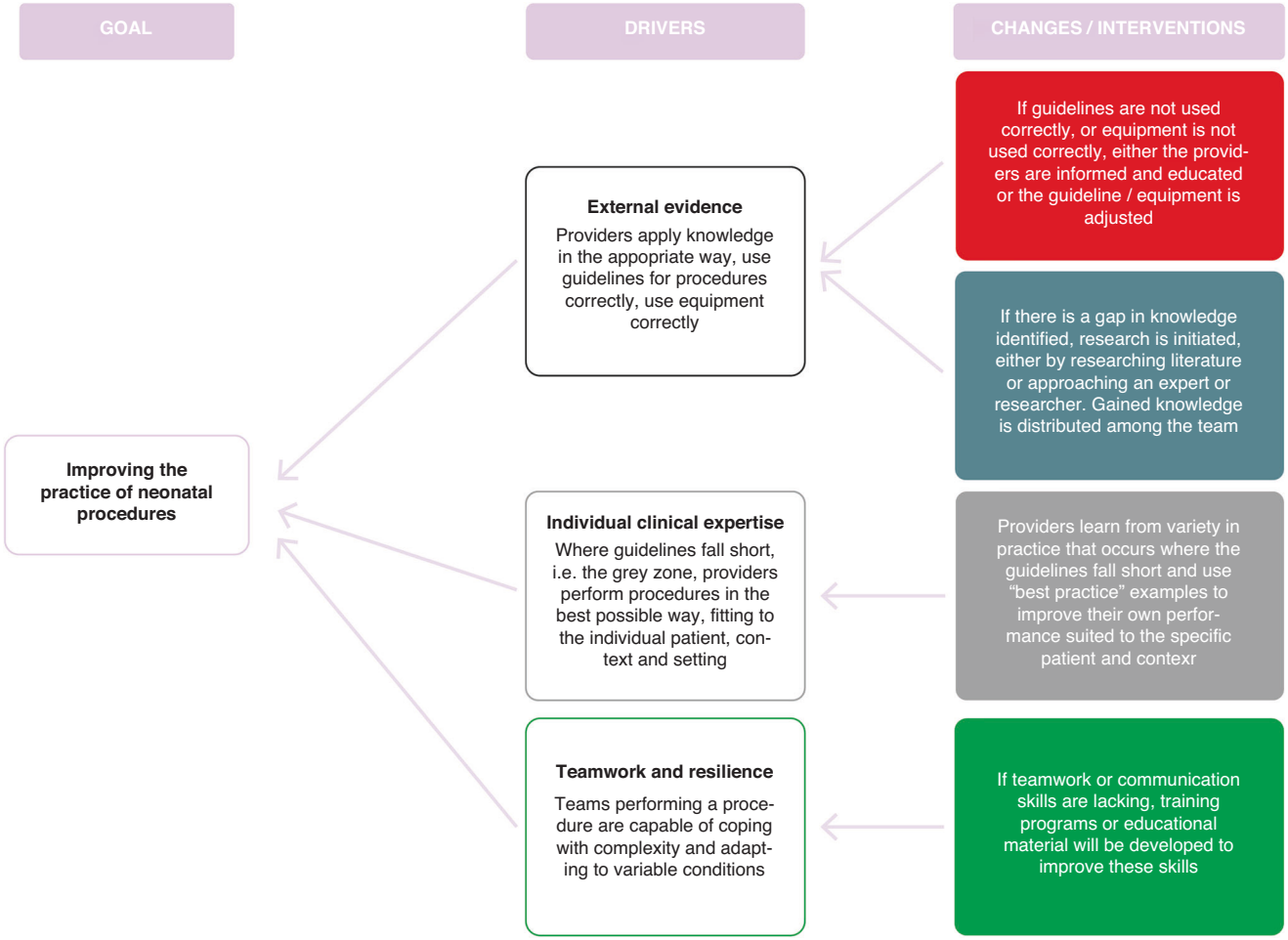

Fig. 2 Driver diagram.

(LUMC), a tertiary level perinatal center with an average of 600–650 admissions per year, of which about 100 admissions are out-born. The NICU is comprised of 17 single-patient rooms and 4 twin-rooms. On average, 125 healthcare providers in our NICU are involved in hands-on care, including 12 consulting neonatologists, 3 fellows, 10 pediatric residents, 5 physician assistants and 95 registered nurses, of which on average 10 nurses are in training. Daily practice on the NICU was video recorded and these recordings were reviewed in VR meetings every two weeks that were open to all healthcare providers involved in hands-on care on the NICU, including but not limited to those who were in the recording. During these meetings, all NICU team-members were considered "co-researchers" and provided the input for action research cycles aimed at improving neonatal care.

