

## **Background**

Admission of a baby for neonatal care represents a deeply traumatic time for parents. Webcam technology facilitating live streaming of the baby when the parents are unable to be physically present have been introduced to support bonding and parental engagement in care.

## **Aim**

This systematic review explores the impact and experiences of webcam technology upon parents of babies in the neonatal unit and neonatal healthcare professionals.

## **Methodology**

A systematic search of Embase, Medline and Scopus were conducted using the keywords 'video technology', 'newborn', and 'neonatal intensive care'. Studies written in English and exploring live stream technology were included. Thematic analysis per group (parents, and healthcare professionals) was undertaken to identify similarities between themes across published studies.

## **Results**

Ten studies were included. Six explored the impact of webcam technology on parents only, two on both parents and healthcare professionals, and two on healthcare professionals only. Thematic analysis per group identified 3 themes for parents including: parental wellbeing, parent-infant bonding, and quality of care. Two themes were identified for neonatal healthcare professionals including: quality of care, and feasibility of webcam technology.

## **Conclusion**

Webcam technology has many documented benefits for parental wellbeing. However new technology requires adequate staff training, support, and plans for ongoing maintenance. Further research is required to explore the long-term impacts on breast milk production and infant neurological development.

**Keywords:** neonatal, technology, webcam, parents,

## **Introduction:**

The impact of having their baby admitted for neonatal care is extremely stressful for parents and studies during this period have identified symptoms of stress, anxiety and Post-Traumatic Stress Disorder (PTSD), highlighting the potential long-lasting traumatic nature of such an event.(1, 2) For parents, stress and anxiety can be exacerbated if they are unable to be present with their baby as often as they would like due to their proximity to the neonatal unit, siblings requiring care at home or work demands. Approaches to the care of families in the neonatal unit appreciate this impact and the Family Centred Care (FCC) model, considered the gold standard in neonatal healthcare, is based on a collaborative relationship between healthcare staff and families to provide medical and nursing care of the baby as well as support for families during the hospitalisation period.(3) The Covid-19 pandemic response, however, highlighted limitations to this approach as NHS Hospital Trusts restricted parental access to their baby on the neonatal unit in initial attempts to reduce infection risks.(4) This had huge implications for families; their ability to form relationships with their baby and the healthcare staff working with them was dramatically curtailed, and siblings, extended family and friends had no access to the baby at all.(5) Studies have shown that compromised proximity and reciprocity have negative effects on both parental mental health, parent-infant bonding and infant neurodevelopment; restricting parental access to their baby arguably enhances the potential for these outcomes during the postnatal period and beyond.(6, 7)

To enhance parent engagement and bonding, webcam technology has been introduced globally in many neonatal intensive care units. Small cameras, placed above the incubator, allow parents to view a live video stream of their infant during times they are unable to be present. Parents can choose to share the live stream link with friends and family, supporting integration of the baby into the family community. Webcam technology, where available, was crucial for many families unable to be present with their baby on the neonatal unit during the COVID-19 pandemic due to ward restriction.(8) Initial studies exploring the use of webcams have shown that parents perceive the technology as helpful during the prolonged separation from their baby, making them feel reassured and enhancing feelings of attachment with their baby.(9, 10) Similar studies have also identified, however, that the ability to monitor their baby on demand caused distress and anxiety for some parents, highlighting potential unintended consequences of the technology.(11) Due to the limited research in this area, the European Foundation for the Care of Newborn Infants (EFCNI) highlighted the need to undertake further research into the impact of webcam technology on clinical practice before considering implementation of this service within the standard of neonatal care.(12) The aim of this systematic review and qualitative thematic analyses was therefore to explore the impact and experiences of the

implementation of webcam technology in neonatal units on staff, parents and infants through identifying and analysing studies conducted in this area to date.

### **Methodology**

The study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) in 2021 (CRD42021278502) and the detailed prespecified protocol is available upon request. No amendments were made to the protocol during the review. Prisma guidelines were followed to conduct this Systematic Review and three databases were searched for eligible studies: Embase, Medline and Scopus. The search details through keywords and medical subject headings (MeSH) were agreed with a health specialist librarian at University College London (UCL) and a total of 997 studies were included at screening phase. The search was conducted around three concepts and related MeSH terms:

- I. Video technology: eHealth, telemedicine, camera systems, telehealth
- II. New-born: preterm, premature, prematurity, baby/babies, neonate, infant
- III. Neonatal Intensive Care Unit: NICU, neonatal unit, NNU

### **Eligibility Criteria**

This review included studies written in English that focussed on the perceptions of parents and staff regarding the use of live video streaming on the neonatal unit and the impact of webcam technology upon staff, parents, and infants. No date limitations were set due to the recent innovation of webcam technology. Studies that were not written in English, that were assessing any technology other than live video streaming or based in outpatient settings were excluded.

