Grow and Know: Understanding Record-Keeping Needs for Tracking the Development of Young Children

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ABSTRACT

From birth through age five, children undergo rapid development and learn skills that will influence them their entire lives. Regular visits to the pediatrician and detailed record-keeping can ensure that children are progressing and can identify early warning signs of developmental delay or disability. However, new parents are often overwhelmed with new responsibilities, and we believe there is an opportunity for computing technology to assist in this process. In this paper, we present a qualitative study aimed at uncovering some specific needs for record-keeping and analysis for new parents and their network of caregivers. Through interviews and focus groups, we have confirmed assumptions about the rationales parents have and the functions required for using technology for record-keeping. We also identify new themes, potential prototypes, and design guidelines for this domain.

Author Keywords

Qualitative study, design inspiration, developmental delay, healthcare, children, design requirements.

ACM Classification Keywords

H5.m. Information interfaces and presentation (*e.g.,* HCI): Miscellaneous, K4.2 :Computers and Society: Social Issues, J.3 Computer Applications: Life and Medical Sciences

INTRODUCTION AND MOTIVATION

It is estimated that as many as 19.5 percent of children in the United States between ages 3 and 17 have had a developmental delay, a learning disability, or an emotional disorder [1]. Many of these disorders are not apparent at birth and can manifest anywhere between the ages of 2 and 6, or even later. Many advocates argue that early detection is the key to improving the well-being of these children, and previous research has shown that the earlier interventions are started with atypically developing children, the more

effective they are in helping the children cope with disabilities [27]. One way of improving the chances of early detection is through regular visits to the pediatrician and detailed record-keeping of when children meet different developmental milestones. Not meeting specific milestones by a certain age may be an early warning sign of any of these disorders. Thus, the Centers for Disease Control and Prevention in the United States (CDC) has launched a national campaign called "Learn the Signs: Act Early" to educate new parents about the warning signs of developmental delays. The aim is to enable parents to detect problems with their children and seek treatment as early as possible. The CDC outlines approximately 250 developmental milestones children should reach between birth and five years that parents can use to gauge the progress of their child's development.

Although tracking the developmental progress of every child is an important public health goal, the job is largely left to parents to complete. Manually tracking every milestone is a daunting task for new parents, on top of the many additional responsibilities in their lives. Additionally, parents may not have the knowledge to identify and document these records. Consulting a paper-based manual every few months may be too cumbersome and not interactive enough, and parents may be so overwhelmed by parenting that they forget to record the many new things their children are doing. In addition to just checking off which milestones their children have achieved, parents should also track whether or not their children have lost any of the previously attained milestones or have slowed developmental progress overall. This is because signs of developmental delay can also manifest as a regression of skills or a plateau in skill development.

Many parents already engage in record-keeping tasks for their new children, such as making photo albums or writing down important firsts, such as a first tooth, in a baby book. Thus, there is already a desire to conduct record-keeping for sentimental reasons. Computing technology has the ability to address some of the difficulties and tedium associated with manually tracking milestones. Furthermore, this technology can be persuasive in nature and actually motivate the collection process. We believe parents and caregivers can use appropriately designed instruments to track and record their

children's developmental milestones. Proactive technologies can prompt parents to look for specific milestones at key times or even help contact a healthcare professional if parents have any questions. Thus, we are exploring design requirements and technology solutions to help motivate and organize new parents in tracking and documenting developmental milestones and alert them if there are any signs of developmental delay.

We present here the results of a qualitative study consisting of interviews and focus groups with new parents, experienced parents, secondary childcare providers, and medical professionals. The aim of these investigations was to understand current rationales behind record-keeping and determine functions that computing technology will need to support and motivate record-keeping activities. We also aim to identify key design guidelines and potential prototypes for new technologies for assisting parents with record-keeping.

This paper begins with related work in the area of designing technologies for new families and record-keeping. Next, we explain our study design, describe our sample population, and provide results from hypothesis testing and the emergence of themes. We then provide a discussion of the considerations we uncovered and propose two prototypes that we believe may meet the needs for the population. We close with conclusions and future work.

RELATED WORK

Although understanding the process of raising children is a common subject for the fields of Developmental Psychology and Education, this has yet to be explored extensively in the field of Human-Computer Interaction. In this section, we relate our work to five key areas relevant to this community: supporting new family needs, early detection of disorders, coordination of care teams, requirements gathering for healthcare related applications, and using technology to motivate changes in behavior.

Supporting New Family Needs

Foucault *et al.* conducted a cultural probe with new parents to determine their technological needs [12]. While that study broadly examined all ways of supporting new parents, our study is particularly focused on helping parents keep better records and detect developmental delays earlier. Dalsgaard *et al.*, examined the relationship between older children and their parents, however, did not focus on record-keeping [7]. Others have explored ways of preserving family memories, such as through annotating and organizing home movies through a Family Video Archive [2] and through storing memorabilia in various "memory boxes" [13, 28]. Although these technologies primarily serve as tools for enjoyment, they serve as inspiration for ways we might store health-based data in a way that is enjoyable.