Intervention

Record. We have focused on procedures on the NICU that are performed with both medical and nursing staff: neonatal stabilization in the delivery room and procedures on the NICU such as sterile line insertions, endotracheal intubation and Minimally Invasive Surfactant Therapy (MIST) (Fig. 1). Recording procedures was already part of standard care on our NICU, although we expanded it for this project.

Neonatal stabilization at birth has been recorded in our unit since 2009 with the *Microsoft LifeCam Cinema* camera (Microsoft Ireland Operations Ltd., Dublin, Ireland) to obtain a close up view of the infant and the hands of the providers in combination with the physiological parameters of the infant through *Polybench software* (Applied Biosignals GmbH, Weener, Germany). Healthcare providers are not recognizable in this recording. These recordings are part of standard care and are shared with parents and healthcare providers since 2014.

For the current project, we expanded recording of neonatal stabilization at birth with a *GoPro Hero 9* camera (San Mateo CA, US) to obtain room-view imaging and used the *Rode wireless Go* (Rode, Sydney, Australia) microphones to obtain audio. We used the *Tobii* eye-tracking glasses (Tobii pro, Stockholm, Sweden) for audio-visual recording of the procedures performed on the NICU. We did not use eye-tracking data for this study as the focus was on procedures as a whole including context, not necessarily on the data of what the wearer was paying attention to. These recordings were used for this project as part of quality assurance, therefore no patient consent was asked. However, providers always had to give consent, prior to recording.

Reflect. Healthcare providers were asked, on a voluntary basis, to record different procedures with the designated cameras and could request for a video to be discussed afterwards. All providers had to give explicit consent for use of a video in a VR session. The VR session was prepared by the dedicated chair, who previewed the recordings with the healthcare providers involved in the intervention to obtain their perspective, input on context and also consent for use of the video in the plenary VR session. To use a positive connotation we named the VR meetings *Neoflix*. The *Neoflix* sessions were held every two weeks, lasted 30 min and both medical and nursing staff were invited to attend. The sessions could be attended live or online via a digital connection using *Microsoft Teams*. During each session, the dedicated chair emphasised the safe learning environment and guided the discussion. All neonatal providers were invited to actively participate in the session. The providers discussed the neonatal procedures during the session and considered ways in which practice could be improved. The findings and discussion points were noted. Observations of the meeting were reported in field notes by a researcher (VH) and a questionnaire was

distributed among the participants after each session, asking them what they had learned from the session (Fig. 1). Through these two sources of information providers had the opportunity to express their opinion, even if they were reluctant to share it in the plenary discussion during VR.

Refine. The observations of the session and the results from the questionnaire were evaluated afterwards by the *Neoflix* study group (Fig. 1). This group consisted of members from the senior and junior medical staff, a member of the nursing staff, a physician assistant, a member from the quality and patient safety department and a researcher. After each session, the *Neoflix* study group determined, what the identified areas for improvement were and how these would be used in the action research cycles and consequently be used to adjust protocols, create training programs or improve the practice of care on the NICU in other ways.

The *Neoflix* group identified three main components contributing to improvement of the practice of neonatal procedures (Fig. 2). The following primary drivers were incorporated into the driver diagram, (i) enhancing appropriate application of external evidence (i.e. use of guidelines and equipment), (ii) learning from individual clinical expertise, where guidelines fall short, i.e. the gray zone, where healthcare providers perform procedures in the best possible way, fitting to the individual patient, context and setting, and (iii) strengthening teamwork and resilience of the NICU team, i.e. being capable of coping with complexity and adapting to variable conditions. The following actions or interventions aimed at change were defined and included in the driver diagram:

1. If guidelines are not used correctly, or equipment is not used correctly, either the healthcare providers are informed and educated or the guideline / equipment is adjusted.
2. If there is a gap in knowledge identified, research is initiated, either by researching literature or approaching an expert or researcher. Gained knowledge is distributed among the team.
3. Healthcare providers learn from variety in practice that occurs where the guidelines fall short and use "best practice" examples to improve their own performance suited to the specific patient and context.
4. If teamwork or communication skills are lacking, training programs or educational material will be developed to improve these skills.

