December 2003

Telebaby®: Live Video Streaming from a Neonatal Ward Using the Internet

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TELEBABY®: LIVE VIDEO STREAMING FROM A NEONATAL WARD USING THE INTERNET[1]

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Abstract

New information technologies can be efficiently used to fill in the gaps in the human need of communication during the difficult time of hospitalization. The Telebaby® project was designed and supported by the University Medical Centre Utrecht. Telebaby® links parents from home to their newborn receiving intensive, high or medium care. The monitoring of the login behavior of the parents has shown that standard Internet technology for distributing multimedia allows parents to virtually "visit" their baby more often. The preliminary results indicate that Telebaby® offers the parents the feeling of control and principally reduced the state of anxiety associated to the mother-child separation. A simple system like Telebaby® was easily adopted by the parents and has proven to be an efficient concept. Implementing Telebaby® in a hospital environment proved to be a real challenge.

Keywords: Internet, video streaming, healthcare

Introduction

The concept of attachment is central to most discussions on the role of parenting. The whole purpose of bonding may sound paradoxical, but it is a natural phenomenon that enables the child to develop feelings of security in strange environments, to be later able to separate from the main caregiver (Bowlby, 1969, 1988). If skin-to-skin contacts are recognized to be primordial to the development of healthy premature newborns, any separation between a mother and her child affects not only the child but also the mother (Klaus and Kennel, 1976, 1985). Attachment is gradual and not an automatic or immediate process that the mother should experience (Rutter, 1979). Caregivers are experiencing traumatic stress and anxiety-state when separated from their newborn (Klaus and Kennel, 1976, 1985). The idea of an Internet facility to link the premature to their parents was thought to support the parents in that difficult time. The authors assumed that it will give the caregivers a higher feeling of control on their relationship with their newborns and will reduce their anxiety-state. Previous experiences that linked mothers to their children have been reviewed and encouraged the authors to persevere in their project (Bialoskurski et al. 1999, Lupton and Fenwick 2001, Woollet and Phoenix 1991).

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All the knowledge gathered in the Telebaby® project is freely available for other perinatal centers.

Sponsoring of the "Friends of the Wilhelmina Children's Hospital" made it possible to implement a system that allows a mother to view from her hospital bed her newborn on the intensive, high or medium care unit through an internal video circuit. The concept of Telebaby® originated from the idea to distribute these images over the Internet. Step-by-step a connection between the hospital and home was built: Telebaby® was born. Parents were enthusiastic about the possibility to use the Telebaby® facility as complementary to their regular visits at the hospital. The monitoring of the login behavior of the parents has shown that standard Internet technology for distributing multimedia allows parents to virtually "visit" their baby more often and principally reduced the state of anxiety associated to the mother-child separation. The preliminary results indicate that Telebaby® offers the parents the feeling of control. To conclude with, Telebaby® surely appealed for its concept. More important, Telebaby® contributed to the well-being of the caregivers and thus of their newborns.

The paper describes first the project and the supporting technologies. The results of the login behavior of the parents and the preliminary results of the questionnaire are presented. The paper concludes with some research limitations and future developments.

Project

The Perinatal Center of the University Medical Center Utrecht consists of two wards, the Obstetric Care and the Neonatal Care. The center has an annual budget of 20 million Euros (90% personnel), enrolling 400 employees who operate 3 million Euro worth of medical equipment. The Obstetric Care handles 10,000 (new) cases with 30,000 follow-up consults. Of 4,500 admissions, 2,500 are adults and 2,000 are newborns of which 1,000 low care, 500 medium care, 500 intensive/high care (Figure 1). In total, the admissions and 600 short stay days generate 30,000 nursing days in 80-100 beds and cribs.

Prior to the development of Telebaby® several issues concerning privacy and safety were raised. Given their nature only practice could prove the extent of their relevance. More practical issues like costs and image quality were dealt with before the project started. One major concern was the 'Gimmick' effect; a developed system that only shortly appealed for its concept, not for its contribution.

The Telebaby® project started small and experimental. A team of three persons was formed covering all necessary skills such as programming, financing and understanding of the medical and nursing activities of a Perinatal Centre. The management assigned a minimal and recoverable budget of 7,500 Euro. If the project had failed, most of the computer equipment could have been re-used elsewhere. The goal of the team was to test the concept and the technology. Within half a year, the team decoded and transmitted the signals required for transmission using standard Internet technology. Figure 2 presents a picture of a baby using the internal video circuit that was used in a corporate campaign on innovativeness within the University Medical Centre Utrecht. Physicians, nurses and parents became curious.