Early Detection of Developmental Delay

Much research on the early detection of developmental delay focuses on identifying a single sign or a set of behavioral, physical, or biological signs that can be compiled into a questionnaire for diagnosis, or a *diagnostic screener*. For example, doctors may test infants for unusually large heads, believed to be an early warning sign of autism [21]. Behavioral consultants use survey instruments that have been shown to detect autism in children as young as 18 months old [4] and researchers have demonstrated the promise of analyzing home movies of infants as a means of predicting Asperger's Syndrome [29]. These diagnostics rely on some form of data collection, either actual measurements on a child or through parent reporting, and can benefit from more effective means of data collection. For example, Fell *et al.* examined ways to automatically analyze baby babble as an early indicator of speech-related disorders [10].

The use of computers to collect health data for the purpose of early detection has also become a topic in Computer and Information Sciences. Many commercial and research efforts have sought to collect and track health records electronically to ease the burden of analysis and to allow for easy transfer and backup of records. Intel's Proactive Health group has looked at the effects of long-term tracking of data on the identification of decline or other age-related or chronic disorders [9]. Their work on "embedded assessment" has proposed embedding detection technology in games or activities that adults are already doing [23], which is similar to ideas that come from our study.

Coordinating Care

Childcare is a collaborative task, like many other coordinated care activities. Consolvo *et al.* coined the phrase Computer Supported Cooperative Care (CSCC) to describe the area of coordination applications that help teams of caregivers [6]. The Digital Family Portrait [24] is an example of a research system designed to help coordinate care amongst caregivers of elderly parents. The care of children has many similarities to the care of the elderly and individuals with chronic conditions, as Abowd *et al.* outline [3]. Pinelle & Gutwin [26] have explored coordinating teams of caregivers within home settings for people with physical therapy needs, and with respect to the coordination of care for newborns, Gronvall *et al.* explored the coordination of caregivers for premature babies in an intensive care unit [15].

Understanding Needs for Health and Wellness

We are taking a similar approach to others in gathering the design requirements for technology supporting record-keeping for newborn children. Qualitative methods, such as interviews, focus groups, surveys, iterative prototyping, and observations, are often effective in determining need for any technology and specific functional requirements. Previous work has successfully used these techniques, including determining design requirements for technology in healthcare [5, 18], designing for care for the elderly [19], and assistive technology for individuals with cognitive disabilities [8]. We use this previous research as a model for how to conduct our research in this new domain.

Persuasive Technology

As with many applications aimed to support healthy lifestyles or better living, any technology we build to help parents keep better records on their own will require some amount of motivation. This work is being defined in a new area termed Persuasive Technology [11]. Our work builds upon other applications that use games as a persuasive means to discourage unhealthy behaviors, such as watching too much television [25] or encourage healthy behaviors, such as physical activity [22]. We believe there are many similarities to motivating healthy childhood development as there are in motivating healthy aging, as described by Intille [20].

STUDY DESIGN

Past experience motivates our belief that technological solutions can play a key role in effective tracking of developmental progress. However, before developing technologies to support parents of newborns in this process, we needed to further understand the benefits and needs, as well as the shortcomings of the current practices.

Thus, we interviewed 8 new parents, 8 experienced parents, and 5 secondary caregivers (some of whom were also parents). We conducted two focus groups, one with 9 daycare providers and one with 4 medical professionals. Individual and group interviews lasted between one and two hours and were semi-structured in nature. The content of the interviews consisted of questions regarding current practices for documenting developmental milestones, recording rich media such as pictures or videos, hopes and fears about developmental progress, plans or experiences for care of the children, and then feedback on ideas we had for technology prototypes. We transcribed all interviews and focus groups after they were completed for systematic analysis.

Target Stakeholders

We identified four sets of stakeholders we believed would provide insight into the problem of record-keeping for young children and used them as the subjects of our interviews and focus groups. With all participants, we prompted discussion of rationales for wanting to keep records and any functions technology would need to provide to enable the process. Additionally, we inquired about willingness and availability to capture and review records, as well as any concerns they may have about the privacy issues associated with video recording and other record types. This section provides an overview of the specific issues we discussed.

New or Expecting Parents

Parents of newborns or expecting parents are our primary users for this type of technology. They can provide us with a prospective on their plans for keeping records on their new child. Additionally, they can share concerns or ideas they have about being a parent, discuss how much time they plan to dedicate to documenting their child's development, and the value they place upon the potential of record-keeping.

