
Challenges of Implementation of a Web-Camera System in the Neonatal Intensive Care Unit

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DURING PREGNANCY, PARENTS EXPECT A HEALTHY newborn, ready to be welcomed home promptly after birth. A lengthy hospital stay for the newborn disrupts this vision, and when babies are in a neonatal intensive care unit (NICU), mothers and fathers often feel disconnected from their newborns.^{1,2} Parent–newborn bonding is promoted in a welcoming NICU environment, especially for parents separated from their hospitalized neonate.

Although many NICUs are transitioning to a more family-friendly environment, the high-technology setting can be intimidating for parents of a newborn.^{1,3} Parents often struggle with the “shock of a preterm baby,” a “lack of control,” a “feeling of not belonging,” and feelings of “alienation” with the neonate in the NICU environment.^{2–7} NICU environments that are not family friendly such as restricted visiting times, lack of privacy, or no parental sleeping areas compound these issues related to the parental feelings.^{2,6,8}

Although technology can play an important role in strengthening family-centered care in the NICU, a positive NICU environment requires congruence between high-tech and high-“touch” (i.e., care and concern for the family in a complex, sometimes overwhelming environment). The first part of this article provides a description of technology use related to video in the NICU.

IMAGES, WEB-CAMERAS, AND TECHNOLOGY IN THE NICU

Various types of interventions for parents have been explored to aid in connecting with the neonate. Photographs of the neonate improve attachment of the mothers to their NICU-hospitalized infants.^{9,10} Only two research studies are in the published literature related to parents and either photographs or video images.

Only one researcher has examined the use of photos with preterm neonates and an observational tool was used to assess bonding. Huckabay examined 40 mother–infant dyads,

20 control and 20 experimental, where the experimental group received a picture of their hospitalized neonate.⁹ The experimental group had significantly higher bonding behaviors than the control group mothers even though both groups had 24/7 access to their hospitalized neonates.^{9,10}

The videophone, a telehealth technology, was used to connect mothers with their hospitalized neonate.¹¹ Picuch and colleagues gave seven hospitalized postpartum mothers a videophone, which they could call the NICU at any time, and compared them to seven control postpartum mothers.¹¹

ABSTRACT

Over the past ten years, web-cameras often have been used in the NICU to support parents and connect families with their hospitalized neonate. This article describes the history of images and video use in the NICU to aid in linking parents and then focuses on the challenges and lessons learned through redesign, installation, and management of a new web-camera system. Technology can support NICU families, and when implemented with input from nurses and families, the process can be a positive experience.

Disclosure

The author has no relevant financial interest or affiliations with any commercial interests related to the subjects discussed within this article.

Accepted for publication December 2011.

They found that mothers who had the videophone called the NICU more frequently than the control group. This difference in number of calls even continued after both sets of mothers were discharged from the hospital. After the study, the mothers were interviewed. The mothers said that the video image gave them a realistic view of their neonate's severity of illness. In addition, some mothers said that they spontaneously talked with their neonates while they were viewing their images.¹¹

In a descriptive article, Mussell and colleagues explained a system where a closed-circuit television and videotaping service was used in their two hospitals.¹² Families viewed their hospitalized neonate from the NICU at a remote sister hospital. After a mother was discharged, staff would typically tape the neonate and then mail the VCR tapes to parents to view at home.¹²

Web-camera projects have begun in numerous facilities in the United States.^{13,14} Facilities in the Netherlands and Australia are also currently using video cameras in the NICU that enable parents and families to view photographs or real-time video via the Internet.^{15,16} Until recently, hospitals created their own web-cameras, but now there is a commercially available product for hospitals to purchase.¹⁷

Building upon these innovative technologies, an NICU web-camera pilot project has served as a telehealth solution for families separated from their hospitalized neonates. In a rural state in the southern United States, the state's only academic medical center launched the NICU web-camera project to aid parents in connecting with their hospitalized neonate.

The Angel Eye Camera System uses a web-camera in the NICU that enables parents to view their neonates from remote locations, such as other hospital rooms or their homes. This technology captures real-time, bedside images of the hospitalized neonates; allows for one-way audio from the parent to the neonate; and is illustrated by the next story.