Figure 1. The Neonatal Intensive Care

Figure 2. The Corporate Campaign

The internal automation department and an external Internet streaming professional (Infoland) ensured the stability of the technology used. The focus concerned the implementation. Providing maximal support to the users (parents and nurses) was recognized to be the most important factor for success or failure (Oudshoorn 2001).

A budget (75,000 Euro) was acquired through sponsoring ("Friends of the Wilhelmina Children's Hospital"). The largest part of the budget was consumed by hard- and software (55,000 Euro). For this the server, encoders, laptops, the adaptation of the internal video circuit and customized software were realized. An estimated 400 hours were used to develop and implement the concept (excluding the software development by Infoland). This totals 20,000 Euro in personnel costs.

Hardware

The internal video circuit consisted of twenty analogue Panasonic cameras. The cameras were mounted on a standard equipment rail on the crib (Figure 3) and had a fixed focus. They were connected to an internal coax network with an XLR plug that also provided power. Due to the fact that the camera was located outside the crib, the image sometimes lost quality because the plastic top of a crib could produce shimmering. The cameras were routed to the TV of the mother (Figure 5) (or an Internet stream) using a patch bay (Figure 4). This way, fifty cribs could be connected to fifty beds.

Figure 3. Neonate in Crib with Camera

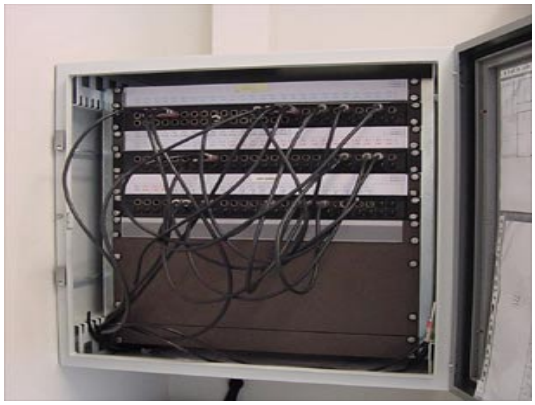

Figure 4. Patch Bay

Figure 5. View from Bed Mother

The internal video circuit had to be adapted for video streaming using the Internet. An encoder transformed the analogue signal of the internal video circuit into a digital video stream. The encoding was done on-line/real-time with a delay (buffer) of five seconds, and the frame rate was ten frames per second. This way, a 56K modem on an average bandwidth network was able to adequately handle the dataflow. We experienced that a higher quality did not provide a better image of the newborn since the load of encoded data was relatively low: changes in light intensity are low, the newborn hardly moves and movement around the crib is limited. Sound was not encoded. Technically this would be possible, but out of privacy considerations sound was not transmitted. From an ethical perspective, the microphone of a newborn in another crib could accidentally transmit speech from physicians or nurses providing care to another nearby newborn. Furthermore, it is the general belief that misinterpretation from for example the audio control signals from respiratory equipment could raise instead of lower anxiety.

The streams are offered to a server that distributes them to the viewers. The server is a standard Compaq PC (800 MHz, 16 Gb, 522 Mb). The four encoders are also standard Compaq PC's, all with four Osprey 200 Codec cards (Figure 6 and 7).

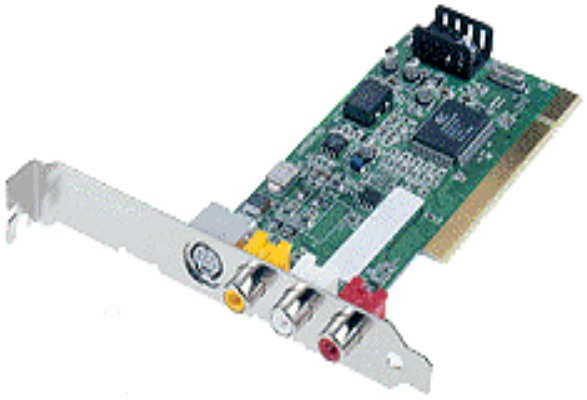

Figure 6. Osprey 200 Codec Card

Figure 7. Telebaby Server and Encoders

Software

The software used is Windows 2000 as operating system with Windows Media Encoder and customized I-stream software from Infoland. Telebaby® is accessible through a standard browser on the hospital's website. The login screen (Figure 8) holds a "Thank-you" page for sponsors and a disclaimer page covering legal issues. There were four types of users: the administrator, the automation department, the nurse and the parent. Different users have different menus. The administrator (supervisor) has access to all menus. This includes the system users menu where types of users can be set, the camera control menu that holds IP settings of the streams and the general fields menu where the patient data fields that are displayed along with the stream could be defined. The automation department and nurses can access the patient menu where streams are assigned to patients and pre-defined patient data fields are filled in. The camera overview menu gives a thumbnail page of active streams (Figure 9). The parents (Figure 10) only have access to the parents' menu, which displays the stream of their newborn and some patient data fields such as name, unit, bed, the unit's telephone number and the name of the primary nurse. All other menus were not accessible from outside the hospital.