### **Data extraction and quality assessment**

All studies identified using keywords and MeSH terms were exported into Mendeley. Duplicates were removed and the final 997 articles were screened independently by PP and KC to assess their suitability according to the eligibility criteria. An additional 965 studies were ineligible based on title and abstract. The final 32 articles were read in full by PP and KC; 10 articles were included in the final analysis (figure 1).

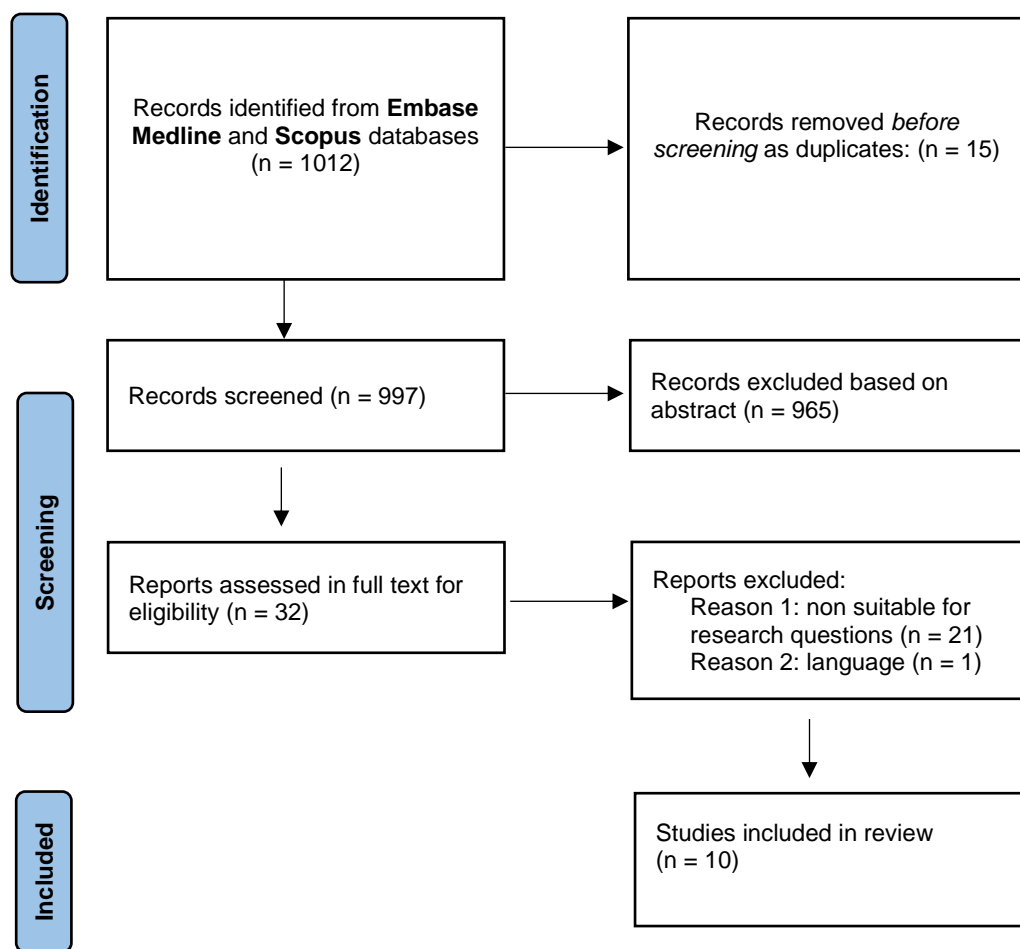


Figure 1: Systematic Review PRISMA flow diagram

All articles meeting the inclusion criteria used a variety of methodological approaches focusing primarily on mixed methodology with an emphasis on qualitative findings to explore webcam use from both the parent and staff perspective (supplementary table 1). The quality assessment was therefore conducted using CASP guidelines for qualitative research and articles were appraised based on the 10 CASP questions and study specifics: staff, parent or infant focus, type of study, aim, number of participants, time of intervention, type of technology used and main study themes (supplementary table 2). Two researchers (PP & KC) reviewed the articles independently by creating a comprehensive summary table for all the reviewed articles according to the CASP checklist. Each article was assessed for validity of the study (section A), results (section B) and usefulness of the results (section C). A third researcher (KG) resolved any discrepancies. No concerns in terms of the quality of the included studies was found and therefore no study was excluded.