Experienced Parents

Experienced parents have already been through the process of raising children and can offer valuable insights into the strategies that worked or did not work for their own children. In our interviews, we focused on what kinds of records and artifacts they collected for their newborn children, what they did with those records, what records they wish they had collected, and whether or not technology would have had a positive impact in record-keeping for their child. We also asked them about their practices of taking their child to see a medical professional. For experienced parents who had children with special needs, we discussed the diagnosis procedure and any technology needs to support current care or early intervention.

Secondary Caregivers

Because families often have both parents working outside the home, many children spend time in the care of a secondary caregiver, such as a nanny, a daycare provider, or a family member. Secondary caregivers often take on some of the responsibility for record-keeping and can offer perspectives on caring for children as a profession. In our interviews with secondary caregivers, we discussed their workload and experience with developmental concerns for the children in their care. Additionally, we asked about current practices, if any, in helping parents look for and document milestones or capture video or photographs.

Medical Professionals

The child's pediatrician and the office staff (*e.g.*, nurses) are often the first people to detect developmental delays due to their expertise. Additionally, they will often answer any questions parents may have and can offer advice on which records to keep in addition to medical records. For the pediatric professionals, we inquired about the process for assessing developmental progress and their willingness to review records collected by parents.

Interview Participant Details

We recruited participants primarily from Atlanta and the surrounding area, but also sought participants from other areas in the United States. Interviewers recruited participants through Craigslist.org, specific mailing lists (*e.g.*, a nanny mailing list), and word-of-mouth. All participants received a $20 gift card for participating. Although we did not specifically seek women, all but two of the respondents were mothers or female daycare providers. Participants came from a wide variety of backgrounds and socioeconomic statuses (see Table 1). Most parents were married, but we also interviewed several single mothers, divorcees, and parents in a second or third marriage. Although we did not specifically recruit for this, ten participants had experience raising or caring for children with a variety of developmental concerns.

Table 1: Summary of interview participants, including demographic information, socioeconomic status, and occupation.

Category	#	Gender	Marital Status	Age Groups	Education	Household Income	Occupations
New Parents	8	Female (6) Male (2),	Married(6), Single(1), Divorced(1)	18-24 (2), 25-32 (2), 33-40 (3), 41-50 (2)	High School(2), Bachelor's(1), Master's(2), Ph.D/J.D.(2)	$25-50K(4), $50-100K(2), $100-150K(1), $150K+(1)	social caseworker, graduate student (2),stay at home mom (2), middle school teacher, computing researcher, lawyer
Experienced Parents	8	Female (8)	Married(8)	25-32 (3), 33-40 (4), 41-50 (1)	High School(2), Bachelor's(4), Master's(1), Ph.D/J.D.(1)	$25-50K(3), $50-100K(3), $100-150K(1), $150K+(1)	science teacher, job development and real estate worker, church office manager, stay at home mom (2), client services representative, substitute teacher, real estate agent
Secondary Caregivers	5	Female (5)	Single(2), Married(3)	18-24(2), 25-32(2), 33-40(1)	High School (2), Some College (2), Bachelor's (1)	$0-25K(2), $25-50K(1), $50-100K(1)	in-home nanny (2), part time nanny, daycare provider , preschool teacher

Focus Group Details

Because time with medical professionals and daycare employees is difficult to obtain and schedule, we chose to conduct focus groups to maximize input. We recruited focus groups participants through direct contact with the manager for either the pediatrician's office or the daycare center. All focus group participants also received a $20 gift card.

Daycare Focus Group Participants

We conducted a focus group at a university-affiliated daycare center, which is a franchise of a national chain. The focus group included 8 lead teachers (all female) caring for children from infants to pre-kindergarten (around age 5),and one office manager. The teachers also had a wide range of ages and experiences with the company and in teaching, ranging from someone who had been with the company for eight years to someone who had just started that week.

Medical Professional Focus Group Participants

The second focus group included medical professionals from a pediatric practice in a suburban town. The practice was associated with a state-funded children's hospital. Many of the patients at this practice were of lower socioeconomic status and almost 50% of them were Hispanic immigrants. The focus group consisted of two pediatricians (one male, one female), a nurse practitioner, and the office manager.

ANALYSIS METHODS AND RESULTS

We analyzed interview transcripts for specific hypotheses we made about the rationales behind and functions required for technology to support record-keeping. Additionally, our analysis aimed at uncovering additional, unanticipated issues brought up by participants.

