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Improving neonatal resuscitation: ethical aspects

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CHAPTER 5

BENEFITS OF RECORDING AND REVIEWING NEONATAL RESUSCITATION: THE PROVIDERS' PERSPECTIVE

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ABSTRACT

OBJECTIVE

To assess benefits of recording and reviewing neonatal resuscitation as experienced by neonatal care providers.

DESIGN

A qualitative study using semi-structured interviews questioning neonatal care providers about their experiences with recording and reviewing neonatal resuscitation. Data were analysed using the qualitative data analysis software Atlas.ti 7.0.

SETTING

Neonatal care providers working at Neonatal Intensive Care Units (NICUs) of the Leiden University Medical Center, the Netherlands, and the University of Pennsylvania School of Medicine, the United States of America participated in this study.

RESULTS

In total 48 NICU staff members were interviewed. Reported experiences and attitudes are broadly similar for both NICUs. All interviewed providers reported positive experiences and benefits, with special emphasis on educational benefits. Recording and reviewing neonatal resuscitation is used for various learning activities, such as plenary review meetings and as tool for objective feedback. Providers reported to learn from reviewing their own performance during resuscitation, as well as from reviewing performances of others. Improved time perception, reflection on guideline compliance, and acting less invasively during resuscitations were often mentioned as learning outcomes. All providers would recommend other NICUs to implement recording and reviewing neonatal resuscitation, as it is a powerful tool for learning and improving. However, they emphasized preconditions for successful implementation, such as providing information, not being punitive and focusing on the benefits for learning and improving.

CONCLUSION

Recording and reviewing neonatal resuscitation is considered highly beneficial for learning and improving resuscitation skills and is recommended by providers participating in it.

INTRODUCTION

Neonatal resuscitation is the most provided form of acute resuscitation performed in hospitals, with 10% of all neonates needing support in stabilization and 3% needing resuscitation.(1, 2) Effective neonatal resuscitation has the potential to save lives and reduce disabilities.(3) However, resuscitation is complex and may not always be maximally effective. Further improvement of the quality of neonatal resuscitation is therefore pursued.

Various Neonatal Intensive Care Units (NICUs) around the world implemented the technique of recording and reviewing neonatal resuscitation in order to improve the quality of provided support during transition at birth. Although NICU staff members agree that recording and reviewing neonatal resuscitation can improve the quality of the procedure, concerns about implementation of the technique and the impact of the technique on providers are raised as well.(4) These concerns create a barrier to further implementation of the technique at other NICUs.

For a wider study, we interviewed neonatal staff members who participate in recording and reviewing neonatal resuscitation in order to gain an understanding of factors that could impede or assist implementation of the technique. In this paper we report the experienced benefits for learning and improving neonatal resuscitation and the necessity of preconditions for a safe learning environment.

METHODS

For this study, which is a sub-study of a project where we review factors that impede or assist wider implementation of recording and reviewing neonatal resuscitation, we conducted semi-structured interviews with NICU staff members working at the NICU of the Leiden University Medical Center (LUMC), the Netherlands, and the Hospital of the University of Pennsylvania (HUP), the United States of America. To produce maximum variation in the study sample, participants were selected through purposive sampling. Using an interview guide, participants were questioned about their experiences with recording and reviewing neonatal resuscitation.

LUMC

The LUMC is a tertiary level perinatal centre with an average of 850 admissions a year. In 2009, recording and reviewing video and vital parameters of neonatal resuscitation

was implemented. Since 2013 audits are conducted, discussing, among others, the technical performance and the documentation of the resuscitation. All NICU staff members are invited to participate in the meetings. Audits are prepared and chaired by the coordinator of the audit. As recording and reviewing neonatal resuscitation is considered standard care since 2016, recordings are stored as part of the medical record and parents are invited to watch the recording of their child accompanied by a provider.

HUP

The HUP is a tertiary level perinatal centre with an average of 800 admissions a year. Since 2015, video, audio and vital parameters of neonatal resuscitation are recorded and reviewed. Providers meet for review conferences, discussing recordings of neonatal resuscitation and relevant literature. All NICU staff members are invited to participate in these meetings. Review conferences are prepared by the coordinator of the program, together with a fellow. The video recordings are part of the hospital's quality improvement and peer review program and are therefore protected under the Pennsylvania Peer Review Protection Act.