### Analysis of findings

Thematic analysis, using the six-phase of analysis guide was used to analyse the findings of the included studies.(13) When exploring mixed method studies, descriptive analysis of quantitative data was undertaken and results mapped onto the results of the thematic analysis.(14, 15) All studies were initially grouped according to their research focus: parents, staff or infants. Subsequently two independent researchers (PP & KG) identified the concepts found within each study results, exploring them in comparison to each other, grouping similar concepts together to create broader themes representing the overall findings. (16) The final themes were discussed, revised, and agreed with both researchers.

## **Results**

Ten papers were included and critically appraised within this systematic review exploring the impact of webcam use upon staff, parents, and infants. Of these, three were based in the US, two in Australia, and four in Europe (England, Scotland, Germany, and a multicentre study in Ireland & France). Eight collected and analysed parental perceptions on the use of webcams in neonatal units, of which two also included healthcare professionals' perceptions. Two of the ten articles focussed only on healthcare professionals' perceptions. No articles were found which explored the impact on webcams on infants. Findings were analysed according to group: parents and healthcare professional's perceptions.

### **Parental Perceptions**

Of the eight studies exploring parental perspectives, thematic analysis across all study findings identified three main themes: parental wellbeing, parent-infant bonding, and quality of care.

#### **1) Parental wellbeing**

Findings across all studies highlighted the potential for webcam technology to have both advantages and disadvantages upon overall parental wellbeing whilst their infant is admitted for neonatal care. In a qualitative interview study with parents whose infant was admitted for neonatal care in a single unit in Scotland, Kerr et al found that parents reported a greater sense of proximity and closeness to their baby when able to see them through webcam technology. Parents reported a sense of reassurance and that video livestreaming enabled a 'shared' experience with family and friends who were also able to view their baby.(9) Findings also highlighted the ability of webcam technology to help prepare parents to see their baby in the unfamiliar environment of the neonatal unit, aiding emotional wellbeing of both parents and therefore supporting maternal recovery. Reimer et al found similar findings in their interviews with parents whose infants were currently on a neonatal unit in Germany

and using webcam technology; parents reported a greater sense of control and reassurance over their situation.(17) When evaluating the use of live streaming technology with 17 parents in a neonatal unit in the UK, Psychogiou et al found that parents reported seeing their baby made them feel less anxious and worried.(18) In focus groups after a minimum of 2 weeks of their baby being admitted for neonatal care in three neonatal units in France, parents in the study by Le Bris also highlighted the use of webcam technology would make them feel close to their baby and provide a sense of reassurance.  
(11)

In the same study, however, parents shared concerns they would feel distressed when the camera was not on, not pointing at their baby, when seeing their baby in distress, or when seeing a clinical procedure undertaken via livestreaming.(11) Findings from Kerr et al also found that parents shared feelings of anxiety due to the constant instinct to monitor if their baby was ok when they were not with their baby, and from seeing clinical procedures undertaken on their baby.(9) Parents in the study by Reimer et al also reported increased parental stress when unable to comfort their upset baby, or if they witnessed distressing events during livestreaming.(17) Kubicka et al compared the responses from 159 parents who did (n=80) and did not (n=79) use webcam technology using the NICU:PSS to explore impact upon parental stress and anxiety at either their infants 30<sup>th</sup> day of life or within 7 days of anticipated discharge in a single neonatal unit in the USA.(8) The authors reported lower stress levels in parents using webcam technology in comparison to those who did not, suggesting there may be overall benefits provided by the use of this technology if appropriate parental support is provided.(8) Rhoads et al similarly used the NICU:PSS, along with the STAI-S and MIB scales, to measure parental stress in those using webcams at three time points (once per week for 3 weeks).(19) Findings highlighted significant correlations between higher levels of stress in relation to the baby's appearance as measured by the NICU:PSS and maximum number of minutes viewed in any one session.(19) Qualitative data gathered from open-ended survey questions, however, indicated that overall parents felt that the webcams reduced their anxiety levels, leading Rhoads to suggest that educational sessions to facilitate parental understanding of the neonatal unit routine may help ease the stress and anxiety experienced by parents when viewing their baby through webcams.(19)