Study of the intervention

Action research cycles were used to implement interventions or changes in practice, observe the effect over time and re-evaluate if the changes had an effect[23–25]. During one month, the first type of procedure was reflected on, sterile line insertions. The following month, the second procedure was assessed, intubations and MIST procedures, and in the third month neonatal resuscitation at birth. This cycle of three months was repeated three times. The effect of changes that were proposed regarding a specific type of procedure were re-evaluated again when that procedure was recorded and reviewed in the next cycle. Therefore, continuous cycles were created where identified areas for improvement could be addressed and reflected upon.

The first step of action research was to categorize the identified areas for improvement of the *Neoflix* sessions. Structured pathways were developed for taking steps in implementation of action research. Findings were categorized in either, (1) protocol or equipment adjustments, (2) input for research, (3) aspects of variety in care, resulting in tips and tricks, or (4) development of educational material or training programs. It was determined if the target group of the 'action' was members of the medical or nursing staff or both.

In the second step, the corresponding strategy was followed and implemented. Because only part of the NICU-team was present during the VR sessions, decisions on protocol adjustments could not be made immediately and needed, for instance, to be discussed first during a neonatal (nursing) staff meeting where more providers were present before they could be implemented. The variety in practice or best practices of care were distributed among staff via e-mail, newsletters or posters. When the team concluded that for a certain item training was needed, training programs or educational materials were developed. Sessions could also lead to seeking advice from experts or to research questions.

During the third step, consecutive VR sessions on that procedure were used to evaluate whether implementation of the strategies was sufficient.

When no new findings regarding the identified area for improvement came up in following review sessions of an intervention, the cycle was considered closed. When following sessions showed that the implemented change did not have the desired effect or if the discussion focused repeatedly on the same aspects, the identified area for improvement would be addressed in an additional cycle.

Measures

Using the driver diagram, the following indicators were used for studying improvement processes; the number of identified areas for improvement that were addressed in one or multiple cycles and categorized as; (1) protocol or equipment adjustments, (2) input for research, (3) aspects of variety in care, resulting in tips and tricks, or (4) development of educational material or training programs.

Analysis

In consistence with the standards in qualitative research, observations have been reported in field notes. Field notes from observations during the VR sessions, the evaluation sessions by the *Neoflix* study group and the results of the different action research cycles of the four categories were analysed by VH and RW using a content analysis to quantify concepts, themes and keywords within the four categories[26]. The qualitative data analysis software *Atlas.Ti* (version 23) was used for coding. Emerging themes were discussed and verified during consensus meetings with the study group.

Ethics approval

This study was reviewed by the Ethics Review Committee of the LUMC (N21.169). In concordance with laws and guidelines, a statement of no objection against execution of the study was issued.

RESULTS

In total, eighteen VR meetings were held in the nine month period, of which six sessions concerned recordings of sterile line insertions, six concerned intubation or MIST procedures and six concerned neonatal resuscitations. In the nine month period, 48 procedures had been recorded in total. All recordings were previewed with the recorded healthcare providers but not all could be used in VR. Recordings were used in VR only if audio-visual quality was sufficient, if that month was about that recorded procedure and if the procedure was not too complex to be discussed within the 30 min time limit. If providers requested for a recording to be discussed in VR, that recording was often chosen by the chair of the session. We also aimed to include recordings which showed different providers performing the procedure. No provider declined use of their video for VR. The sessions were attended by a mean(SD) of 17(5) providers per session, including 7(2) medical staff members, 8(3) nursing staff members, and 1(1) medical student or researcher. At the end of the study period, 101/125 (81%) providers of the NICU attended at least one *Neoflix* session, of which 65/101 (64%) were members of the nursing staff and 36/101 (36%) members of the medical staff. Afterwards, the *Neoflix* study group evaluated the observations made during the VR sessions and the results of the anonymous questionnaire. In total, 120 findings were identified by the study group as areas for improvement. 56/120 (47%) identified areas for improvements originated from the sessions of sterile line insertions; 36/120 (30%) from sessions of neonatal stabilization and 28/120 (23%) from sessions of intubations or MIST procedures.