Figure 8. Login Screen

Figure 9. Camera Overview Menue

Implementation

A team of nine "Ambassadors of Telebaby®" was formed. This team of nurses was given extra training in order to facilitate the implementation process and to provide basic support for parents. Over fifty percent of the parents had Internet at home. For those who did not have a personal computer, five pre-configured laptops including an Internet account were at their disposition. Parents first had to fill out an intake form gathering information varying from address to type of Internet connection used (cable, phone, ISDN). Nurses used the intake sheet to add the newborn's data in the patients' menu and assign a stream. Parents (and other users) had a hardcopy manual that was comprehensive in language use and had step-by-step screenshots. The software also had an extensive, more technically oriented manual that was accessible via the website. Parents were asked to log in on a demonstration stream first. This was to reduce anxiety when logging in on their newborn for the first time. Only after having successfully logged in on the demonstration stream parents were given the login-name and password for their own child. If parents could see the demonstration stream, there were almost no technical barriers that could keep them from logging in on their newborn. A blue or black stream indicated that the camera has been unplugged or covered at the unit, for example when parents who visit the unit do not need the camera or when the camera is physically in the way when providing care to the newborn. More than one viewer can access the streams at one time. Parents were free to pass on the login name and password to relatives.

Figure 10. Parents at Home (Mr. & Mrs. Krol)

Implementing an externally oriented information system in a hospital triggers safety issues, particularly when this system crosses the boundaries of the hospital's networks. Hospitals have tight security policies. In this case the streams were rerouted through the completely separate and more open network of the medical faculty. This way complicated political oriented discussion could be avoided. Acceptance of the system by physicians and nurses was obtained by relating it to the perinatal center's basic philosophy of keeping mother and child as closely together as possible in a clinical setting. Telebaby® extends this philosophy when the mother is discharged. Physicians and nurses had the basic right to switch the camera off when providing care to the newborns. However, the quality of the care was stressed to be equal with or without the camera being switched on. The 24-hour nature of perinatal care combined with the fact that some of the nurses only took night shifts has made the training difficult to plan and demanded for a crisp-clear instruction manual.

Results

The login behavior of the parents was closely monitored. The log file contains data such as duration and frequency (Figure 11) of use per stream (29.663 log records) or a unique viewer identifier generated by the Windows Media Player. At 10 pm the unit's lights dim and image quality drops, so usage is minimal. The usage was high between 11 am and 3 pm. Clearly "anxiety visits" can be marked out. These short but frequent visits at 2 pm and 9 pm offer parents the feeling of control. They shortly see their newborn and log off, most likely after seeing him moving. At 10 pm the unit's lights dim and image quality drops, so usage is minimal.

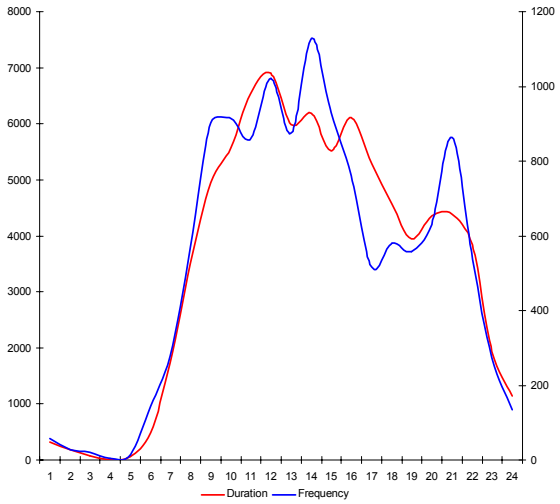

Figure 11. Duration and Frequency of Use

The system use over time varied and depended on the admission and discharge of patients and parents. Mothers that used the internal video circuit usually applied for the Internet streaming facility when they were discharged and their new-

born stayed admitted. The average system use over time per user drops after the first few days of usage and picks up in the end, exceeding the initial use. System use in the weekend was low. In the weekend parents visit the hospital more often to have physical contact with their newborn. Important was that parents did not visit their newborn less often while using the Telebaby® system. 'Live' visits were always first choice.

A questionnaire (k=31) was distributed to the parents after using the system. Preliminary results indicated first that parents rated the Telebaby® system on a 5-points Likert scale (from –2 not useful at all to +2 very useful) to be very useful (m =1.84, SD =0.38). The parents evaluated positively the value that Telebaby® added to the general level of health care provided to their newborns (m = 1.70, SD = 0.67). When using the system, parents worried less about their newborns (m=1.26, SD=0.82).