Analysis Method

Going into this study, we had intuitions about appropriate designs for helping to track developmental milestones. However, we needed to confirm whether these hypotheses were correct. Therefore, prior to conducting the interviews, we distilled six rationales for why parents would want or need to use technology supports:

R1. Parents and caregivers often do not have time to track developmental milestones
R2. Parents want the best outcome for child

R3. Parents need reminders of when to record data
R4. Parents may miss events that occur while away
R5. Parents and caregivers are already motivated to record data, pictures, videos, or keepsakes
R6. Parents want to be able to share information and pictures of their children with others

We also outlined nine functions we believed this type of technology would need to support:

F1. Provide proactive reminders to enter data
F2. Monitor child's health and development and alert parents if anything is unordinary
F3. Use sensors to automatically collect information about a child so parents don't have to record it
F4. Create keepsakes, memorabilia, or photo albums to share with friends and family
F5. Allow parents to share information they collect with healthcare providers if there is a concern
F6. Provide an all-in-one data repository for child, including both health and sentimental records
F7. Allow for multiple caregivers to provide input and use of the system
F8. Allow for the capture of pictures and videos for both health and sentimental reasons
F9. Give parents the opportunity to share information or experiences with other parents, or read more about parenting from trusted online sources

We also conducted an analysis of the transcripts to look for additional themes that fell outside our hypothesized rationales and functions. The themes examined include additional rationales and functions and any other interesting issues discussed during the interviews and focus groups.

We coded data from the interviews and focus groups to look for the predicted 6 rationales and 9 functional requirements. For the interviews, researchers read the transcripts and marked times a particular rationale or function was mentioned. We coded roughly half of the interviews (11/21) a second time and conducted inter-rater reliability between coders. When coders disagreed on 33% or more of the items on a transcript, a third coder would check the disputed items and decide how to code them. This lead to an inter-rater reliability of 95% agreement.

Results – Emergence of Trends

According to our analysis, the average agreement between the participants and our predicted rationales ranged from 61% to 83% (see Table 2). We conducted independent sample T-tests[1] between the 3 groups of caregivers, which indicated that there was no significant difference amongst stakeholder types in their agreement with our predicted rationales and functions, nor was there a difference between the two types of predictions we made.

Table 2: Percent agreement for different stakeholders with our predicted rationales and functions

	Rationales	**Functions**
New	60.42%	66.67%
Experienced	77.08%	68.06%
Secondary	83.33%	66.67%

The different stakeholders we interviewed agreed with the rationales more often than not, which confirms our prediction that there is a need for designing technology for record-keeping. Although we had no prior hypothesis on how participant agreement with the rationales and functions might differ amongst the different stakeholders, we did see some interesting differences when looking at particular rationales and functions (see Figure 1). We conducted additional T-tests between experienced parents and secondary caregivers, which showed secondary caregivers more strongly agreed than parents on Rationale 2 ("Parents want the best outcome for their child", t(7) = -2.646, p=.03). Inherent in this rationale is the notion that if caregivers "catch" potential problems, then the child is more likely to have a better outcome. Perhaps secondary caregivers, as professionals, are more likely to notice problems that working-parents may overlook. This is supported by comments made by one nanny during the interview and the daycare providers in the focus group. They mentioned that many times, they had been the first to notice problems with a child in their care and not the parent.

Our analysis indicates that there may be a better appreciation for the value of computer-assisted record-keeping by experienced parents and professional caregivers than new parents. For example, for Rationale 3 ("Parents need reminders"), tests showed lower agreement between new parents and experienced parents (t(14) = -2.16, p=.05). On Rationale 4 ("Parents may miss developmental milestones") tests also showed lower agreement between new parents and both experienced parents (t(12.36) = -2.26, p=.04) and secondary caregivers (t(7) = -3.42, p=.01).

These results may point to a difference between the optimism of new parents and the practicality of experienced caregivers. New parents often expect to be around for all of their child's milestones and may overestimate the amount of time they will be able to devote to record-keeping. On the other hand, experienced caregivers (both parents and professionals) know that, after a while, it is nearly impossible to keep records of all of their child's development and thus request reminders to document their child's progress. Along the same lines, new parents were less likely than professional caregivers to agree that Function 7 ("Technology should include multiple user input") is a desirable function of computer-supported record-keeping (t(7) = -2.65, p=.03). Again, this may be because new parents believe they will be around for all of their child's milestones, whereas professional caregivers know that keeping track of a child's milestones is one of their responsibilities and thus may be expected to maintain the child's developmental record.
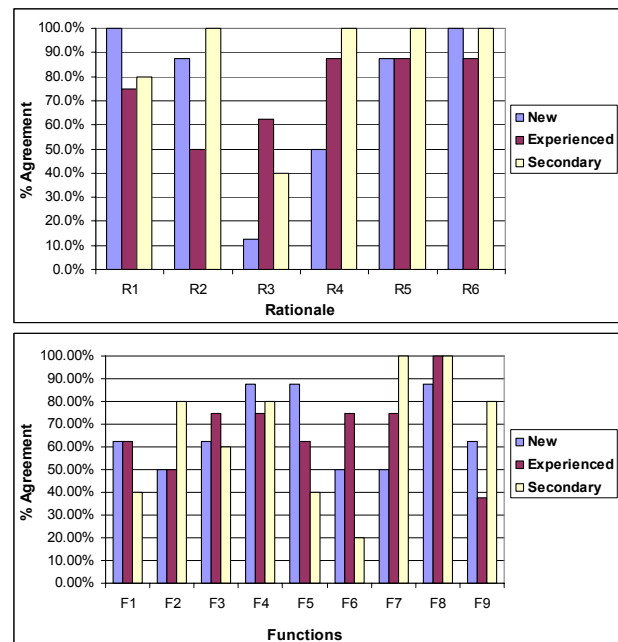

Figure 1: Percent of New Parents, Experienced Parents, and Secondary Caregivers that agreed with the predicted rationales (top) and functions (bottom).

