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Opportunities in Designing HCI Tools for Lactation Consulting Professionals

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ABSTRACT

Long-term breastfeeding has been shown to exhibit several environmental benefits and health benefits for both the mother and baby. Despite the known advantages, several mothers choose not to maintain breastfeeding long-term. How long a mother breastfeeds is heavily influenced by lactation and latching, and so the mother's critical point of support is the lactation consultant (LC), who guides and provides instruction for creating a more positive breastfeeding experience. Empowering lactation consultants with methods to deliver instruction and support remotely is essential for advancing telehealth and wide-scale adoption. This paper presents findings from a need-finding study of 6 LC's that sheds light on ways to address some of the challenges faced by the LC community when providing remote lactation support. Based on the interviews, a number of potential technologies were identified around wearable sensing, annotation tools, and digital repository for virtual education.

CCS CONCEPTS

• **Human-centered computing** → **User centered design**; • **Applied computing** → **Consumer health**; • **Social and professional topics** → **Remote medicine**.

KEYWORDS

Remote care, breastfeeding, lactation consultant, human-computer interaction

1 INTRODUCTION

Growing evidence in the peer-reviewed literature suggests that children who were breastfed for longer periods have fewer dental malocclusions, lower infectious mortality and morbidity, particularly against gastroenteritis, upper respiratory and ear infections [5, 10]. Studies link breastfeeding to protection of children against obesity later in life [11, 21]. Exclusive breastfeeding has been shown to have lower gastrointestinal infections in the child, more rapid maternal weight normalization after birth and a prolonged amenorrhea for the mother [9]. In the past 20 years, the possibility that breastfeeding may modulate critical genomic imprinting events has become apparent. Since early in an infant's life, the gene expression is being fine-tuned for life; such breastfeeding-related imprinting may have potential life-long effects [7]. The act of breastfeeding has benefits seen in early childhood development such as higher IQ scores and better school performance in children at the age of 5 [8]. Also, mother's own milk is a free, natural renewable source of food that requires no packaging or storage. Making it an essential component for the United Nations Sustainable Development Goals [19], especially impacting goals 2, 3, 4, and 12. These recent findings have led researchers to postulate that human milk may not only serve as a complete, well-adapted and specialized nutrition source but likely also a highly precise and personalized medicine that an infant receives in their early phases of health imprinting [13].

Issues mothers face, and why they give up on breastfeeding early?
Despite compelling evidence on the benefits of exclusive breastfeeding and often mothers knowing about the benefits, less than 19% of infants meet the WHO's recommendation of exclusive breastfeeding until the age of 6 months. To further put this in perspective, although the breastfeeding rates are on the rise in the US and 84.1% of newborn infants started to breastfeed in 2017, it quickly plummets to below 46.9% and 25.6% for exclusive breastfeeding at 3-months and 6-months, respectively [3]. Additionally, analyzing the breastfeeding rates in Brazil in 2019, the prevalence of exclusive breastfeeding among infants is higher, for children around 4-months and 6-months is 59% and 45%, respectively [18]. Mother-baby relationship and individual attributes are a major determinant affecting continued breastfeeding. The intent to breastfeed is established by the third trimester [15] with the intent being a strong predictor of initiation and duration. Around 70% percent of hospitals in the US promote feeding education and support to new mothers before being discharged, where they are taught/shown how to position and latch their newborn, assess effective breastfeeding, and hand express milk [4]. However, this support period is short, especially

when it is expected that the mother will breastfeed exclusively until the baby is 6 months old.