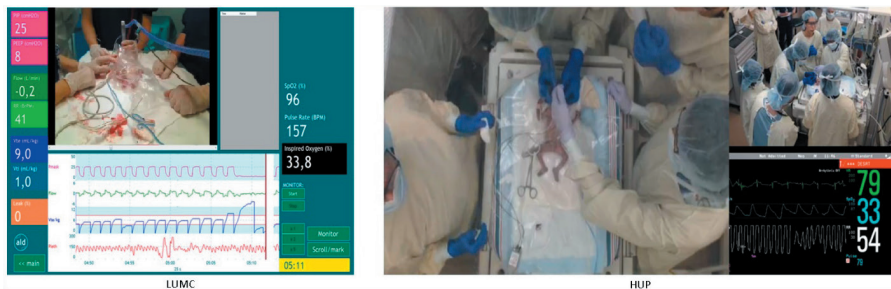


Figure 1. Recording at the LUMC and the HUP

The LUMC and the HUP differ both in their method of recording (figure 1) and their process of reviewing: the LUMC conducts weekly audits of 15 minutes, whereas the HUP conducts an hour lasting review conferences six times a year; the HUP records audio, whereas the LUMC is still considering to record audio; the position of the camera and the amount of cameras differs between NICUs; providers of the LUMC use a respiratory functioning monitor, both during resuscitation and audits; and the HUP has a live stream that allows providers to watch resuscitations at the ward.

ANALYSIS

Data collection and analysis occurred simultaneously. Interviews were audio recorded and transcribed. Transcripts were analysed in two stages. Data were manually reviewed in a process of open coding. Subsequently, data were reviewed using the qualitative data analysis software program Atlas.ti (version 7.0). Themes emerged after initial review of data, which resulted in adaption of the interview guide. In later interviews, participants were therefore directly questioned about their educational experiences.

ETHICS

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

RESULTS

Interviews were conducted from February 17th through December 27th 2017. A total of 49 interviews were conducted with 48 NICU staff members, of various ages and levels of experience at the NICU. Table 1 shows participant characteristics. One participant was interviewed twice, as initial analysis of the interview showed that more information on specific themes was required. Interviews lasted between 24:19 – 93:05 (mean 45:43) minutes. Duration of interviews varied widely, as providers differed in their exposure to being recorded and reviewed.

Although both NICUs differ in the design of their review process, reported experiences and attitudes are broadly similar. Interviewed providers highly value recording and reviewing neonatal resuscitation and benefits were reported by all providers, with special emphasis on educational benefits. Negative feelings and experiences were reported by many providers, but these were mostly overcome by being exposed to the procedure in a safe learning environment that allowed learning and improving. Three overarching themes were identified: recording and reviewing neonatal resuscitation as a learning activity; reported learning outcomes; and preconditions for successful implementation. These themes and illustrative quotes are presented in table 2-4.

Table 1. Participant characteristics

	LUMC (n = 24)	HUP (n = 24)	TOTAL (n = 48)
Male (%)	33	29	31
Age mean (range)	39 (26 – 54)	40 (28 – 77)	39 (26 – 77)
Years of experience at NICU mean (range)	9.2 (0.5 – 31)	10.4 (0.5 – 46)	9.8 (0.5 – 46)
Staff members (%)			
Attending	29	29	29
Neonatal fellow	13	25	19
Physician assistant	13	4	8
Respiratory therapist	N/A	13	6
Nurse practitioner	N/A	8	4
Registered nurse	29	21	25
Paediatric resident	13	4	8
Medical student	4	0	2
Involved in neonatal resuscitation studies	13	8	10

RECORDING AND REVIEWING NEONATAL RESUSCITATION AS A LEARNING ACTIVITY (TABLE 2)

Both NICUs implemented recording neonatal resuscitation as a research tool. Over time, the technique developed into a tool for various learning activities. To date, the technique is mostly used for the review conference (HUP) and the audit (LUMC). Recording and reviewing neonatal resuscitation is furthermore valued as a feedback tool, both for asking feedback on performance, and for providing feedback on the performance of others. This was reported not only by junior providers, but also by senior providers, who emphasized how reviewing resuscitations with their peers allows them to keep on learning and improving.