Identified areas for improvement

The identified areas for improvement from video review were categorized into one of the four categories by the study group with each their own strategy for implementation (Fig. 3). Of the 120 findings, 84/120 (70%) were categorized as aspects of variety, 20/120 (17%) as development of educational material or training programs, 10/120 (8%) as protocol/equipment adjustments, and 6/120 (5%) as input for research. Main themes were identified: sterility, technique and use of equipment, preparing the table (for sterile procedures), communication, teamwork, parents'

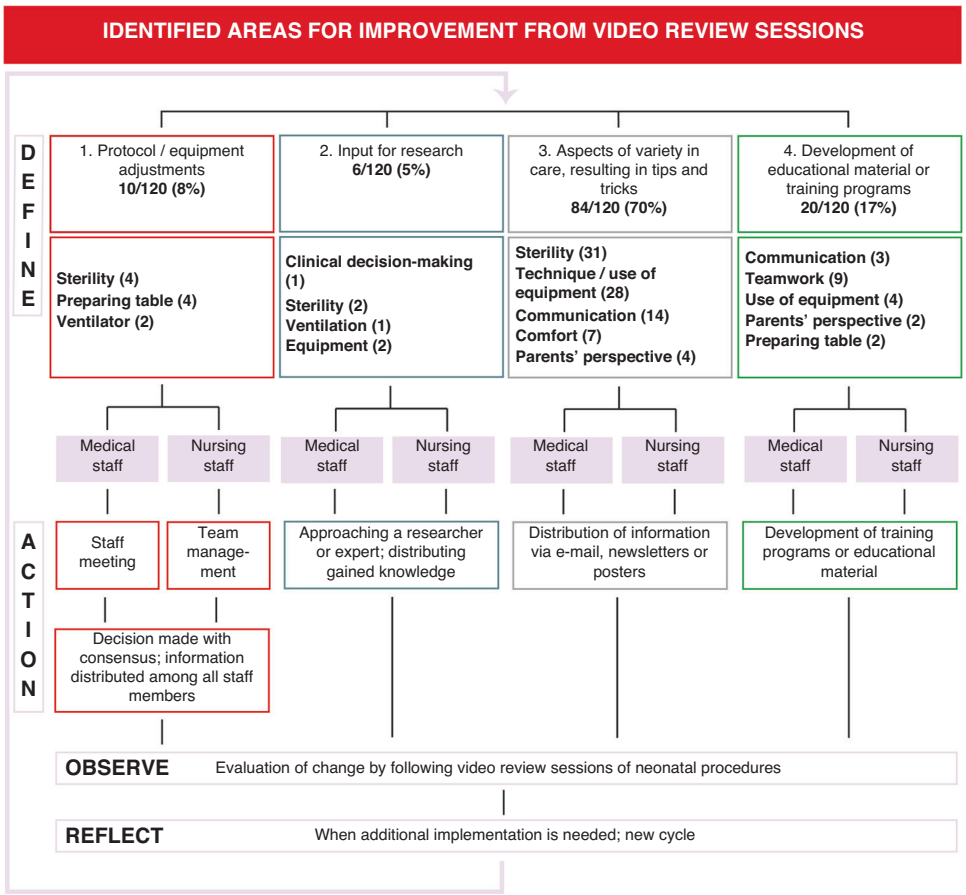

Fig. 3 Strategies for addressing the areas for improvement. Action research cycles of areas for improvement from video review sessions of different neonatal procedures. Findings ($n = 120$) are grouped in themes per category (n).

perspective and ventilation. The identified and addressed areas for improvement from the different categories have been described in detail in Table 1. Of these areas for improvement, 25/120 (21%) came up in VR sessions after certain changes had been made through the first cycle regarding that area for improvement. For these findings, additional cycles of action research were deemed necessary, after which they were recategorized and addressed in a different cycle. One of the identfied areas for improvement requiring additional cycles, stimulation of effective communication, has been described in Table 1 and worked out in detail in Fig. 4.

DISCUSSION

The results of this study provide a detailed insight into how VR resulted in the identification of various areas for improvement in neonatal care, including neonatal stabilization, sterile line insertion and intubation and surfactant administration. The VR sessions were attended by medical and nursing staff members, who were given the opportunity to reflect on the procedures from different perspectives. Through attending VR sessions, the healthcare providers involved in hands-on care identified 120 areas for improvement in total. VR empowered providers, not only to identify areas for improvement, but also to address these step-by-step, potentially improving the practice on the NICU as a whole.