Post-initiation on breastfeeding, however, research has reported that insufficient milk supply has been consistently reported as a reason for early weaning. Of the 50% women that report that they perceive their milk supply as insufficient, only about 5% of women suffer from a physiologically insufficient supply [14, 17]. Infant fussiness and crying, perceived hunger, and the inability to calm the baby further cause a mom to presume that she lacks enough nutrition.Because of this misperception, many mothers supplement breastmilk with formula, reducing the natural demand for breast milk, causing a reduction in maternal supply, and therefore affirming a mother's misperception that she is the problem. Other reasons that reflect in the early interruption of exclusive breastfeeding includes fatigue related to breastfeeding, the mother's return to work or study routines, medical conditions in the baby and/or mother, difficulties with breastfeeding techniques, lack of support from family, and low self-esteem, or even personal reasons [2].

In fact, these reasons are much more impactful in first-time mothers. Without previous experience at home and with no expert feedback, such as from a Lactation Consultant (LC), quit breastfeeding sooner than recommended. On a public health scale, however, it is economically infeasible and not scalable to have care providers administer assessment tools on a frequent basis. Also, many families do not live close enough to any lactation consultation service such that they could even be offered said infrequent visits. The increased need for remote care options also came due to the COVID-19 pandemic, to limit the number of patients in-clinic and is a safer option for mothers and children who are part of a group risk population.

The role of lactation consultants in long-term breastfeeding. A lactation consultant is a professional that supports and educates parents in breastfeeding, milk supply, breast and nipple issues. The support that an LC promotes to mothers and infants facilitates breastfeeding and are a key point to reinforce this act. The LC is trained to help and advise in issues that were even mentioned in the previous session, such as challenges in breastfeeding, planning milk extraction for the mother's new work routine, giving support and feedback when others around don't provide. The work of an LC mostly happens in hospitals, clinics, and at their patients' residences. It involves observing the mother and baby, latching positioning, breast appearance, listening and touching the baby, investigating issues, and finding solutions for issues that impede the mother from breastfeeding properly. With the COVID-19 pandemic and higher adherence to virtual consultations, the LC work had to be remodeled to accommodate the mother's needs with the same quality but without the resources from in-person consultations.

How LCs assess breastfeeding quality? A metric that is often taught to LCs today to assess milk-supply sufficiency is through a ratio referred clinically as SSB (suckle, swallow, and breathe), which shows the baby's coordination for milk extraction. Clinically, an SSB ratio of 1:3-4 is recommended [6]. Intuitively, a high SSB ratio, say 1:6, would mean that the baby requires sucking 6 times before there is enough milk to warrant swallowing, indicating a potential of insufficient milk supply. On the other hand, a low SSB ratio of 1:1, would indicate that milk is gushing out and the baby is trying to keep up by swallowing after each suck and gasping for air. In this case, although the baby may be getting enough milk, the feeding session is very unpleasant and tiring, and can lead to the baby becoming resistant to breastfeeding. LCs utilize such tools like SSB ratios, visual assessments of latching and head positions, and verbal feedback with the mother to provide the support a mother needs to have a positive experience.

Remote education for LC is both challenging and an opportunity to increase the reach of care: As remote education, including clinical training, is becoming more standard, LC educational programs are also beginning to shift different parts of the program to an online format. This shift creates new challenges as well as opportunities. Prior to a fully online format that was adopted during the COVID-19 pandemic, some LC programs are already offered through a hybrid online education where students would have remote classwork as well as learning supplements such as videos of breastfeeding examples. This remote portion would be supplemented by an in-person clinical practicum where LC students are placed at a physical clinic. In a fully remote program, however, such in-person training is unavailable, and instead is substituted with simulations where students are exposed to various cases and conditions professionals might face when working in the field through videos and role-play activities. This learning modality simulates a clinical setting to help students draw on context they will work in for the future. However, learning to assess the SSB is challenging for students with limited experience working with mothers and babies.

The content covered in LC specialization requires both an understanding of the theory while learning to apply it to actual repetition in practice of helping mothers breastfeed, which requires active listening, touching, and observing the mother and infant. When transferring this knowledge to a virtual and simulated setting, some perceptual and cognitive training cannot be effectively replicated. Therefore, the learning curve and effort required for a virtual-based LC education can lead to challenges in assimilating the same content given in-person. However, although the shift to a purely, or at least primarily, virtual training may present its challenges, the opportunity is that, if designed correctly, such a virtual learning modality will enable much greater access to such education across the world, and especially for those who are based in rural areas and low-income communities, where there is limited availability of clinics and hospitals that allow receiving LC interns.