Providers reported to appreciate reviewing recordings of neonatal resuscitation as it allows objective feedback. Recordings are used for feedback in various settings. Feedback can be provided during plenary review meetings, or on an individual base: trainees sit down with their trainers to review their resuscitations. Moreover, recordings are discussed by the team performing a resuscitation. As such, reviewing recordings also functions as a debrief tool. Recordings are furthermore used for teaching and orientation.

Table 2. Recording and reviewing neonatal resuscitation as a tool for various learning activities

	CITATION
RESEARCH	"And I think it's like an unique opportunity for research, because it's so unusual. Like all the things that men might want to study in the NICU, like, we don't usually have video, like primary source. We could actually look and know like what was done and what the vital signs were at that moment. Like that's I think a pretty unusual opportunity, so to have that and to be able to use that for research is, is a pretty powerful tool." (PHCP14)
AUDIT	"And, well, eventually we thought we should actually implement it as an audit, in order to improve ourselves by reviewing the video." (LHCP1)
REVIEW CONFERENCE	"[Y]ou know we have our video review conferences that are also barely new, and those are very helpful. I think we always learn a lot from those, because we all, I think, have similar behaviours and fall into similar patterns or have similar challenges in resuscitations. So they're often widely implementable." (PHCP23)
FEEDBACK ONE-ON-ONE	"I think you get different perspectives, so, if I just watch the video by myself I may not pick up exactly what I could have done differently. But when you watch it with people who are more senior, more expert, they can give you tips about, you know, this went OK, but you could have thought about this, or you could have done this differently." (PHCP13)
TEAM	"But I do think that it's just an invaluable tool to sit down watch yourself in a resuscitation. Watch how the team communicated, how technical skills were done, how people adapted the things. And I think that if you could sit down with the team right after and watch it, well, it's really uncomfortable, I think it would be a really good tool for kind of self-improvement, team improvement." (PHCP15)
DISCIPLINARY	"[A]s paediatricians we are sometimes working solo [...] we do work as a team, but when working with your patient, when you are on service, or whenever, your colleagues almost never see what you are actually doing. So, you do not get a lot of feedback on that. This is especially true when being the supervisor. A resident will not easily tell you: he, you should have done this or that. So reviewing a video is an ideal way of actually look at that objectively." (LHCP21)
INTERDISCIPLINARY	"Like, I didn't know that, when you, when you, push morphine, you can get rigidity in your chest wall. I never knew that. Also, sometimes your pattern of resuscitation and compresses, can be a little off. Sometimes it takes a clinician to say: you're going to fast, or you're going to slow." (PHCP18)

	CITATION
TRAINING	"[B]ecause we have so many people we're teaching there, but every one of us can also learn. So we're, we're constantly learning and looking at the sequences around. And so I think there's room for every single person to look at that and, even if you do it perfectly, you still wanna teach the people that you're with what you're doing and why you're doing and what the sequence is." (PHCP10)
ORIENTATION	"Before she even got to see or go to a delivery, I did pull up one of our deliveries and showed her a typical OR delivery. Which is nice for an educational purpose in that sense too. They can see kind of what to do before they even do it." (PHCP17)
DEBRIEF	"We also encourage people to use the tool as an immediate debrief. So the baby is stable, OK guys, let's just watch it really quickly. What went well, what didn't go well. Very real time feedback and debrief." (PHCP3)
CLINICAL CARE	"But, whenever things did not go well from the first start, or when the patient needed more support, sometimes you can see that later on these children also do worse, or you may feel that they weren't breathing well from the very beginning. It may then help to get a better picture of what actually happened during the resuscitation." (LHCP10)

LHCP: LUMC Health Care Professional; HHCP: HUP Health Care Professional

REPORTED LEARNING OUTCOMES OF RECORDING AND REVIEWING NEONATAL RESUSCITATION (TABLE 3)

Interviewed providers regarded recording and reviewing neonatal resuscitation as a unique way to learn and improve. It allows a different perspective than when actually being in a resuscitation, resulting in, for instance, a better perception of time. Furthermore, appropriateness of interventions and guideline adherence can be evaluated. This offers opportunities for fully assimilating guidelines of neonatal resuscitation. Providers reported that they regard recording and reviewing neonatal resuscitation as actually improving patient safety and the quality of provided care, although they realize this may be difficult to prove.