Although this study was not focused on measuring improvement via adherence to guidelines, time to achieve a certain goal, or mortality rates, the results of our study demonstrate how VR combines forces and insights of different staff members to make small changes aimed at improving care in various ways. The neonatal procedures which were recorded have in common that they can be complex, emergent and time-sensitive and are performed by a multidisciplinary team consisting of medical and nursing staff. The care at birth for the high risk infants is highly influential for short-term and long-term outcomes of infants[15,27,28]. Guidelines and protocols have been created to offer guidance and to improve the consistency of care in these critical moments. Studies using VR to improve care therefore often measure the outcome by assessing guideline compliance or errors[2,6,29–33]. However, we argue that in intensive (neonatal) care, the best possible care can vary between patients and sometimes guidelines fall short[17,34]. In addition to evidence-based knowledge, individual clinical expertise including knowledge of the context and patients are highly valuable and could provide for numerous moments to learn and improve together[14,16,31,35]. Strengthening teamwork or communication skills can improve resilience, which in turn could strengthen patient safety in the future[10,16,17]. Previous research has already shown how video recording can lead to identification of novel practices or success factors and to questioning or even changing of guidelines[36,37]. VR thus offers the possibility of taking quality improvement to the next level[38]. It could be an alternative approach to improving quality of care by learning from reality.

The multidisciplinary approach of VR, in which practitioners are seen as equals, adds to the value of the improvement processes following the VR sessions[39]. During each *Neoflix* session, on average 17 medical and nursing staff members participated. While organizing the project, we put a lot of emphasis on involving both medical and nursing staff, resulting in discussions with everyone involved in hands-on care. Previous studies noted that it is challenging to get all staff within the team to participate in action

Table 1. Identified and addressed areas for improvement.

# of cycles	Protocol / equipment adjustments	
2	Sterility: DEFINE: During video review sessions it became evident that putting on sterile gloves next to the sink increased the risk of getting unsterile, i.e. a provider would lay out the sterile gloves next to the sink and would then start washing the hands, which could lead to contamination of the gloves. ACTION: The protocol for sterile line insertions was adjusted, emphasizing that the use of sink to lay out the gloves was not allowed anymore. The information was distributed. CHECK: Following video review session showed that the sink was still used. REFLECT: An additional cycle was deemed necessary.	DEFINE: The team was to be reinformed about the protocol adjustment. ACTION: The information that the protocol was adjusted was distributed amongst the NICU team via a newsletter. CHECK: Following video review sessions showed that the protocol adjustment was followed. REFLECT: Intervention was seen as sustained. End of cycle.
2	Preparing table: DEFINE: A recurrent theme during the sessions of the sterile line insertions was the difficulty to insert the diaphanoscope into the sterile bag. Multiple video review sessions highlighted that inserting the light into the sterile bag was challenging for healthcare providers. ACTION: Tips and tricks were shared with the NICU team on how to do this. CHECK However, in following sessions this challenge showed up again. REFLECT: An additional cycle was deemed necessary	DEFINE: Equipment was adjusted by ordering a larger size sterile bags. ACTION: A video was recorded where this larger bag was used and it was communicated to the team that these bags were available on the NICU. CHECK: Following video review sessions showed that the larger size bags were used. REFLECT: Intervention was seen as sustained. End of cycle.
1	Ventilator: DEFINE: A new ventilator was going to be introduced to healthcare providers, using video review sessions to help guide implementation of the ventilator. ACTION: Video review sessions were focused on the new ventilator and evaluated experience of healthcare providers and to answer questions. CHECK: Following video review sessions where the ventilator was used did not show any difficulty in using the ventilator and no more questions came up. REFLECT: Intervention was seen as sustained. End of cycle.	
	Input for research	
1	Clinical decision-making: DEFINE: Question came up, what to do when a “cannot ventilate, cannot intubate” situation occurs; who will be called for back-up and how? This question had to be answered. ACTION: Other NICU’s were approached to obtain knowledge on their pathways, the pathway in our NICU was identified and the gained knowledge was distributed. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	
1	Sterility: DEFINE: The video review sessions identified a lack of clarity on how to apply hand alcohol. ACTION: An infection prevention expert within the hospital was approached and knowledge was obtained and distributed. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	
1	Ventilation: DEFINE: Questions came up during video review regarding synchronized ventilation. ACTION: These were communicated to the research team, knowledge was obtained and distributed. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	
1	Equipment: DEFINE: During video review sessions of a sterile procedure and a surfactant administration procedure, the need for an extra ‘table’ during the procedures was identified. ACTION: We sent out a newsletter stating that this would be investigated. One of the healthcare providers responded and suggested to use a certain adjustable table. We contacted the provider and tested the use of the adjustable table. CHECK: Development of table is ongoing. ACT: Cycle is ongoing.	
	Aspects of variety	
1	Sterility: DEFINE: During video review sessions, several tips were given on sterility, e.g. positioning of the infant in the sterile field, preparing the table, how to reduce movement in the room. ACTION: These tips were communicated to the entire NICU team. CHECK: It was discussed that optimization of sterility depends on the specific situation. REFLECT: No additional cycle necessary as these are aspects of variety in care.	