HCI tools for lactation consultants: It is an established practice in the field that the use of technologies during breastfeeding should be limited and not necessarily relied upon to promote strong human bonds for the mother and child, such as eye contact and touch[12]. At the same time, with the practical issues of trying to promote widespread adoption of breastfeeding, the need for better access to lactation experts, and improving educational reach through online education, the practice of lactation consulting, which was once highly physical and in-person, is now being challenged to rely on technological interfaces. It is in this context of an inevitable interweaving of information technologies into the practice and training of lactation consulting where we see an opportunity to investigate HCI tools that can help facilitate remote patient care without invalidating the human experience for the mother, and at the same time improve the overall efficacy of the care provided.

HCI works around supporting lactating mothers: To the best of our knowledge, there are no works around investigating the needs for technological interfaces of lactation consultation. However, the HCI community has worked on breastfeeding encouragement (Feed Finder), milk donation initiatives (Milk Matters), maternal and familiar support through technology [1, 16, 20].

This paper aims to investigate challenges and opportunities to improve the experience of lactation consultants in their clinical practice as they contend with the need to work with information technology and also in practical aspects of education for LC students. For better at-home self-efficacy for mothers breastfeeding without support, we anticipate that continuous, automated monitoring and detection of breastfeeding issues could provide positive reinforcement, actionable feedback, and early interventions by escalating to a professional LC expert, leading to higher rates of continued breastfeeding. We start the investigation around continued breastfeeding practices from the lactation consultant's side due to the critical role in providing professional support to the mother seeking solutions to their breastfeeding problems. The LCs interviewed in this paper experienced a variety of cases and have interacted with several mothers with different issues. Therefore the information gathered from LCs served as a basis for this investigation. On the education side, we want to understand how we can implement tools that will stimulate and help students better train their cognitive senses, for more realistic virtual learning experiences, where content absorption, practice and sensory stimulus are better explored than the current state of the art. Education and work aspects are brought together when we observe remote settings used for both purposes, which is believed to be continued in the future from our investigation's findings.

1.1 Contributions

In a formative study, we performed qualitative interviews with open questions to LCs in the field with different levels of experience and different backgrounds. These interviews served as an initial probe that provided the authors contextual information about their work profile and study routines, verifying aspects of their experiences that worked and did not work for them in virtual settings. In this paper, the main contributions are as follows:

(1) Interview with 6 lactation consultants from Brazil, with varying backgrounds and levels of experience. Each LC responded to 20 questions related to their consulting work and learning experiences in both virtual and in-person environments.
(2) Analysis of the main challenges the lactation consultant community faces when providing maternal care and their sentiments regarding working in virtual settings.
(3) Identification of areas in which the HCI community can contribute to LCs professionals having better experiences and higher adoption of virtual tools for a broader reach of lactation support worldwide.

2 METHODS

To identify needs and get to know more about the day-to-day routine of lactation consultants and students, we designed a set of 20 interview questions. The questions were used in the video interviews and became available as an online survey for the LCs who could not join by video but agreed to participate. The participants

were lactation professionals who (1) currently work in the field, (2) have more than 1 year of work experience, and (3) have or are in the process of obtaining the IBCLC (International Board Certified Lactation Consultant) certification. The participants were recruited through social media platforms and snowball sampling (i.e., participants recommended other people working in the field).