Providers reported learning from reviewing their own performance during resuscitation, as well as from reviewing performances of others. Reviewing one's own performance is considered valuable for reassurance and self-improvement. Providers often compared reviewing actual resuscitations with debrief after simulations, but considered the first more valuable, as this includes actual emotions and interventions.

Extra exposure was the most frequent reported benefit of reviewing others performing resuscitation. Being exposed to more resuscitations, especially more difficult ones or those including intubation, is considered very instructive. Furthermore, providers considered that plenary review of resuscitations allows them to keep their knowledge up-to-date and also provides a forum to discuss approaches. This results in more uniformity in procedures.

Providers reported various benefits of adding extra features to the review process, such as the possibility to train communication skills or crew resource management when recording audio. Although these additional features are considered valuable, implementing them should be considered carefully, as they may affect providers negatively as well.

Providers reported that recording and reviewing also affected their professional standard. Recording and reviewing taught providers to act less invasively during neonatal resuscitation. At the HUP, this led to fewer hands on the baby, at the LUMC to providers spending more time evaluating the baby's condition before being interventional. Reviewing neonatal resuscitation furthermore contributes to a culture of openness, allowing providers to openly discuss procedures of any kind. Finally, providers stated that recording and reviewing neonatal resuscitation benefits the relationship with parents, as it instils trust and shows that the NICU is striving for quality improvement.

All interviewed providers reported at least one learning outcome. The educational value, however, differed between disciplines. Various providers emphasized the importance of a more interdisciplinary approach during review meetings, although they realize interdisciplinary reviews are challenging to implement in the daily routine at a NICU.

Table 3. Educational benefits

	CITATION
TIME PERCEPTION	"It's easy to go back, it's harder to go back and think about what you think, because time is so skewed and like when you're doing a resuscitation. So it's nice to be able to go back and see how long each thing took." (PHCP17)
DISCUSSING APPROACHES	"Yes, and discussing, I mean, there is so much uncertainty in neonatology that I think, you know, just discussing different ways to approach the same situation inevitable is part of our field. Cause there are a lot of things where it's grey and you don't know what the right way to do would have been." (PHCP14)
CREW RESOURCE MANAGEMENT	"I mean if you think about it, and again, it's not exact the same thing, but like, in airplanes, like the black box, like things like that, it's a recording of everything that happens on the plane and it's reviewed. And I think that that is again invaluable for figuring out when things go wrong, how things go wrong. And so I think that it could also be from, like when things do go wrong, like are there system things that we can change? Are there personnel things that need to be changed?" (PHCP15)
INTERNALIZE PROTOCOL	"From an educational standpoint how it helps me is in the sense of just sort of following the steps of resuscitation, dry, stem, stimulation. How to give PPV. Sort of how to think about what the next steps are." (PHCP12)
EXPOSURE	"Well, residents for instance, they can see how other people perform during resuscitation, and they can take things away from that. Because your exposure as a resident is relatively low, as you are not on service all the time. And oftentimes you do not even get the chance to perform an intubation at all, as we are trying to be non invasive, and as such you can see how a intubation is performed. Your exposure increases, as you can see more. Normally, you would only see like twenty resuscitations a year, of which one or maybe five include intubation. But by reviewing you can actually see it five times more." (LHCP16)
DATA COLLECTION	"And I think it's like an unique opportunity for research, because it's so unusual. Like all the things that men might want to study in the NICU, like, we don't usually have video, like primary source. We could actually look and know like what was done and what the vital signs were at that moment. Like that's I think a pretty unusual opportunity, so to have that and to be able to use that for research is, is a pretty powerful tool." (PHCP14)