Parents were slightly less enthusiastic about the quality of the picture (on a 10-points scale with 10 maximum score) but generally satisfied (m=6.35 SD=1.10). Parents who used the internal video circuit find the image quality of the streaming facility less satisfactory, while parents who never used the internal video circuit rate the overall image quality (both refresh rate and size) higher.

Conclusion and Limitations

Parents were enthusiastic about the possibility to use Telebaby® complementary to their regular visits at the hospital. The monitoring of the login behavior of the parents has shown that standard Internet technology for distributing multimedia allows parents to virtually "visit" their newborn more often and principally reduced the state of anxiety associated to the mother-child separation. The preliminary results of a questionnaire conducted on (N=27) parents indicated that Telebaby® gives to the parents a certain feeling of control on their newborn. Parents of newborns are preoccupied; a not working system lowers their control over their newborn and raises anxiety.

A system like Telebaby® could become a standard facility for perinatal centers. However, some more investigations should be conducted at the experimental, ethical and legal levels. For clear ethical reasons we could not design a control group of parents not beneficiating of the Telebaby® system. The monitoring of the login behavior of the parents revealed that the parents did share the password and login information to visit their baby. If that kind of positive attitude towards such technology is promising for the future, ethical considerations of privacy and security should be taken as serious threat to the generalization of such systems. From a cultural perspective, it will be interesting to see how different cultures are reacting to such a project. From a medical perspective, by adding dynamic medical data such as saturation and heart rate the concept can prove to be more useful for physicians and nurses (Gray et al. 1998, Halamka, 2001). Research suggests that the mother's voice plays an important role in the mother-child bonding, an expansion worthwhile to be investigate. Broadband Internet could make the exchange of sound from the parent's home to a hospitalized newborn more feasible (Dekkers et al. 2002).

To conclude with, major contributions for patients can be found in applying standard information technology. Overall, if a system like Telebaby® cannot replace the skin-to-skin contact of a baby with his caregivers, it surely brings the unit more relaxed parents. Spitz (1945) will surely agree that such a system may only be favorable to the hospitalized newborn's wellbeing. With healthcare moving towards a much more patient-orientated approach, the authors suggest that a relatively simple and low cost application such as Telebaby® can also contribute to the wellbeing of the caregivers and thus of their newborns.

References

Bialoskurski, M. Cox, M.C. and Hayes J. "The Nature of Attachment in a Neonatal Intensive Care Unit" *Journal of Perinatal and Neonatal Nursing, 13*, 1999, pp. 66-77.

Bowlby, J. *Attachment and Loss*: *Attachment*, *1,* New York, Basic Books, 1969.

Bowlby, J. *A Secure Base: Parent-child Attachment and Healthy Human Development*, New York, Basic Books, 1988.

Dekkers L., Dijkhuizen W.J., Van Geelen N., Golder T.J., Huizinga H., De Jager M. "Een Toekomst van Glas: Vooruitlopen op de Doorbraak van Breedbandtechnologie." *Stichting Maatschappij en Onderneming, Den Haag*, 2002

Gray J., Pompilio-Weitzner G., Jones P.C., Wang Q., Coriat M. and Safran C. "Baby CareLink: Development and Implementation of a WWW-based System for Neonatal Home Telemedicine." *Proceedings of the AMIA Annual Symposium*, 1998, pp. 351-355.

Halamka J. "Inside a Virtual Nursery" *Health Management Technology, 6*, 2001, **http://www.healthmgttech.com**.

Klaus, M.H., Kennel, J.H. *Maternal-Infant Bonding*. St Louis, Mosby Press, 1976.

Klaus, M.H., Kennel, J.H. *Parent-Infant Bonding*. St Louis, Mosby Press, 1985.

Lupton D. and Fenwick J., "They've Forgotten that I'm the Mum: Constructing and Practising Motherhood in Special Care Nurseries*." Social Science & Medicine, 53*, 2001, pp. 1011-1021.

Oudshoorn N., Brouns M., and Van Oost E. "Diversity and Distributed Agency in the Design and Use of Medical Video-communication Technologies*." Inside the Politics of Technology*, 2001

Spitz, R. A. "Hospitalism: An Inquiry into the Genesis of Psychiatric Conditions in Early Childhood". In A. Freud et al. (Eds.), *Psychoanalytic Study of the Child*, 1, pp. 53-74, New York: International Universities Press, 1945.

Woollet A. and Phoenix A. "Psychological Views of Mothering." *Motherhood: Meanings, Practices and Ideologies*, Sage, London, 1991, pp. 28-46.