The interview aims to identify the struggles of lactation professionals during their studies, usage of technologies in virtual consultations, and verification of positive or negative factors associated with using virtual learning and virtual consultations in their daily activities. The participant is made aware of the project's goals and asked for permission to take notes of their responses. We asked open-ended questions for the participants to gain rich information that will help us identify the primary needs the lactation community has to provide better care for mothers. The interviews were performed virtually using video calls and lasted an average of 45 minutes. The questions were split into four categories: background and context information, education history and learning experiences, work and general practice, and remote work experiences of lactation professionals. The interviews were conducted in Brazilian Portuguese, being performed by one of the authors, who transcribed and translated all the responses for further analysis. Below are listed the open questions used in the interview.

- Background:
  - What is your current role?
  - How long have you worked as a lactation consultant?
  - Are you IBCLC certified? Since when?
- Education history:
  - How did you study to become a lactation consultant?
  - How did you prepare for the IBCLC certification?
  - Did you have practice hours during your studies?
  - What is the routine of the theory and practice class for the consultant training?
  - How did you learn about the topic suckle-swallow-breathe? Please detail.
- Practice:
  - What were your biggest challenges when you were learning about breastfeeding?
  - How did you overcome these challenges?
  - Did you do any simulations in class? (e.g. role playing, scenarios)
  - What are important factors to look at in a session that indicates breastfeeding quality?
  - What are the most important skills you judge to be important for a lactation consultant?
  - Do you consider hearing the baby sounds essential to perform your job?
  - What is your current work setting?
- Remote work:
  - If you perform remote consultations, did you start before or after COVID-19?
  - Do you like the format of remote consultations?
  - What are your biggest challenges or concerns regarding providing remote consultations?
  - Did you notice any benefits for the mother in remote consultations?

3 RESULTS

3.1 Participant responses

A total of four participants responded to recruitment for video-call interviews (P1-4) and two participants responded using the online survey (P5-6) due to schedule conflicts. The interviews were qualitative, focusing on getting to know the field until we have a saturation of information. The participant's age ranged from 25 to 43 (μ= 36, σ = 6.75) years. The average years of experience as lactation consultants ranged from 2 to 20 years (μ= 9.66, σ = 6.65). The participants' specialty varied from nurse-midwife to Ph.D. in midwifery, with the lowest education level being an undergraduate degree. Table 1 summarizes the participant's demographics information.

Table 1: Participant's demographics

Characteristics	Frequency (n)	Percentage
Total	6	100%
Gender (Female)	6	100%
Age group (years)		
Less than 30	1	16%
Between 30 and 39	3	50%
More than 40	2	34%
Work experience (years)		
Less than 10	3	50%
Between 10 and 19	2	34%
More than 20	1	16%
IBCLC certified?		
Yes	2	34%
No	4	66%
Role		
Midwife nurse	4	66%
Physical therapist	1	17%
Speech pathologist	1	17%
Work locations*		
Hospital	2	34%
Clinic	3	50%
Residential	6	100%
Virtual	5	83%

* Participants were allowed to choose all work locations that applied.

In Table 2 we provide a quick summary of some of the common findings through the participant's responses. These key findings are then combined into six themes and further discussed in detail below. From the table, we captured similar responses from participants but also drew out differences that appear to exist between LC's with different levels of experience and backgrounds.

(a) LC's sentiment around remote consultation is varied. All participants note a variety of challenges they face with remote consultation even though they recognize the benefits that it may have around access, with some being more positive about the use of remote sessions (P2-4), while some would prefer to not (P1,P5-6). P4 notes that because lactation consulting is not a screening procedure, it does not end with a single visit. Instead, it is a process that continues until things are going well and may need to restart when the mother is unsure. In this way, remote consultation allows an LC to have more frequent interface with each mother, yet at the same time support multiple mothers at once by removing the need to commute. On the other hand, P1, a midwife with 14 years of experience prior to receiving a IBCLC certification, notes that in her practice, she relies on long in-person consultations that could last 3 hours and cannot replicate the same experience in a virtual setting.