	CITATION
COMMUNICATION SKILLS	"But even how you communicate, the words you use, the tone you have, the way you instruct people, the way you give feedback or ask people to do things, are all things that, that you know, it's a lot of that communication and personal, you know personal style or communication skills that watching the video allows you to understand that better than you would just trying to recall that." (PHCP24)
DOCUMENTATION	"But in my opinion this has more to do with being trained in reviewing those moments, so you can actually be more aware of how to document and how to reflect on those decisions that in retrospect turn out to be important for the whole process." (LHCP10)
REASSURANCE	"So, afterwards, I, the whole team sat down and we looked at it again. [...] I think we were all kind of feeling, like afterwards, is there more that we could have done differently, you know, would the outcome have been different. And so I think it was helpful for us to sit down and look at it and, you know, talk about little things we might have done differently, but, you know, in the end it was like, I don't know if there was anything we really could have done that would have ultimately have made so that baby survived. But it was helpful to have the video as a tool to go back and not just rely on our memories of what happened." (PHCP14)
RESPIRATORY FUNCTIONING MONITOR	"It needs a few resuscitations and a few audits to understand how to interpret those numbers and graphs. A lot of it is pattern recognition, so it's helpful if you are telling us, well, this is what we can see now. This is the pattern. And if you see that pattern recur, so yesterday night I saw this pattern and I thought, oh, these are good tidal volumes, I can see air getting in the airways, I do not see obstruction, I do not see leakage. Those patterns you learn to recognize and this helps you to read the monitor." (LHCP20)
SELF-AWARENESS	"Or, watched yourself on a video, it's, you see a lot of your own manners and some of them make you cringe, but you also notice things, like either during a resuscitation a kid was fine, but I kept on turning my head and getting distracted by other things and not focusing on the kid in front of me. Even though he was fine, but it just, it just, it reminded me how distracted I get by everything else in the room. And so with things like I think it can be a really good tool." (PHCP15)
SELF-IMPROVEMENT	"If you do not do the audit, you don't know. You do not get that feedback. Maybe you would feel better, but, well, somehow you are unconsciously incompetent. And of course, it's easier to be unconsciously incompetent than consciously competent. But, in the end it's better for everybody, for your patient, but as well for yourself, to have been made aware about things you did suboptimal. [...] And there are definitely things I learned and that I would do differently later on or still do differently than I did at that moment." (LHCP21)

	CITATION
ROLE DIFFERENTIATION	"I think the, just like less people touching, just being a bit more specific about the roles themselves. Before this, we've been very, it was very vague. It was just, I'm the leader and I'm the airway and I'm the this and I'm the that. But we weren't very clear about what is it I want you to do in that role. And so, you know, that's, that's been helpful." (PHCP25)
PHYSIOLOGY	"And you need to know a lot about physiology, that you do know as a neonatologist, but to put this knowledge into practice may not be this obvious for everyone. [...] But you do learn how to do that by reviewing these videos. [...] And as this is taught during review, you learn a lot about the physiology of transition at birth." (LHCP21)
PROTOCOL COMPLIANCE	"And that's one of the biggest things I've seen in the program, is, and we know it all along, but every one of these resuscitations, the steps take a lot longer, or are instituted a lot later than what you think. And so this, this says, let's get these steps in order and do them in a quick fashion." (PHCP10)
KEEPING KNOWLEDGE UP-TO-DATE	"I think everybody has room for improvement. No matter how much experience people have and, with the way like in health care things constantly are changing, I think like, you know, just staying up-to-date with the current procedures and policies. So I think it's helpful." (PHCP6)
PROTOCOL ESTABLISHMENT	"I think, I think just the, it really, one is, like it facilitates an open discussion on how we perform our resuscitation and how we can do things better [...] But then we also say like how, like we identify this, how is the division gonna adjust this?" (PHCP7)

PRECONDITIONS FOR SUCCESSFUL IMPLEMENTATION (TABLE 4)

Providers reported negative feelings and experiences with recording and reviewing neonatal resuscitation and therefore emphasized preconditions for using the technique. Providing information, such as information about data storage and the legal status of recordings, is considered very important for providers in order to feel safe when using the technique.

Many providers reported feeling nervous when their performance was reviewed by colleagues. These feelings were reported more frequent by junior providers and providers who stated that they felt less confident about their clinical performance. Feelings of anxiety normally reduced after exposure. Providers tended to give little weight to negative feelings, as they experienced the benefits of recording and