In a study similar to Rhoads et al, Kilcullen et al explored the experiences of 28 parents using webcam technology in a neonatal unit in Australia over four time points (admission, after a week, 2 weeks, and 3 months post discharge) using the same measurement tools (NICU:PSS, STAI-S and MIB) and open-ended questions.(20) Whilst findings of reduced stress levels and webcam use did not reach significance at any time point, there was a trend towards lower levels of anxiety and thematic analysis

of open-ended question responses highlighted strong parental acceptance of the webcams due to the reassurance and ability to view their baby 'on-demand'(20)

## 2) Parent-infant bonding

Several studies reported findings which explored parental perceptions towards webcam technology and highlighted the positive impact upon perceived parent-infant bonding. In the qualitative element of their mixed method study, Kilcullen et al reported that parents felt webcam technology promoted positive emotions and a sense of 'love' when seeing their baby, and allowed parents, siblings, wider family and friends to develop an emotional connection to the baby.(20) In the same study, however, one mother reported feeling upset because whilst she could see her baby, she could not experience physical contact, highlighting the complex nature of parent-infant bonding. Findings from Reimer, Le Bris and Kerr support the findings that webcams may promote parent-infant bonding, with parents reporting that webcam use helped them to feel closer to their baby when they were not physically together. (9, 11, 17)

In the mixed methods study by Kubicka et al, findings highlighted a significant positive association between improved bonding scores and time spent viewing the livestream from the webcam at the final time point of the study after 3 weeks. (8) Kilcullen et al also found a significant correlation between improved bonding scores and webcam technology use, albeit at earlier time points in their study. Parents reporting lower perceived bonding at admission were also found to use webcam technology more often. (20) Thematic analysis of open-ended questions provided additional insight, with parents reporting that use of webcam technology also promoted sibling and wider family bonding, suggesting that livestreaming could be used to facilitate bonding between parents and their baby from admission through to discharge. (20)

When discussing parent-infant bonding, several studies reported a positive impact of webcam technology upon maternal breastfeeding intentions and practices. Weber et al designed a survey to compare responses to questions exploring parental perceptions of their baby's condition, engagement in care and feeding intentions between parents using (n=30) or not using (n=70) live streaming on a neonatal unit in the USA.(21) Findings highlighted a lower intention to stop breastfeeding in mothers that used webcam technology compared to those who did not, along with higher rates of babies receiving breast milk at discharge.(21) These findings are supported by qualitative interviews with mothers themselves in the studies by Reimer, Kerr, and Kilcullen who described an improvement in

their ability to express larger volumes of milk when watching the livestream of their baby at home, due to feelings of closeness experienced when seeing their baby.(9, 17, 20)

### 3. Quality of care

Several studies concluded that webcams were a valuable tool to improve the care provided to families. Parents in the study by Le Bris described how webcam technology could promote personalised care through enhancing the relationship between parents and healthcare professionals, and facilitating increased parental engagement in their infants care and behaviour.(11) Parents in the study by Reimer et al described how using webcam technology increased their confidence in the quality of care provided to their infants, as they felt that healthcare professionals would be more 'vigilant' if they knew a webcam was livestreaming events.(17) Conversely, however, parents also reported concerns that livestreaming could increase levels of stress and anxiety in healthcare professionals and therefore impact the parent-healthcare professional relationship, potentially increasing the risk of clinical errors with their baby.(11) Not getting to know neonatal team caring for their baby, resulting from use of livestreaming and subsequent reduced interaction, also increased parental concerns over levels of trust and a less personalised approach to care.(11) When comparing responses of webcam users to non-webcam users, however, Weber et al did not find any significant difference in participants responses to questions around perceptions of quality of care received and engagement in care by healthcare professionals.(21) Parents in the qualitative element of the study by Rhoads et al reported that they felt webcams supported care delivery, as they helped parents to cope better with the reality of having a baby admitted for neonatal care.(19)

#### **Staff Perceptions**

Four of the ten papers explored the impact of webcams upon neonatal healthcare professionals. Thematic analysis of the findings identified two main themes: quality of care, and the feasibility of webcam technology.