Results - Emergence of Themes

After coding for the original rationales and functions we proposed for record-keeping technology, we analyzed the remaining data to extract relevant themes, considerations, rationales, and functions that fell outside of our predicted needs. To do this analysis, we used a Grounded Theory approach [14]. We had the coders make notes of other interesting data points during the rationale and function coding. Then, one researcher sorted them into themes. This resulted in eight extracted themes, which we describe below.

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[1] To compensate for our smaller sample size, we conducted independent sample t-tests using the more conservative critical t-values that assume unequal variance.

Customized Records for the Individual Child

Many parents reported that existing lists of developmental milestones were too generic and impersonal and thus did not fit their child's particular needs. For example, they do not even account for differences between boys and girls (*e.g.*, girls tend to develop more quickly in certain aspects). Other reasons for customization include premature births or cultural differences (*e.g.*, a child learning two languages may develop language skills at a different rate). One nanny also said she believed that children with nannies may receive more attention than those in daycare, and thus it could affect how quickly children achieved milestones.

> **Nanny:** *"[The child's mother] is always like "oh, he's not doing this... what are we going to do...is this okay??" and I'm like "[child's name] was born 3 weeks early too" and there's gestational age versus actual age ... I think doctors have been saying for the first two years, a lot of children will follow their gestational age in development."*

Supporting Interactions with Pediatricians

Several parents reported that their pediatrician is their most trusted source for information and instructions for caring for their children. However, a pediatrician's time is very limited, and scheduling appointments outside of regular visits takes time and potentially extra money. Pediatrician participants reported that they require all parents to list milestones their child has achieved since their last checkup, but a few parents stated it was sometimes difficult to remember or easily fill out these questionnaires.

> **Mother of 1 year old girl:** *"as far as when they're new ... all the stuff that you have to keep up with, like when you go to the doctor's office. They want to know how much they're drinking, and how much they use the restroom.... you know, all day is such a blur .... So something that would make that easier for me would be a godsend."*

Pediatricians supported the idea of parents bringing a list of completed milestones to the visit to help them fill out their sheets. This would also help parents keep their own personal records consistent with the ones kept by their pediatrician. Pediatricians stated that young children were sometimes uncooperative or upset during visits, and thus they would ask parents to conduct vision or hearing screening at home prior to their visit. Parents said at the end of their regular pediatrician visits (*i.e.*, "Well Baby" visits), they would receive a list of things to look for in the next month and they found it useful. However, one pediatrician reported these lists were often forgotten or misplaced once they left the office.

> **Pediatrician from focus group:** *[referring to sheets sent home with parents] "Some parents will say they're very useful....for most of our parents, it's extremely stressful, the whole situation, so by the time you come to the tip sheet, most of the time the tip sheets are left behind... they had it, but the kids are crying, we've stuck them [with needles]... by then, they really don't want another piece of paper to read, because all they want to do is get their kids in the car."*

Difficulties with Capturing Records

Parents and caregivers mentioned a variety of reasons for not recording as much data as they wanted. We predicted a lack of time as one, but participants spontaneously mentioned many issues that we had not considered. For example, parents often record pictures and some videos of their children, but it is difficult to organize them. The advent of digital cameras means that parents can take as many pictures as they want, but they often end up with so many pictures that it is hard to find the "good" ones. Participants also reported difficulty in recording videos or pictures of their children doing spontaneous things (*e.g.,* events outside of planned photo sessions at birthdays and holidays). Also, once children are walking, they are very mobile and thus difficult to capture. We heard numerous times that parents tend to collect fewer pictures and data on their second, third, or later children. Parents suggested this was because they did not have time, but also suggested that the novelty of a new baby was not as strong for their second child.

> **Mother of two:** *"When you have your first child, everything is so new and fresh, and then by the time the second one rolls around...you're just so overwhelmed with having two that you're...it's not that you don't want to do...you just forget. and the time goes fast."*

Parents also expressed frustration in the difficulty of recording and sharing videos. They had significant concerns about the privacy of secondary caregivers, and nannies echoed the same concerns over privacy.