Table 4. Preconditions for successful implementation

	CITATION
MIND SET	"So making sure that everybody has like the shared mentality, like: yes, like there will be things we find that we do wrong, and we're gonna acknowledge that. And that's how we're gonna improve." (PHCP23)
BLAME FREE, SHAME FREE	"So, yeah, I think you should introduce it well and that you need to pay attention to a safe environment during review, especially in the beginning. It should not be blaming and shaming, but it should be constructive. And we should keep in mind that there may be more ways to reach the best outcome for our patients." (LHCP11)
CREATE INVOLVEMENT	"And also have all of the sort of stakeholders in that, have the nurses, have the RT's, have everyone kind of sit down at a table and be like: how can we use it together so everyone feels like they're part of it." (PHCP15)
PROVIDE INFORMATION	"I think just transparency about the process and just like, like, you know, when it's been recorded, when they're being deleted, how you can review it, both informally, and then that the formal reviews are done in a kind of like, you know, non-accusatory way they're done from the point of like: let's learn, let's improve, let's look at our practice." (PHCP7)
FOCUS ON BENEFITS	"Before you start plenary meetings, you have to make sure you explain everyone very well what's the goal of these meetings, so they know it's not about judging people, or grading them, but because you want to discuss together what you are doing. So they know the goal is to learn together. In order to improve care." (LHCP21)
EXPOSURE	"So I think having more exposure, then you're less afraid of it, you're less afraid because oh yeah, this is not about getting in trouble, it's all about dynamics and how we can improve our logistics and also improve the outcome for this baby." (PHCP11)
DATA PROTECTION	"I think if it wasn't as secured, if it wasn't, you know, if it hasn't be a secured server on a password protected storage, like I think all of this things need to be in place for in order to all of the physicians to feel safe and stuff." (PHCP7)
PREPARE PROVIDER FOR REVIEW	"I think it's important to watch the video on beforehand. The best would be not to do that, but that would be very harsh. (...) I think it's decent to discuss it on beforehand. It would make it easier, so somebody will know a bit what is gonna happen during the plenary review and he can prepare himself a little for that." (LHCP21)

reviewing neonatal resuscitation for learning and improving the quality of the procedure. All providers stated that the benefits of the technique outweigh the concerns.

In order to prevent or reduce negative feelings and enable learning and improving, providers highlighted preconditions for a safe learning environment. Providers considered involvement, a shared group culture or mind set, focus on the educational benefits, and a blame free, shame free environment as essential conditions for an effective review process. Creating a safe learning environment is considered an ongoing process and a shared responsibility for all providers who benefit from the technique.

When preconditions are met, recording and reviewing neonatal resuscitation is acceptable for providers, and definitely recommended to implement at other NICUs. Furthermore, providers assume that recording and reviewing actual care could be valuable for other procedures, such as laryngoscopy, or at other wards, such as the ER or other ORs. Moreover, providers proposed recording consultation with patients in order to improve communication between providers and patients.

DISCUSSION

Our study explored benefits of recording and reviewing neonatal resuscitation as experienced by neonatal care providers. Recording and reviewing neonatal resuscitation is considered highly beneficial for learning and improving resuscitation skills. All interviewed providers would definitely recommend other NICUs to implement recording and reviewing neonatal resuscitation, but stated that preconditions should be met for successful implementation.

Knowledge and skills often diminish shortly after Neonatal Resuscitation Program (NRP) and equivalent trainings.(5, 6) Matterson et al. showed that resuscitation skills diminish between two and four months after completion of neonatal resuscitation training.(5) Therefore, activities that boost knowledge and skills are recommended. (7) Sawyer et al. and Cordero et al. furthermore showed that multiple sessions are needed in order to actually improve resuscitation skills.(8, 9) Many NICUs therefore conduct regular simulation training of neonatal resuscitation. Various studies reported improvement of neonatal resuscitation skills after simulation trainings.(5, 10, 11) In our study, providers considered reviewing actual neonatal resuscitation

even more valuable for learning and improving clinical performance than reviewing performances after simulations.

Enhanced learning after reviewing actual resuscitation was reported by Shivananda et al. and Skårre et al.(12, 13) Many studies highlight the clear educational benefits of recording and reviewing actual care.(14) Yet, an improvement in clinical performance after reviewing recordings of actual resuscitation could not be proved.(2, 15-17) In these studies, clinical performance was mostly scored as correct performance of hands-on technical skills. Successful delivery room management, however, demands a combination of technical, cognitive and behavioural skills.(18) Interviewed providers in our study reported learning outcomes in all these domains. For instance, when reviewing recordings, providers are trained on physiology and clinical indications (cognitive skills) and they receive objective feedback on mask technique (technical skills) and communication (behavioural skills). The improved clinical performance that interviewed providers reported experiencing may be due to the learning effect on this combination of skills. Increased self-assurance about clinical skills, which has been reported to improve resuscitation skills(10), may also contribute to the learning effect.