#### 1) Quality of care

Three of the four articles found healthcare professionals perceived webcam technology to increase nursing workload and stress. In a prospective questionnaire study, Joshi et al explored the perceptions of nursing staff of webcam use upon workload to determine whether webcams interfered with nursing care.(22) Over a period of seven months, 42 nurses completed 753 surveys about infants in their care. Of these, 623 of the surveys reflected the care of infants who had webcam technology at the cot side, whilst 130 did not. Findings highlighted that nurses perceived an increase in workload and stress from



manipulating the position of the webcams and answering parental concerns related to the images they could see on the live stream. Nurses reported this impacted negatively on the quality of care they could provide to the baby.(22) The perception of increased nursing workload in relation to parental concerns was also found in the study by Kilcullen et al, who explored nursing perceptions of the impact of webcams pre and 6 months post implementation of the technology on a single neonatal unit in Australia.(23) There were no significant differences between time points; staff reported workload concerns at both points which could impact the quality of care provided to infants and families, including increased need for parental support whilst webcams are in use and equipment concerns. This feeling of increased workload and stress was compounded when nurses were caring for multiple babies who were all using webcams.(23) These findings are similar to those reported by Kubicka et al, who found in their survey of 35 paired neonatal nurses working with and without webcams in a neonatal unit in the USA, that regardless of webcam experience, nurses believe that webcam technology negatively impacted upon quality of care resulting from increased nursing stress and workload.(8) Despite this, neonatal healthcare professionals in this study also highlighted the potential of webcam technology to benefit parents from enhanced bonding and attachment. This is further supported by the results of focus groups with healthcare professionals in the study by Le Bris, who reported that webcam technology could function as complementary monitoring devices to monitor the baby's health status to enhance clinical practice. (11)

## 2) Feasibility of webcam technology

Feasibility concerns were reported by neonatal healthcare professionals in studies exploring staff perceptions of webcams. Neonatal healthcare professionals in the focus groups undertaken by Le Bris et al reported the need for technical, maintenance and training support while using webcams on the neonatal unit, suggesting a designated person to manage the cameras.(11) Similarly healthcare professionals in the study by Joshi et al reported various technical issues, such as connectivity, imaging, failure of equipment to work, parents being unable to log in and general trouble shooting following the implementation of webcams.(22) The suitability of the equipment was also questioned by neonatal nurses in the survey by Kilcullen et al, who reported concerns regarding the location and stability of the camera equipment around the baby.(20)

## **Discussion**

The aim of this systematic review was to explore the impact of webcams on parents, infants, and healthcare professionals on neonatal units. Eight of the ten identified papers reported findings from studies exploring parental perceptions with thematic analysis identifying 3 themes: parental

wellbeing, parent-infant bonding, and quality of care. Four of the ten papers reported findings from studies exploring staff perceptions with thematic analysis identifying two themes: quality of care and feasibility of webcam technology. Overall, our review highlighted positive perceptions from parents in respect to the integration of webcams within neonatal environments. The main benefits reported by parents included reduced stress and anxiety levels due to the ability to 'view' their baby on demand, therefore alleviating feelings of distress and separation and providing a sense of reassurance.(8, 9, 20) This was also reflected through reported feelings of reassurance provided by webcam technology by parents.(9, 11, 18) Kilcullen et al found parents reported an increased use of webcams if the length of their infants hospitalisation increased, suggesting webcams could contribute towards enhanced positive feelings of reassurance, better engagement with their baby as well as improving overall parental health and wellbeing.(20) Webcams were also found to be a valuable tool for improving care by being able to personalise and maintain parental involvement with their baby during their admission to the neonatal unit.(11, 21)

Recognition of the importance of parental engagement in their baby's care has led to the development of approaches such as the Family Integrated Care (FIC) model, designed to increase parental engagement through their direct involvement in the baby's care in neonatal units.(24) The implementation of this model, however, has seen discrepancies between hospitals and healthcare systems among regions and countries due to the different selected approaches.(25) The findings of this review highlight the potential role of webcam technology as tools to promote family engagement and therefore this family-centred care model, through enhanced bonding not only between parents and their baby, but also in the wider family context of siblings, grandparents, extended families and friends. Our findings also highlight the role played by webcam technology in improving parents and families' mental health, with potential implications for improved benefits for long-term infant cognitive development. The potential stress and anxiety faced by parents who have a baby admitted to the neonatal unit has the potential to hinder the baby-parent bonding development and subsequent infant neurodevelopment; the potential benefits of using webcam technology could help to counteract these feelings through helping to improve bonding whilst also potentially aiding future infant neurodevelopment.(7, 26) .