> **Nanny: "***A lot of parents will just put up a ceiling camera... and a lot of times nannies will quit over that, because the parents say 'oh, I just want to see what's going on during the day'... it's this great feeling of distrust... and there are times when like [child's name] throws up...and I'll be like "I'm just going to take off my shirt because no one's here" and if there's a nanny cam, it's an invasion of privacy."*

Record-keeping is Not for Everyone

Some participants reported that they did not need or want to record information on their children. Others mentioned friends or acquaintances who felt no need for such recording. Some reasons against collecting data were a desire to "let nature take its course" or rely on parental instincts.

> **Father of two:** *"Yeah so, I don't document... you wouldn't get from me a diary of daily activities, his improvements, even a social improvement, all of that stuff. No, I don't track that. I just let nature I guess work on him."*

Some parents stated that fixating on developmental milestones may cause unnecessary paranoia or worry if children do not meet the milestones spot on.

> **Father-to-be:** *"In my case, I do worry and I do think about all this stuff, but ... finding out the details of everything that you can worry about is not a good exercise. There's not enough time, first of all, because of all sorts of pathologies, and second of all, it's not healthy... it can drive you crazy in the end."*

Some participants did not like the ideas of videos at all, again stating concerns with privacy and discomfort with being on

camera. For example, one nanny did not like how she looked on camera and was concerned if the parents she worked for showed the videos to people she did not know. Lastly, some pediatricians in our focus group expressed a concern that any technology to support data collection may be too costly for lower income parents.

Knowing What, When, and How to Record

Another emergent theme was that parents confessed not knowing what data to collect beyond "the basics." They reported receiving much information, but still found it difficult to decide what was "right". Participants from all stakeholder groups expressed a need for reliable sources for data. Parents also stated that sometimes it is difficult to separate fact from fiction when it comes to raising a healthy child. Pediatricians noted that some patients read false information on the Internet and try to argue with doctors, especially when it comes to immunizing their children.

> **Pediatrician from focus group:** *"I think with middle class families, a lot of times, at least in my experience, is that they have too much information. And they almost don't know how to decide what information is valid and what isn't. For example, in modern middle-income families, they'll say they don't want immunizations... the no immunization part really bothers me. When you ask them where they get the information, it's off the Internet. There are good sources, and there are bad sources."*

Newer parents reported a need to have assistance with recording, and experienced parents said they would have liked assistance when they were first starting out. Parents and secondary caregivers reported that they would often use their child's peers in playgroups or daycare to serve as a comparison for their own child's growth, and experienced parents stated they used their older child as a baseline for their subsequent children. Parents and caregivers expressed a need for better descriptions of milestones and a place to get more information if there was confusion. If there was a milestone their child was missing, they would like instruction on how to encourage the child to achieve that milestone. For example, if the milestone required the ability to play with toys in creative ways, there would also be a suggestion for toys that may help the child achieve this goal.

> **Nanny:** *"I remember reading one [a listed milestone] once and was like 'what are they talking about?' but...you know, sometimes they have the quotations marks on these, like "helps" around the house...I'm like…'what do you mean by "helps" around the house?'"*

Several participants expressed frustration with milestone lists that only allow for yes or no answers, when they really should have a range of values (*e.g.*, plays "make believe").

Reflection and Analysis on Childhood Records

Study participants suggested several ideas for reviewing and analyzing collected data beyond what we predicted. Many parents wanted to look over data for sentimental reasons or for curiosity (*e.g.,* compare their children with others). Those concerned about health requested the ability to see trends over time, such as graphs of height, weight, or number of

words in their vocabulary. One participant mentioned that she would like to be able to get a quick overview if she was pressed for time, but if she had more time and was curious, that she would like to see more details. One experienced parent mentioned needing to remember data to tell schools.

> **Experienced mother of three:** *"Nowadays when they go into school, they want to know when they sat up, when they walked, when they talked, when they rolled over, and I'm sitting here trying to think of things later, and I'm like "oh lord..." and I pretty much end up guessing. Because after 5 years, I can't [remember]..."*

> **Experienced mother of two:** *"I think that would be great as we get older... you want to look back more on those things...I think now...my husband is 40 and he wants to start looking back at the video tapes. So, I think that as we get older, you want to start going back more."*

Pros and Cons of Computerized Recording

Participants expressed mixed views on using computers to help with recording information about their children. Most acknowledged that computers may have the ability to make their lives and data recording easier, but they had some concerns. Some of the advantages of using a computer that were reported were that it was easier to enter, it was more interactive, it had the ability to back up data, and that it could be very helpful in helping them to organize data. One participant liked the idea of using her computer to track progress so much that she had tried to keep track of her children's records in a spreadsheet, but complained about a lack of a good method for organization.