Angel Eye: A Sick Mother and a Safe Baby

Physicians faced a tough decision and after careful consideration, they decided: a mother diagnosed with acute lymphocytic leukemia delivered her baby ten weeks prematurely to save both her own life and that of her baby. After a cesarean delivery, the mother was taken to the intensive care unit (ICU) to receive aggressive chemotherapy and recover from her delivery. Because of her compromised immune system, she was unable to see, hear, or touch her newborn son, which devastated the new mother facing a life-threatening illness in her own right. NICU nurses, an NICU social worker, and information technology (IT) staff collaborated to deliver a laptop to the ICU. Using the web-camera, the ICU-hospitalized mother saw her baby while he was in the NICU incubator for the first time since delivery through web-camera and the password-protected website. She was able to connect with her baby any time, enabling her to see with her premature son

FIGURE 1 ■ NICU nurse adjusts the Angel Eye camera for a better view of the infant.



while she received treatment. After completion of her first round of chemotherapy and returned home, the mother and family praised the technology and the staff for the sensitive response to her needs.

Angel Eye has evolved since it was installed in January of 2006 and has made an impact on hundreds of families who had neonates in the NICU. During implementation of the web-camera system, developers have faced some challenges and learned valuable lessons that may help translate this technology into other settings. Challenges in implementing the system were in three major areas: technology, family, and NICU staff issues.

TECHNOLOGY CHALLENGES

Equipment

The first challenge when developing an NICU web-camera system is determining which equipment is best for a particular NICU. When Angel Eye was created and piloted in 2006, no web-camera systems were available to purchase. Nurses, physicians, information technologists, and physical plant created a web-camera system, Angel Eye, for the facility.

The technological challenges related to implementing Angel Eye included hardware design, website design, audio, family access to high-speed Internet in their community, and technical support. The second-generation camera, which is currently in use, has one-way audio from the mother to the neonate instead of two-way audio. Despite a family's wish to receive and transmit audio with their hospitalized infant, national and international regulations on privacy must be observed. If the NICU environment does not provide privacy for two-way audio, telehealth programs should transmit only one-way audio or no audio at all.

Currently, 21 NICU beds in private rooms are equipped with a mounted camera and speaker with the capability to transmit one-way audio. The mother can talk, sing, or read to her neonate using the speaker mounted on the NICU bed.

The calibrated decibel level (less than 65 dB) was determined in collaboration with the medical director of neonatology for the NICU and the hospital's audiology department. The calibrated decibel level is based on the ambient noise of the incubator (50–55 dB) and normal conversation levels (60–75 dB). Prior to use, each Angel Eye speaker was calibrated and tested. Testers screamed into the microphone at the remote site, dropped books by the microphone, and made other various household noises. At no time did the decibel level in the incubator rise above 65 dB during the audio testing. Additional measures were also tested to ensure privacy. The private NICU rooms alleviated the privacy concerns faced in a large, open NICU where other families or babies could be seen if the camera lens was in view. To prevent this in open NICU environments, the new camera design prevents the ability to pan the room or the hallway, which also helps to ensure patient privacy.

Technical Support

Readily available technical support for families and NICU staff is essential for the success of a web-camera system. Frustrating technology problems should be the least of the worries of a family separated from their hospitalized infant. To alleviate any worries related to technology, a 24/7 toll-free hotline linking participating families to an information technologist help desk allows families to diagnose problems and receive assistance. The help desk triages phone calls from families and NICU staff, and the Angel Eye IT specialists return phone calls within 24 hours.

Family Computer Access

Some Angel Eye families were disappointed to find their home computer or Internet connection produced a still picture effect when accessing live video feed, rather than a fluid video image of their hospitalized baby. Slower computer processors produce still picture results. Nevertheless, one mother who used Angel Eye in a small rural town three hours away from her neonate said that a still picture was better than no picture of her neonate. She also said that she was able to view the feed as video when she used a family member's computer.¹⁸

High-risk pregnant women often deliver in a tertiary care center, which may be miles or hours away from their home.^{19,20} Because the problem here is with participants' resources, a creative solution was needed because many rural families do not own a home computer. To address the issue, Angel Eye developers encourage programs new to the technology to coordinate with local hospitals, health units, or libraries to allow families to use digital subscriber line (DSL) or high-connection speeds to view their hospitalized infants through a web-camera. In the Angel Eye team members' experience, local community resources are more than happy to offer high-speed connections and computer access to families separated from their infant.

FAMILY-CENTERED CARE CHALLENGES

Angel Eye developers faced difficulty when determining the intervals at which families could view their neonates via the website. When Angel Eye was instituted, the web-camera was accessible for viewing only twice a day for 15 minutes each time. Families, however, demanded more viewing times, and the camera is now on 24 hours a day, 7 days a week. This change has enhanced parent and family satisfaction.²¹

Another issue associated with the family's viewing revolved around day-to-day care of the neonate. Many discussions centered on whether to turn the camera off during procedures, baths, assessments, and so forth. Nurses were concerned about families being able to record these tasks. The legal department at our facility was helpful in resolving this issue. It is essential for each hospital to create a policy that works for families, NICU nurses/staff, and the legal department. Administration in the NICU chose to leave the choice of whether to view during procedures to the nurse, but nurses were strongly encouraged to leave the camera on during assessments, baths, and other routine tasks. One mother noted that she and her husband were able to view their twins getting baths through the Angel Eye camera system. She was moved during this viewing and stated that it was not her twins' first bath, but it was the twins' "first bath" for her and her husband.