Table 1. continued

1	Technique / use of equipment: DEFINE: During video review sessions, several tips were given on technique and use of equipment, e.g. on how to put on a tourniquet, use of the Pedicap, heat management and drug administration. ACTION: These tips were communicated to the entire NICU team. CHECK: It was discussed that optimization of technique and use of equipment depends on the specific situation. REFLECT: No additional cycle necessary as these are aspects of variety in care.	
1	Communication: DEFINE: During video review sessions, several tips were given on communication, e.g. how to communicate the saturation effectively during stabilization, how to cope with stress on the ward, how to reduce movement in the room, how to evaluate more effectively and how to delegate tasks better. ACTION: These tips were communicated to the entire NICU team. CHECK: It was discussed that optimization of communication depends on the specific situation. REFLECT: No additional cycle necessary as these are aspects of variety in care.	
1	Comfort: DEFINE: During video review meetings of procedures performed on the NICU it was discussed that nurses could take on a leading role in determining how much sedation was needed, as they know the baby best. ACTION: These tips were communicated to the entire NICU team. CHECK: Afterwards nurses became more assertive in determining the level of comfort for the infant during certain procedures, as was observed in following video review sessions. REFLECT: Intervention was seen as sustained. End of cycle.	
1	Parents' perspective: DEFINE: Parents were invited to review recordings of stabilization as well. By reviewing these videos with parents, we had the chance to ask parents how they experienced this period, what they were thinking and what they needed from the NICU team at the time. ACTION: Their input was used in the *Neoflix* session of that video by sharing quotes from parents. CHECK: Following video review sessions showed that more attention was given to parents during stabilization. It was discussed that optimization of support depends on the specific situation. REFLECT: No additional cycle necessary as these are aspects of variety in care.	
	Development of educational material or training programs	
1	Communication: DEFINE: The video review sessions on intubation identified a difference in interpretation of the commands that were given during intubation. For instance, 'lifting' the (video) laryngoscope represents a certain technique and movement, which was not interpreted in the exact same way by all staff members. This had to be resolved. ACTION: Based on these findings a video of the commands with corresponding movements and techniques was made and presented to the team as a training tool. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	
3	Effective communication: DEFINE: Various video review sessions showed that closed-loop communication remained challenging. It was discussed that caregivers needed to communicate instructions and responses in a clear and specific way. ACTION: Therefore, recordings of best practice in communication during neonatal stabilization were combined in a video that was shown in the Newborn Life Support (NLS) training of all staff members at the NICU. CHECK: In video review following sessions, effective communication remained challenging. Additionally, other themes emerged, such as the importance of role differentiation before starting an intervention and checking if preparation was complete and all equipment was present. All findings combined, the need for a structured 'time-out' was identified. For one, it could help to activate a sense of participation among caregivers. By performing a time-out before the procedure, caregivers might be more prone to speak up later during the intervention. Second, it could help with role differentiation and preparation. ACT: An additional cycle of was deemed necessary.	DEFINE: The *Neoflix* study group has started the design of a checklist for a time-out procedure. ACTION: First a draft version was made and discussed with medical and nursing staff. Then the time-out checklist was tested, whilst recording it. This video was evaluated during a video review session. CHECK: Afterwards, the time-out checklist was adjusted again before it was implemented as standard care. ACT: Time-out procedure was implemented. Following cycle was used to adjust the time-out it with new feedback from video review sessions or healthcare providers.
2	Use of equipment: DEFINE: Video review sessions identified that it remained challenging to connect the pulse oximeter properly. This had to be resolved. ACTION: Knowledge on how to do this properly was distributed	DEFINE: Extra attention had to be given to this in training. ACTION: Training was adjusted, giving more focus on connecting the pulse oximeter. CHECK: Following video review sessions did not focus on this