(b) Virtual settings can be difficult due to dulled senses. LCs often ask mothers to record a video of their baby breastfeeding by holding the camera from above so they can evaluate general actions such as the mother's holding arm position, the baby's head position with respect to the breast, the baby's mouth shape and movement, breast size and shape and its relation to milk production, and the baby's head and chin tilt. Figure 1 represents the current scenario on the mother's side. However, in doing so, it is sometimes quite hard to hear the subtle sounds made by the baby during this video call or in a video recording made by the mother. In some situations, LCs mentioned that the mothers would try to describe the situation verbally by describing the sounds the baby is making and what they are seeing that the baby is doing (P1, P2, P3). In person, this would usually be done by visually observing the baby's mouth movements and hearing sounds that would give clues about milk extraction. At times, LCs would try to circumvent this issue by asking the mother to bring the phone close to the baby's mouth, but by doing so, they can no longer see the baby's mouth and position. In addition to the actual observation of the breastfeeding directly, P5 and P6 noted that not being physically present also reduces their ability to look and feel the family living contexts (living conditions, environmental noise, family, smells, etc).

(c) Physical manipulation is missing in virtual settings. During a remote session, LCs (P2,P4,P5,P6) find it difficult to directly help the mother position the baby's head or show the mother how to move their hands by direct manipulation. Instead, everything has to be done through verbal description and gesturing. Interestingly, in contrast, P3 mentions that regardless of whether she is in-person or not, she would try to avoid actually touching the baby and mother to help promote independence of the mother in trying to get the baby to do the right thing.

(d) Remote lactation consulting is useful for mothers' independent learning. P2, P3 and P4 noted a benefit to remote sessions that appears to be a by-product of the inability to as easily communicate through verbal, visual, and physical demonstrations. The mothers develop a sense of independence and confidence by having to try to really understand what the LC is communicating and by trying to do it themselves, while the LC had to improve communication and instruction techniques for an effective consultation. The LC cannot easily tell if the mother is doing is correctly, so the mother has to describe what they are feeling and seeing more directly. At the same time, because the LC is there, the sense of support by a professional is still present (P1, P2, P3).

(e) Annotations on videos are a way to provide feedback to the mother. To help mothers get detailed feedback and allow them to review instructions, some LCs would request mothers or family

Table 2: Common findings from participants' results

Agree (n)	Participant ID						Common Issues and Sentiments Expressed
	P1	P2	P3	P4	P5	P6	
3		✓	✓	✓			Likes providing Remote Consultations (RCs)
3	✓	✓	✓				Noticed benefits to the mother from RCs
3		✓	✓	✓			Uses video annotation as a guidance for mothers
1		✓					Uses written step-by-step guide for mothers check when needed
4	✓			✓	✓	✓	Issues with analyzing baby's mouth in RCs
3	✓	✓	✓				Relies on mother mentioning the baby's sounds in RCs
3		✓	✓	✓			Changed communication and instruction techniques for RCs
3	✓		✓	✓			Used RCs before the pandemic and aims to continue using
6	✓	✓	✓	✓	✓	✓	LC is not only about breastfeeding, but mainly supporting the mother
3				✓	✓	✓	Touching the baby is essential for a consultation
4	✓	✓	✓	✓			It's difficult to identify signs of milk extraction when learning breastfeeding
6	✓	✓	✓	✓	✓	✓	Observe nutritive suckling is essential for seeing effective breastfeeding
2		✓		✓			Observe diapers is essential for seeing effective breastfeeding
4	✓		✓		✓	✓	Baby sounds is an important component for solving problems in breastfeeding

members to take a recording of a breastfeeding session. Then annotate with arrows to show what is in the wrong position and how to adjust it on screenshots of specific seconds in the video, or even reinforce that specific movements and noises are correct when answering questions (Figure 2).