In addition to discussing the web-camera system with the legal department, it is important to create privacy authorizations and waivers in conjunction with the hospital's privacy office. Depending on the relationship of the viewer to the neonate, the facility can decide whether to use a privacy authorization waiver or simply a privacy waiver. Because of the wide range of Angel Eye users, NICU administration determined that the Health Insurance Portability and Accountability Act (HIPAA) authorization waiver best fit its needs.

FIGURE 2 ■ Mother and father view their baby via the Angel Eye website.

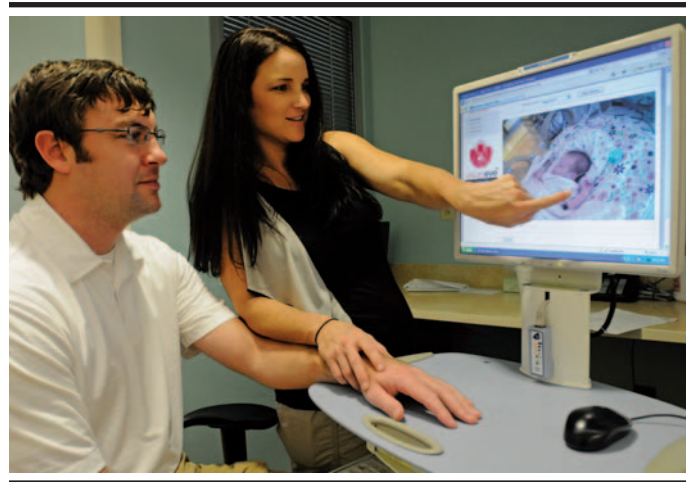


FIGURE 3 ■ Sibling of an NICU infant views her little sister from home using the family's laptop computer.



NICU STAFF CHALLENGES

Winning the support of NICU nurses can mean the difference between success and failure for a program like Angel Eye. Because NICU nurses must interact daily with NICU web-cameras, they need to be supported and educated on the value of the telehealth program. If hospitals haphazardly install web-cameras in the NICU to launch a distant family viewing initiative, they can expect resistance from NICU staff, who often have spent years caring for fragile infants without the constant oversight of parents and families. It is essential that their needs are considered before installing telehealth technology. Further, ongoing education must be extended to NICU nurses to ensure that they understand not only the value of the program, but also how to troubleshoot cameras and when to call for technology support. NICU nurses are not technologists, and their specialized training does not include the integration of remote viewing into daily routines. As with any new procedure, those responsible for its operation should be valued and supported.

Thus, as part of project planning, it is important to ask the NICU nurses for their concerns either in an open format that welcomes discussion or in an anonymous survey, in which nurses can feel free to express their feelings about the new technology. NICU nurses' wishes should be integrated into the design of a pilot project, and the project refined as needed when issues arise.

Web-cameras can place an additional work load on NICU nurses. It is critical to examine nurses' perceptions of the use of this new technology if it is to be fully adopted by the NICU staff. The Angel Eye developers interviewed nurses about the Angel Eye system after it had been in use for some time, and their insights provided a checklist of needs for a new camera system. These needs included an easy on/off switch, a camera that was easy to place and move if needed and would work with a humidified and closed NICU bed system, the ability of the camera to view in total darkness, one-way audio to the

baby's bed, no "panning" capability of the camera, and an easily accessible way to view what was being transmitted by the camera to the website.

During the implementation of the second-generation camera, NICU nurses volunteered to be Angel Eye "super-users" to facilitate family enrollment in and discharge from the Angel Eye system. This allowed adding families and removing families to be conducted in the NICU rather than using a centralized call center IT model. Super-users were trained using the new system. They also received hard copy instructions and a button to indicate that they were Angel Eye super-users. After the super-users were trained, the creators of Angel Eye participated in a four-day long NICU skills fair, which helped the nurses to become familiar with the new equipment, website, and family enrollment procedure. In addition, a recorded "how to" module was created and placed in the yearly assessment modules for NICU nurses and for the NICU super-users.

Family packets and a hard copy of the user guide were placed in each of the medication rooms, which allowed the nurses and super-users easy access to the materials. The user guide provided detailed instructions related to registering and discharging a family as well as basic troubleshooting related to the camera and audio.