> **Father-to-be:** *"Carrying around all this stuff is just not practical and if it burns down…. you lose it. With digital data, if you have it backed up in a couple of different places, then it still exists."*

> **New mother of twins:** *"I've had to look stuff up…and probably the most questions I've asked pediatricians about is speech… but it would be nice to have something that… I'd rather punch it up on the computer and not have to do a stupid search or look through a stupid book. It'd be easier."*

Several participants noted reservations about using a computer to keep track of their records. A few participants who enjoyed making scrapbooks reported concerns that computers seemed less personal than handmade scrapbooks or photo albums. They also questioned the ability of the computer to track physical keepsakes like baby blankets or toys. Lastly, several participants reported a fear of a computer crash leading to the loss of all their records.

> **Future mother:** *"My grandmother has even given me like a grandmother's book that I had no idea this whole time she'd been jotting things down about how she grew up and different things with her and I and, so, that's definitely special…. I would probably do things myself, just because I think it means a little bit more [than on a computer]."*

Diagnosing Disabilities and Disorders

A number of participants had their own children with special needs or had cared for children with special needs, thus,

interesting insights into the diagnosis of these disorders also emerged from these interviews. Most parents commented that their children's diagnoses had been surprises. They did not have any family history of delays, and thus they were not looking for the warning signs. However, once the diagnosis was made, parents reported they believed they could have detected something earlier had they known what to look for. Additionally, several parents decided to wait to see if their child was just slower than average development. They had not expected a delay, they were told things such as "boys develop slower than girls," or they were even told by their pediatrician to wait and see if things improve.

> **Preschool teacher and mother of child with autism:** *"[my daughter] ... did everything typical, then when my son came around, it was kind of like "well, he's not walking yet..." well, "boys develop slower than girls", everyone always tells me that.... I had a general sense that he was delayed, but I thought it was because he was kind of sheltered because we didn't do much besides our playgroup or home."*

In our daycare focus group and also one of the interviews, participants mentioned they had some discomfort in the idea of telling parents that something may be wrong, and oftentimes would go to the director to bring up any problems. One participant mentioned that any computing technology would have to be sensitive when suggesting that their child may have a delay, or perhaps only prompt the parent to consult their doctor.

> **Mother of a son with speech delays:** *"... as the mother of a child who has delays, it's hard for me to see that they really should be doing it [a particular milestone] by this point. ...it's really hard to see that in black in white... to see that first report that your child isn't perfect."*

DISCUSSION AND POTENTIAL PROTOTYPES
Based on the validation of our initial hypotheses of rationale and requirements, as well as the new themes we discovered from our interviews and focus groups, we have specified several design considerations for this domain. In this section, we detail not only the fundamental design considerations emerging from this study, but also the ways in which these considerations might be realized in technological designs.

Key Design Considerations
Take advantage of existing motivations. Keeping useful records on children can be time consuming, but the promise of early diagnosis or better health alone may not be motivating enough to encourage this behavior. Parents are already motivated to keep sentimental records on their children and share that information with friends and family. By building something that tracks both, we may be able to use sentimental record-keeping as a persuasive technology to motivate parents to keep better health records.

The computer should not replace the pediatrician. Both parents and pediatricians have expressed how important doctor visits are for new children, and technology should not interfere with that relationship. Instead, computing technology should be used to improve the parent/pediatrician

interaction and make the precious time together even more resourceful. Moreover, the computer should not be seen as making any diagnosis, only providing supporting evidence for a parent or professional to consult.

Provide a reliable information source. Parents are naturally curious and want to learn what they can, as evidenced by the amount of reading our participants reported they did. By associating software with reliable experts, such as a national pediatrics association, we can increase user confidence in keeping the right records. Additionally, customized lists can be obtained for children, such as using ranges instead of yes/no levels. By providing examples, such as a video or longer description of what "helping" around the house means, a well-designed system could become the *de facto* standard for record-keeping.

Provide for effective communication for the child's caregiver network. Input comes from a range of care providers who have different stakes in the health of the child. Thus, any technology designed for children should allow input from multiple sources and accommodate easy sharing and notification of changes. Furthermore, technology should provide long distance communications channels, because parents may be motivated to share important information with distant relatives or friends.

Potential Technology Designs
In this section, we describe two examples of technologies that may support new parents in tracking and documenting developmental milestones that meet many of the design considerations listed above. The ideas for these applications existed before conducting this study, but we refined and iterated upon them after confirming with subjects that they would be useful. The two technologies suggested below could be used individually or together to support record-keeping and analysis by parents of newborns.

Developmental Milestone & Media Repository
We propose the development of an application that allows parents to enter health-related information, pictures, and videos of their child (see Figure 2). Based on the age of the child, the system can automatically prompt caregivers to enter and check off relevant developmental milestones that their child has achieved. The list of milestones and dates should come from a trusted source, such as the American Academy of Pediatrics. These reminders, either through pop-ups on the screen when they turn on their computer or through email, can prompt them to enter data about their child. Because some participants did not mention the need for reminders (F3), these may be optional, or only appear after a long period of inactivity. The system can allow parents to review progress over time at varying levels of details and if they have any questions, they can view information about various types of childhood disorders or see examples of developmental milestones. Additionally, they can share experiences or upload artifacts with others online (F9). If a child has gone too long without completing a specific

milestone, rather than warning the parent about the potential of a disorder, it will alert them and add it to a list of questions they can print and bring to their pediatrician at their next scheduled visit.