For webcam technology to form part of a family centred approach, parents need to be supported to understand the role and purpose of the cameras while also feeling comfortable to raise their questions and concerns. This review highlighted the concern parents felt about their baby's health and the tendency for them to constantly monitor their baby on the webcams cameras whilst they were unable

to be present on the unit.(11) Parents also experienced distress especially when seeing their baby crying, when cameras were off or not pointing at the baby as they were worried that something was wrong.(9, 19, 20) Further research with parents is therefore required to determine the level of support and initial education required to facilitate and enhance parental use of and experience with webcams.(19) Exploring the impact of communication in this area is vital; studies have repeatedly shown that parents value clear and consistent communication between not only themselves and healthcare professionals, but also between healthcare professionals themselves, to feel engaged in their baby's care.(27, 28) Exploring and evaluating communication training and support when implementing new technology such as webcams into the neonatal unit may therefore help to improve the confidence of neonatal healthcare professionals whilst also ensuring the needs of parents are met.

The impact of webcam technology on the relationship between parents and neonatal healthcare professionals was highlighted by several articles in this review. Le Bris et al highlighted parents reported feeling concerned that healthcare professionals would feel more stressed while simultaneously caring for their baby and being 'filmed'.(11) Parents reported concerns that healthcare professionals would spend less time in the nursery directly observing their baby, as they were able to see the baby through the camera, this way reducing the interaction opportunities, expert reassurance and moments of social engagement in such difficult times.(11) Parents also suggested that webcam technology could lead to loss of trust in professionals if they saw their baby's carer doing "something wrong" on camera; similar concerns were shared by healthcare professionals that feared possible legal repercussions for something that was seen on camera and possibly misjudged.(11) Therefore this shared concern brings up a clear necessity that needs addressing through education and support prior to implementation of webcam technology

Results from this study suggest that the benefits of webcam technology go beyond parental health and wellbeing, and infant-family bonding. Weber et al reports a central role in aiding prolonged breastfeeding in mothers who had used webcams, whilst Kilcullen highlights reports from mothers that webcams led to increased milk production. (20, 21) By integrating webcam technology into the FIC model there could be an opportunity to explore the long-term outcomes of breastfeeding, bonding and attachment with parents, siblings and grandparents as well as the role of the technology in improving clinical practice.

This systematic review is limited in that only livestreaming technology was included; there are other technological innovations in neonatal units which may enhance parental engagement in the care of

their baby, such as video diaries. However, we specifically selected livestreaming technology to determine the impact and perceptions of continuous, live data available to parents. The review highlighted the importance of support for both parents and healthcare professionals during webcam technology implementation. Several studies identify the concern from healthcare professionals that the webcams represent a source of increased workload, including camera manipulation, answering phone calls from parents and overall stress due to the feeling of being constantly watched.(8, 20, 22) This is particularly important when considering the current environment of neonatal care: in the UK only 64% of neonatal units are staffed according to the recommended nurse to patient ratios.(29) Research has also shown that increased nursing workload and decreased staff availability have the potential to increase in-hospital neonatal mortality rate; ways of implementing, maintaining, and evaluating webcam use on neonatal units therefore requires careful consideration by neonatal unit staff.(30) Acknowledging these potential impacts on staff workload could also be a positive prompt to explore the scope of current neonatal healthcare professional roles, and the potential to introduce new figures who will be responsible for managing the ever-increasingly complex technology used in neonatal units. This could rebalance the current workload, improving parent and professionals' experiences of webcam technology and overall standards of family centred care.

## **Conclusion**

The use of webcam technology in neonatal units can potentially improve the mental health and wellbeing of the parents and promote bonding between the infant, their parents and wider family members. Healthcare professionals concerns over workload, stress and privacy concerns need addressing, however, if webcam technology is to be integrated into routine care. The expansion of potential roles in the neonatal unit to include technology specialists could be a possible solution to address the increased healthcare professional workload. Further research is therefore necessary to explore the long-term impact of the benefits provided by webcam technology on areas including breastfeeding, infant neurodevelopment, and Family Integrated Care to ensure both parents and professionals are supported to improve the clinical care provided to all infants on neonatal units.

### **What is known about this topic?**

- Admission of a baby for neonatal care is extremely traumatic for parents
- Livestreaming technology facilitates parental engagement with their baby when they cannot be present on the neonatal unit

### **What this paper adds:**

- Parents perceive livestreaming technology to be a positive addition to the care of the baby on the neonatal unit
- Parental education and support is required when implementing webcam technology
- Further exploration of specific neonatal nursing roles to support digital technology is required

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