Table 1. continued

	as tips. CHECK: Following video review sessions showed that it remained challenging. ACT: An additional cycle of was deemed necessary.	again. ACT: Intervention was seen as sustained. End of cycle.
1	Preparing table: DEFINE: Video review sessions identified that preparing the table for sterile procedures remained difficult. ACTION: Sterility training videos were shared with the NICU team on how to set the table to help improve sterility. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	
	Parents' perspective: DEFINE: Video review sessions showed how parents were supported during stabilization and how this could be improved. ACTION: An element on how to support parents was added to the NLS training. CHECK: Following video review sessions did not focus on this again. ACT: Intervention was seen as sustained. End of cycle.	

Detailed description of the identified areas for improvement that were categorized and addressed in one/multiple action research cycles.

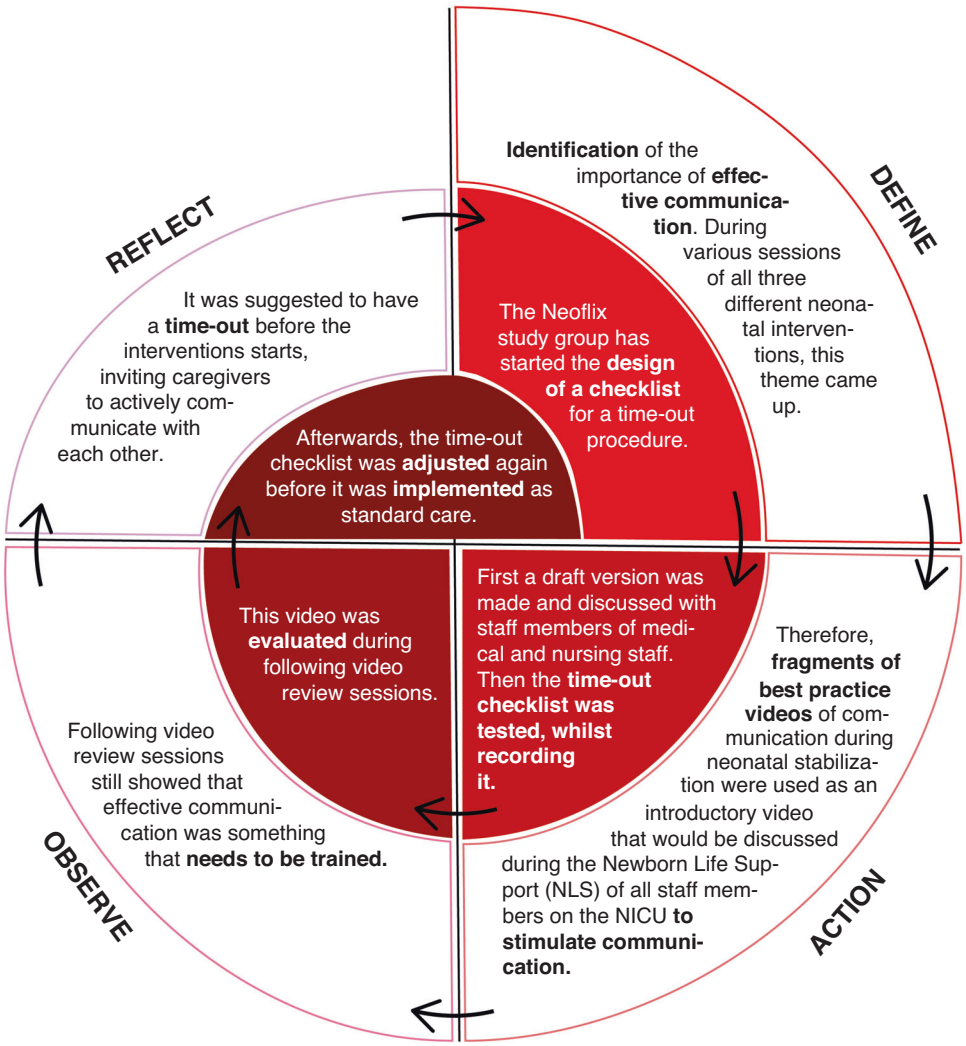

Fig. 4 Identified area for improvement requiring multiple action research cycles. Visualization of how the identified area for improvement regarding effective communication, went into multiple action research cycles.