Based on the reported learning outcomes of recording and reviewing actual neonatal resuscitation, we propose that the technique supports maintaining resuscitation skills. Moreover, we suggest that review processes as performed by the LUMC and the HUP can be even more successful than debrief after simulation trainings, as these review processes are more concise and more frequent than most simulation training programs. Frequently recurring short-lasting booster sessions may allow better integration in the daily routine of NICUs and extra exposure for providers. This extra exposure will especially benefit residents: in the short time of rotating at a NICU, residents will be exposed to various booster sessions. Furthermore, they are more likely to be exposed to a booster session before being hands-on again after a period of rotations at other wards. This will improve patient safety.

Although recording and reviewing neonatal resuscitation is considered valuable for improving resuscitation skills, providers of both NICUs reported that the educational value of recording and reviewing neonatal resuscitation differs strongly between NICU staff members, as it is often logistically impossible for all neonatal disciplines to join review meetings. More research is needed in order to develop a format for review meetings, fitting to the daily routine of a NICU, in which all NICUS staff members can participate, allowing all providers to improve resuscitation skills.

In our study, providers reported that recording and reviewing neonatal resuscitation is acceptable for providers. This is in accordance with previous reported experiences. For example, in 2008, O'Donnell et al. reported that providers accepted recording and reviewing neonatal resuscitation as little different from being observed and instructed by senior colleagues.(19) Gelbart et al. reported that most staff members were willing to participate.(20) Shivananda et al. recently reported that 90% of questioned providers considered recording and reviewing acceptable.(12) This suggests a growing base of evidence that recording and reviewing neonatal resuscitation is acceptable for neonatal care providers, supporting the recommendation for implementation made by the providers participating in our study. However, although participant selection was conducted carefully and anonymously, researcher bias may have occurred. Furthermore, providers may have been biased by positive experiences or providers may have felt constrained to report negative experiences, as the general consensus at both NICUs is very positive. Based on reported concerns about recording and reviewing neonatal resuscitation, both by providers in our study and providers in other studies, we therefore recommend cautiousness upon implementation. As providers who experienced the educational benefits of recording and reviewing neonatal resuscitation generally highly appreciate the technique, we advise NICUs that plan to implement recording and reviewing neonatal resuscitation, to expose providers to the educational benefits as early as possible and to involve them in designing a review process fitting to their educational needs.

To the best of our knowledge, this is the first study to report learning outcomes of recording and reviewing neonatal resuscitation in depth. In order to provide guidance to other NICUs that are planning to implement this technique, we provide an overview of learning outcomes of various forms of review meetings for providers (table 5). This overview may be used to provide neonatal care providers insight in educational benefits and to create involvement in designing a review process fitting to educational needs of providers.

CONCLUSION

Recording and reviewing neonatal resuscitation is considered highly beneficial for maintaining and improving resuscitation skills. Providers using the technique would recommend other NICUs to implement it, assuming that preconditions for a

safe learning environment are met. Insight in educational benefits may be used for successful implementation of a review process, fitting to educational needs of those participating in it.

Table 5. Educational benefits of various review processes

	UNDERGRADUATES (i.e. interns)	POSTGRADUATES (i.e. residents, fellows, neonatal nurse trainees)	SENIORS (i.e. attendings, resource nurses, physician assis- tants)
ONE-ON-ONE REVIEW	N/A	Self-reflection Reassurance Self-improvement Feedback Time perception Internalizing protocol	Self-reflection Reassurance Self-improvement Peer coaching Time perception
DISCIPLINARY REVIEW	Orientation Exposure (Patho)physiology	Orientation Feedback Exposure Internalizing protocol (Patho)physiology Acting less invasively Documentation	Peer coaching Internalizing protocol (Patho)physiology Acting less invasively Documentation Keep knowledge up- to-date Discussing approaches Protocol establish- ment
TEAM REVIEW	Exposure	Debrief Internalizing protocol Role differentiation Documentation	Debrief Role differentiation Documentation
INTERDISCIPLINARY REVIEW	Orientation Exposure (Patho)physiology	Orientation Feedback Exposure Internalizing protocol Role differentiation (Patho)physiology Documentation Acting less invasively	Peer coaching Internalizing protocol Role differentiation (Patho)physiology Documentation Acting less invasively Keep knowledge up- to-date Discussing approaches Protocol establish- ment