(f) Use of tools differ based on level of experience. When asked about the use of tools and metrics like counting the ratio between suckling, swallowing, and breath taking (SSB), many of the more seasoned LC professionals mentioned that tools like this is something they learned in school but may not use explicitly. This is compared with less experienced practitioners who use SSB as a key tool. One midwife noted that she uses the SSB ratio implicitly, not necessarily counting and calculating exactly the ratio number, but intuitively take a mental note of if the baby is swallowing too quick or too infrequently. Some experienced midwives (P1-2) reflected on the importance of learning through practice. Many of the difficult and rare conditions came from having worked in the field for years.

Furthermore, lived experience prior to LC certification training appears to have an influence on an LC's perspectives on use of tools like the SSB. Many of our participants were practicing nurses and midwives prior to returning to school to obtain a formal international certification. As such, they have years of experience working with mothers already and have internalized and shaped much of their practice. Similarly, those who have been a mother themselves compared to those who haven't also have a different level of internalization of some of the concepts they learn in class.

4 DISCUSSION AND FUTURE DIRECTIONS

Through our formative need-finding, we identified general themes around remote and virtual lactation consultation. Much of our interviewees reflected more heavily on aspects around care delivery than on the learning process, as can be expected based on our participants all being practitioners and not currently students. In the future, we will conduct need-finding directly with students in lactation certification programs to gain further insights into lactation

education aspects. In the following section, we will identify a few potential directions that, based on the general themes uncovered in our need-finding, we envision a potential impact on how remote lactation consulting could be conducted.

4.1 Wearable microphone for helping LCs hear better

A common issue brought up by all of our participants is this issue around difficulty hearing the sounds produced by the baby. One of the LCs tried dealing with this by bringing the phone's microphone directly to the baby's mouth, but that means the phone camera cannot be pointed at the face of the baby. If, however, a separate microphone is worn, the sound measurement and visual recording can be decoupled. In a separate, informal interview with mothers around the idea of a lactation support microphone, we found that mothers typically disliked the idea of having the microphone worn by their child but are ok with wearing such a microphone on themselves. The investigation around a wearable microphone can have potential impact for this issue around the inability to hear, however, such a tool must be very simple to set up and not get in the way of skin-to-skin contact during breastfeeding. In lieu of potential concerns around added user burden, an alternative to a wearable microphone may be solutions around audio de-noising and augmentation from the microphone on the smartphone.

4.2 Annotation and video review tools for remote sessions

Without the physical ability to show and manipulate in-person, LCs noted that virtual sessions can sometimes be frustrating in trying to communicate physical movements and positions that the mother needs to do. The mother would have to hold the phone in one hand to show the baby's mouth and their other hand's position, while listening to the LC's descriptions of what to look for, listen for, etc. The way in which LCs tries to make it easier for the mother, then is instead having the mother record a video and then annotate a screenshot with a note as to when in the video this screenshot was
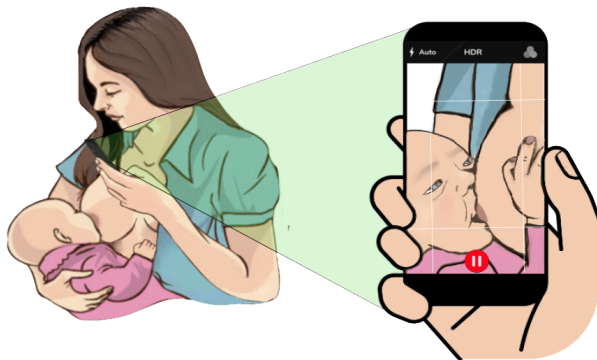
Figure 1: Mother recording herself during breastfeeding.

Figure 2: LC taking notes in screenshots of breastfeeding videos for correcting a mother's practice.

taken from. We could imagine trying to integrate this interaction into a custom video conferencing interface. A mother could be holding the camera to capture the feeding video snippet and as this is happening, the LC could try to communicate, as she does now verbally, but at the same time, could gesture and annotate in-frame. If the mother is confused and needs a visual feedback, they can look at the phone, and in realtime, the interface can replay any part of the session, associated annotations, as well as for the LC to make additional annotations to help talk through feedback and clear confusions.