Figure 2: Sample screen shot of digital repository

Because parents are already motivated to enter pictures and share them with others (R5), the system can encourage uploading of pictures or videos as evidence for milestone completion. Additionally, it can automatically generate keepsakes for parents, such as DVDs of videos captured in relation to their important milestones or an automatically generated newsletter on their son or daughter's development to send to friends and family (F4). To preserve parents' desire for physical artifacts, the system can also help generate photos or decorations for scrapbooks. Secondary caregivers would be able to enter data into the system and send any new information to parents through email. Additionally, if there are any health concerns, the parents can send their child's data, pictures, or videos to their pediatrician to help answer questions or address concerns (F5). Lastly, the computer will provide automatic backups of their child's data onto an external disk or remote server.

Smart Baby Monitor with Specialized Toys

In our focus group with medical professionals, one of the doctors stated that many times, a parent cannot easily convey something their child does and agreed that video may help them better convey questions. Additionally, many parents expressed a desire to record more videos of their children (F8). However, the capture of videos for each milestone a child encounters will be a very difficult task. Thus, we are proposing a smart baby monitor, which selectively archives things it sees [17]. The monitor could be built using a handtop computer with an integrated camera that constantly records and saves the last 15 minutes of video data (see Figure 3). When parents or caregivers observe important events, they can trigger the baby monitor to save video clips of what just happened by tapping a button on the screen.

Some milestones may occur at times or locations when the parent or caregiver is unable to constantly monitor them

(R4), thus, we propose an infrastructure for a set of wireless, sensor-enabled toys (F3). These toys can sense when a child plays with them and trigger recording when events are likely to happen. For example, one of the developmental milestones a child should reach by the time he is 7 months is "picking up and shaking hand toys." A rattle with a wireless accelerometer can sense when a baby shakes it and trigger recording from the monitor nearby. Other toys that can sense developmental milestones include dangling objects that can sense when they are being moved, or a bucket that can sense when objects are being added or removed.

This prototype addresses several concerns raised by the stakeholders in our study. Automatic recording of milestones can help parents who are short on time (R1) or are afraid of missing events (R2). Selective archiving is an appropriate way to manage privacy expectations and control of recording [16] that many of our participants requested. One major factor will be in designing a modular system that will work as a stand-alone application or with a subset of toys to help mitigate some cost concerns associated with equipment.
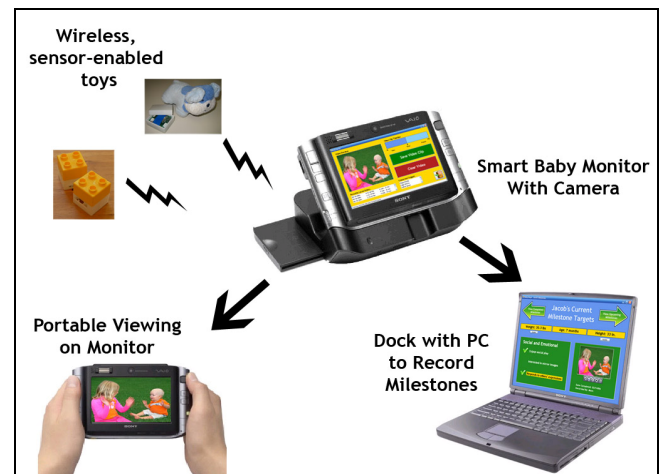

Figure 3: Smart baby monitor with sensor-enabled toys.

CONCLUSIONS AND FUTURE WORK

We have presented the results of a qualitative study investigating the record-keeping needs for families of young children. Our study consisted of interviews with 8 new parents, 8 experienced parents, and 5 secondary caregivers, and focus groups with 4 medical professionals and 9 daycare employees. Our participants confirmed a number of predetermined assumptions and suggested several other important design considerations. We have shown a need for assistance in recording information for young children, especially when it involves assessing developmental progress. This study revealed several issues regarding motivation for recording and concerns this type of technology should address.

We believe this research has also helped identify future research directions in developing new technologies to support this area. We have begun to explore potential technologies that may be able to assist in this domain, leveraging existing practices of baby books and baby

monitors. We have uncovered other technology-centered research questions, such as how records may be automatically collected, which schedule may be most appropriate for prompting record entry, and determination of appropriate locations for cameras and sensing technologies. We believe there is potential for computing technology to both provide parents with comfort in knowing they are doing everything they can to ensure the healthy development of their child and allowing them to collect and reflect on the sentimental moments in their child's life.

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