The family packet included the HIPAA authorization waiver, detailed instructions related to logging onto the website, NICU phone numbers, and the Angel Eye IT help desk phone number. The family packets also provided the families instructions on how they share the website with additional family members and friends. The mothers and fathers can invite an unlimited number of people to register with the website. Up to 20 family members and friends can view the same baby simultaneously, and any of the registered users can access the live stream of the neonate 24 hours a day, 7 days a week. The mother and father can also block users of the website if a family member or person they did not invite is registered.

PROGRAM EVALUATION

The second-generation Angel Eye camera system was formally evaluated in an institutional review board (IRB)-approved study. To collect data from parents, researchers employed an on-line pop-up survey of users of the Angel Eye camera system. Researchers recruited and received consent through electronic methods on the website. After two refusals, users were not asked again to participate. The survey tool contained three Likert scale questions related to overall satisfaction and two open-ended questions.²¹ To collect quality improvement data from nurses, researchers conducted several training sessions and gathered the nurses' input after the sessions. In addition, the super-users collected satisfaction information from individual nurses.

In the first 11 months of the new camera system, satisfaction of nurses and families with the Angel Eye system increased as demonstrated by increased usage and results of a satisfaction

survey. Sixty-five NICU families and 239 individual users from 15 different states have used the new Angel Eye camera system. The number of times a user accessed a view of the neonate ranged from 1 time to 940 times. Thirty people only accessed the view 1 time, but 62 people accessed the video more than 50 times during their neonate's hospitalization.

Twenty users were selected to complete a satisfaction survey. The average satisfaction score was 4.75 out of 5, with 5 being "most satisfied." Open-ended responses were mainly favorable. Three users said they lived far away and they loved the cameras. Two gave constructive comments about audio and the camera angle, such as the camera needed the audio component enabled and the camera angle needed to be improved by the nurse.²¹

CLINICAL NURSING IMPLICATIONS

Integration of a web-camera into the NICU environment provides benefits to health care providers and rural patients alike. Web-camera technology allows infants and their families a unique opportunity to connect with their hospitalized infants through interactive, real-time technologies. Thus, a cost-efficient NICU webcam program has the potential to improve quality of life for participating families by relieving anxiety and cultivating a distant bonding experience. The web-camera technology can aid in the mother's reassurance and shared interaction between family members, but on the contrast, it can also increase the mother's worry. Worry increases if the mother and other family members are not educated regarding the technology and policies prior to use.¹⁸ To decrease the worry related to the web-camera system, a systematic enrollment, education, and technical support system should be in place upon implementation of the program.

Clinical nursing implications include making sure the nursing voice is heard when implementing a new web-camera system in the NICU. Nurses should have an active part in choosing the web-camera system and participate in writing policies, nurse user guidelines, and parent instructions. Nurses should help determine which camera design is best for their units and if audio transmission is plausible. Families should be educated by the nurse or by the educational materials that the quality of the video image will depend on their home Internet speed and that in some areas where dial-up is still a factor, the video may display as a still image. Nurses may find it helpful to have a list of additional places in surrounding areas for parents and family members to view the neonate's image, such as a partnering hospital or a local library. Enhanced teaching of the parents will prevent issues and help desk phone calls associated with the web-camera. Nursing participation when writing and implementing policies related to web-cameras will aid in the NICU nurses' acceptance of the program. NICU nurses are essential to the success of a web-camera project in that they must work with nursing administration, hospital administration, and medical directors to ensure the program is a success at their facility.

FUTURE TRENDS

Using virtual platforms to transcend the walls of the NICU holds great promise for meeting the needs of parents and family members of hospitalized neonates. By drawing on the lessons Angel Eye developers learned in implementation, other NICUs can replicate the Angel Eye model to address these needs. Such technology may especially benefit rural areas, where tertiary care facilities and NICUs are located far from families. Through these strategies, telehealth can bring mothers, fathers, families, and their hospitalized babies closer together.

In the future, health care providers may see live video feeds at any patient's bedside, young or old. A hospitalized parent could connect to family members and friends from any distance, providing opportunities for visiting with the patient they would not otherwise have. Family members living across the world could log in to a secure website to check in on, view, and speak to hospitalized loved ones. Technology could allow friends and family to interact virtually with patients before or after surgery. In some cases, telehealth technology might afford family members their last opportunity to converse with a loved one before death. From this perspective, telehealth interactive video applications could produce life-changing events and cherished moments with sick loved ones.

Future studies should examine the effect of this new telehealth application; in the meantime, other hospitals are encouraged to adopt and modify the Angel Eye model for use at their NICU. This telehealth application leverages affordable technology to deliver clear and healing benefits to suffering families—a definite reason for employing telehealth systems.

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