research or even video review, although it is essential for getting practical and important results[13,20,25,40,41]. However, by regularly organizing the *Neoflix* sessions on our department, all front-line staff was engaged from the beginning and trained in giving each other feedback on a multidisciplinary level. Research has shown that this could make them more prone to do this in clinical care as well, hereby improving collaboration and team cohesion[42–44]. Each session had different staff members attending, but at the end of the study period, 81% of all staff members had participated in at least one *Neoflix* session, showing how VR consistently involved the healthcare providers responsible for performing the neonatal procedures. Some providers might have felt apprehensive to share their ideas with the team during the *Neoflix* session. We aimed to remove this barrier by having participants complete

an anonymous questionnaire after each session, asking what the participants learned from the session. The questionnaire and the observations of the discussion during VR combined were used as the base for action research. However, the *Neoflix* study group used the output from VR to identify the areas for improvement. Therefore, this group influenced how the ideas or discussion points from the sessions would be translated into actual improvement actions. Nevertheless, the study group consisted of members from all different disciplines involved in neonatal care in our unit, striving to represent all different perspectives on the NICU.

Limitations of our study include that we did not measure improvements of clinical performance of the neonatal procedures. This can be explained by our set-up as we used VR to improve aspects of care that are difficult to systematically measure. Action research is then also different from quality improvement as it is guided by research questions that are identified and addressed collaboratively with participants and focused on empowerment of the participants involved[23,40]. Improvement in our study was mostly driven by increasing awareness of aspects of variety in the gray zone of care, resulting in learning through tips and tricks, which corresponded to 70% of the identified areas for improvement. This high percentage can be attributed to the wide variety in practice of clinical care that became apparent through recording neonatal procedures performed by different healthcare providers. Most of the insights from reviewing line insertion concerned hygiene and sterility. Through video recording sterility aspects can be immediately evaluated[45]. The findings that were used for protocol adjustments or development of training and educational material took more time to be fully implemented, for instance, the implementation of the time-out checklist took up to six months.

Strengths of our project include the repetition of the VR sessions. During the nine month study period, 25% of the identified areas for improvement came up in following VR sessions after certain actions had been taken aimed at change. For these findings, additional cycles could be performed, as there were three repeating cycles of three months in our study, focusing on the same neonatal procedures. The areas for improvement were often recategorized before another cycle was performed. An identified area for improvement could first be categorized as at tip, but following VR sessions could lead to recategorization of this finding into, for example, development of educational material. This indicates that a continuous learning and improvement process was initiated by regularly organizing VR sessions[46]. Conducting (multiple) improvement cycles can be time-consuming, which complicates implementation of this method in a busy emergency care department. As a solution, the structured pathways that were developed for each of the four categories were used to guide the performance of the action research cycles and make appropriate implementation easier. It is important to evaluate if the strategies that were created are applicable to other (intensive care) settings as well. It can be argued that one video does not show whether a change or intervention was sustained. Nevertheless, we reviewed the videos in an interprofessional setting, with on average 17 healthcare providers attending. Through multidisciplinary discussion it was discussed whether the practice throughout the entire NICU team was changed or whether another action was deemed necessary. However, this discussion could still have been subject to bias. At the end of the study period, VR was implemented on the NICU. Therefore, future research on our unit can focus on the measurable effect of video review on the long-term.

CONCLUSION

In conclusion, this study highlights how VR sessions of real-time recordings of neonatal care, empowered healthcare providers to identify and address areas for improvement. We recommend embedding regularly held VR sessions on a department and using structured pathways to support implementation of changes or interventions aimed at improvement. VR puts healthcare providers in a position where they have the opportunity to reflect on their own practice and enables them to participate in a continuous learning and improvement process.

DATA AVAILABILITY

All data generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

All authors contributed to the organization of the VR sessions and the performance of action research. AtP, RW and VH designed the study. Data collection and analysis were performed by VH and RW. The first draft of the manuscript was written by VH and RW and all authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

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COMPETING INTERESTS

The authors declare no competing interests.

CONSENT TO PARTICIPATE

The data of this study consists of the observations of the VR sessions and the following action research only. Additionally, verbal consent was obtained from the neonatal healthcare providers before an intervention would be recorded and used for a VR session. The recordings used for the VR sessions were part of standard care and used for quality assurance purposes only so patient consent was not sought. However, if parents were visible in a recording, they were asked for consent for use of the video in the VR session.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Veerle Heesters.