One might imagine the ease of control of such an interface would be crucial, and potentially needs to be designed such that the LC would actually be controlling the interface since the mother would likely have her hands full already. However, as noted by seasoned LCs in our participant group as well as an author of the paper who is a lactation consultant, an important consideration when creating such a user interface is to not lead to an over reliance of technology interfacing the mother and the child. When breastfeeding, the mother should spend as little time as possible looking at the phone screen and instead be focusing on the baby. We imagine that the above suggested interface's semi-asynchronous feedback after the session could be suited for not being overly intrusive with technology use, but it is important to pay particular attention in actual implementation.

4.3 Dashboard for LCs to have better presence of their patients

One LC mentioned the ability to serve more patients with the reduced time commitment of commuting. Although this was not explicitly mentioned by any LC, the authors noted a potential opportunity that may arise due to this increase in reach of patients. In an ideal trajectory inline with the United Nations Sustainable Development Goals, more mothers would be breastfeeding with the help of LCs, a goal that would likely be accelerated by the access to remote lactation consulting. We suspect that this increase in demand could result in individual LCs managing more mother-baby dyads. As such, backend dashboard systems that could help LCs
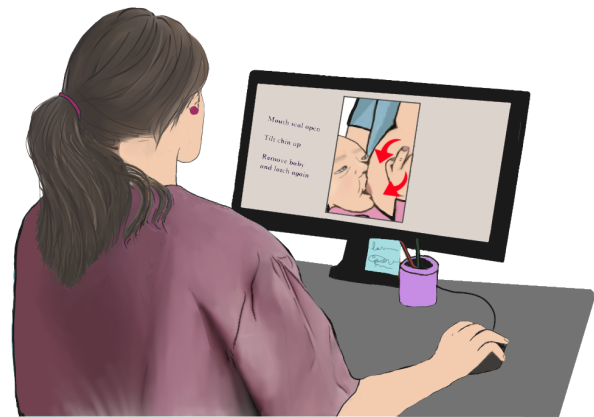
manage each mother could be useful. Information managed and organized for each mother such as video recordings with transcribed annotations, relevant metrics such as SSB ratios calculated by an automated AI system, as well as a direct channel of communication from and to the mother would all be desirable. In particular, we suspect that a key feature of such a system would be for mothers to continuously provide information to the LC, such as any observed pains they are feeling, and record videos out of consultation sessions that a back-end AI system could automatically review. This way, a two-way communication could be established where mothers could reach out through the management tool when they are losing self-confidence for support and for LCs to be alerted to a potential decrease in mother self-efficacy to offer just-in-time support.

4.4 Building a virtual library of difficult and rare conditions for lactation education

One of the potential side effects of lactation consulting becoming heavily remote is the opportunity for a large number of videos being recorded of breastfeeding sessions. Although we would not imagine, due to the inherently highly private nature of breastfeeding that such videos would not be appropriate for mass distribution, it would be possible that mothers may be willing to approve the use of videos for training of lactation consultants. This is particularly important as described by many participants, difficult and rare conditions can sometimes be difficult to learn in school because there is a lack of educational resources and examples, and is often learned through practice. However, such practice is difficult in remote settings, and even when learned in-person through hours of practice, the same observational learnings may not translate as well to remote care. By building a large number of examples of different conditions, we could imagine building better educational content explicitly for the training of remote care delivery. Additionally, with annotations tools such as that described in 4.2, these video samples in the digital library could include relevant notes and descriptions made by trained, practicing lactation experts in context.

4.5 Conclusion

Although the push for LC specialists in the exclusive use of virtual settings is driven heavily by the pandemic, we anticipate that these learning and work modalities will continue to be used in normal times due to the many inherent benefits that could be realized if remote lactation can be augmented properly. The authors believe that the HCI community is well poised to make an impact in the lactation space by helping evolve the user facing interfaces, sensing solutions, and educational tools.

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