REFERENCES

1. Finer N, Rich W. Neonatal resuscitation for the preterm infant: evidence versus practice. *J Perinatol* 2010;30 Suppl:S57-66.
2. Carbine DN, Finer NN, Knodel E, et al. Video recording as a means of evaluating neonatal resuscitation performance. *Pediatrics* 2000;106(4):654-8.
3. Manley BJ, Owen LS, Hooper SB, et al. Towards evidence-based resuscitation of the newborn infant. *Lancet* 2017;389(10079):1639-48.
4. den Boer MC, Houtlosser M, van Zanten HA, et al. Ethical dilemmas of recording and reviewing neonatal resuscitation. *Arch Dis Child Fetal Neonatal Ed* 2018;103(3):F280-284.
5. Matterson Heideh H, Szyld D, Green Brad R, et al. Neonatal resuscitation experience curves: simulation based mastery learning booster sessions and skill decay patterns among pediatric residents. *J Perinat Med* 2018.
6. Patel J, Posencheg M, Ades A. Proficiency and retention of neonatal resuscitation skills by pediatric residents. *Pediatrics* 2012;130(3):515-21.
7. Sawyer T, Ades A, Ernst K, et al. Simulation and the Neonatal Resuscitation Program 7th Edition Curriculum *NeoReviews* 2016;17(8):e447-e53.
8. Sawyer T, Sierocka-Castaneda A, Chan D, et al. Deliberate practice using simulation improves neonatal resuscitation performance. *Simul Healthc* 2011;6(6):327-36.
9. Cordero L, Hart BJ, Hardin R, et al. Deliberate practice improves pediatric residents' skills and team behaviors during simulated neonatal resuscitation. *Clinical Pediatr (Phila)* 2013;52(8):747-52.
10. Malmstrom B, Nohlert E, Ewald U, et al. Simulation-based team training improved the self-assessed ability of physicians, nurses and midwives to perform neonatal resuscitation. *Acta Paediatr* 2017;106(8):1273-9.
11. Bender J, Kennally K, Shields R, et al. Does simulation booster impact retention of resuscitation procedural skills and teamwork? *J Perinatol* 2014;34(9):664-8.
12. Shivananda S, Twiss J, El-Gouhary E, et al. Video recording of neonatal resuscitation: A feasibility study to inform widespread adoption. *World J Clin Pediatr* 2017;6(1):69-80.
13. Skåre C, Calisch TE, Sæter E, et al. Implementation and effectiveness of a video-based debriefing programme for neonatal resuscitation. *Acta Anaesthesiol Scand* 2018;62(3):394-403.
14. Lloyd A, Dewar A, Edgar S, et al. How to implement live video recording in the clinical environment: A practical guide for clinical services. *Int J Clin Pract* 2017;71(6).
15. Sawyer T, Sierocka-Castaneda A, Chan D, et al. The effectiveness of video-assisted debriefing versus oral debriefing alone at improving neonatal resuscitation performance: a randomized trial. *Simul Healthc* 2012;7(4):213-21.
16. Nadler I, Sanderson PM, Van Dyken CR, et al. Presenting video recordings of newborn resuscitations in debriefings for teamwork training. *BMJ Qual Saf* 2011;20(2):163-9.
17. Ades A, Lee HC. Update on simulation for the Neonatal Resuscitation Program. *Semin Perinatol* 2016;40(7):447-54.
18. Yamada NK, Kamlin COF, Halamek LP. Optimal human and system performance during neonatal resuscitation. *Semin Fetal Neonatal Med* 2018.

19. O'Donnell CP, Kamlin CO, Davis PG, et al. Ethical and legal aspects of video recording neonatal resuscitation. *Arch Dis Child Fetal Neonatal Ed* 2008;93(2):F82-4.
20. Gelbart B, Barfield C, Watkins A. Ethical and legal considerations in video recording neonatal resuscitations. *J Med Ethics* 2009;35(2):120-4.

