Parent Experience With False-Positive Newborn Screening Results for Cystic Fibrosis

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abstract

BACKGROUND: The risk of psychosocial harm in families of infants with false-positive (FP) newborn bloodspot screening (NBS) results for cystic fibrosis (CF) is a longstanding concern. Whether well designed retrieval and confirmatory testing systems can mitigate risks remains unknown.

METHODS: Using a mixed-methods cohort design, we obtained prospective self-report data from mothers of infants with FP CF NBS results 2 to 3 months after confirmatory testing at Ontario's largest follow-up center, and from a randomly selected control sample of mothers of screen negative infants from the same region. Mothers completed a questionnaire assessing experience and psychosocial response. A sample of mothers of FP infants completed qualitative interviews.

RESULTS: One hundred thirty-four mothers of FP infants (response rate, 55%) and 411 controls (response rate, 47%) completed questionnaires; 54 mothers of FP infants were interviewed. Selected psychosocial response measures did not detect psychosocial distress in newborns or 1 year later ($P > .05$). Mothers recalled distress during notification of the positive result and in the follow-up testing period related to fear of chronic illness, but valued the screening system of care in mitigating concerns.

CONCLUSIONS: Although immediate distress was reported among mothers of FP infants, selected psychometric tools did not detect these concerns. The NBS center from which mothers were recruited minimizes delay between notification and confirmatory testing and ensures trained professionals are communicating results and facilitating follow-up. These factors may explain the presence of minimal psychosocial burden. The screening system reflected herein may be a model for NBS programs working to minimize FP-related psychosocial harm.

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WHAT'S KNOWN ON THIS SUBJECT: Evidence is mixed with respect to psychosocial response to false-positive newborn screening results. The role of the newborn screening system in optimizing patient experience is not well characterized.

WHAT THIS STUDY ADDS: Persistent psychosocial harm in mothers with false-positive results was not identified by using selected measures but immediate distress was reported. In managing immediate distress and fears related to screen positive results, mothers highly value well-coordinated, efficient, and patient-centered screening systems.

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Newborn bloodspot screening (NBS) for cystic fibrosis (CF) is now established in many developed countries,[1–4] as early detection improves nutritional status, height, and weight gain.[5] CF is the largest single disease contributor to screen positive NBS results in many jurisdictions, and is an exemplar case for understanding the impact of expanded NBS. Approximately 30% of screen positive cases/year identified in Ontario are attributable to CF,[6] the majority of which are false-positive (FP) upon confirmatory testing; as many as 80% of these are CF carriers.[6,7]

As part of efforts to balance benefits and burdens of population screening, the impact of FP results has long garnered attention. In the context of NBS, the concern dates back to 1968 when "Phenylketonuria-Anxiety Syndrome" described the distressing experience of receiving FP results for phenylketonuria.[8] Evidence has since accumulated suggesting that parents may experience a range of reactions related to receiving positive CF NBS results. Tluczek et al[9] found that before confirmatory CF sweat testing, up to 43% of parents who had received an abnormal screening result experienced clinically significant depressive symptoms. However, after the sweat test, parents whose infants were found to be CF carriers did not differ from screen negative controls. Parents' previous knowledge of NBS, CF, and their own carrier status as well as the clinician's approach to informing them influenced this emotional reaction.[9] Similarly, others have found that majorities of parents (74%–96%) reported high anxiety in reaction to positive NBS results but upon receiving normal sweat test results, majorities (64%–86%) were relieved.[10,11] Although detected anxiety appears to be transient,[9–11] 1 to 6 years after identification, up to 29% of parents report worry about the health of their carrier child as well as potential difficulties posed for future relationships. Stress scores are also higher at 1 year postdisclosure among parents who received CF carrier versus negative results.[12,13] Parsons et al,[14] however, found that by 6 months postdisclosure, there was no evidence that carrier identification was associated with a compromised mother–baby relationship. Other survey and qualitative data suggest that, ultimately, the majority of parents feel better knowing their child's CF carrier status.[9,15]

Although the negative psychosocial impact of FP results appears to be transient, vulnerability remains a concern. Responding to this evidence and as a broader measure of quality, *Newborn Screening Ontario* developed programmatic recommendations to minimize delay to confirmatory testing, ensure trained health professionals are communicating results to parents, and build partnerships with primary care providers. Presented herein are quantitative and qualitative data that reflect upon maternal lived experiences soon after CF NBS FP result notification in the context of a centralized provincial program.

METHODS

In Ontario, CF NBS involves a 2-step process of measuring immunoreactive trypsinogen followed by screening the CF transmembrane regulator gene for 39 mutations.[6] Infants who were identified to have 1 CF mutation or an immunoreactive trypsinogen >99th percentile were referred for diagnostic sweat chloride testing. In collaboration with the CF clinic at the Hospital for Sick Children (SickKids) in Toronto (largest pediatric tertiary care center in Canada), we conducted self-administered postal surveys of mothers of CF screen positive infants and a control sample, at 2 months after the infant's birth (Time 1 [T1]) and 1 year later (Time 2 [T2]). We also conducted semistructured interviews with a subsample of FP survey respondents at both time points. Although the complete screen positive population included true-, false-, and inconclusive-positive infants, we focus herein on the longitudinal results from the T1 FP responder group. Research Ethics Boards at SickKids, The Children's Hospital of Eastern Ontario, and The University of Toronto approved this work.

Sample and Recruitment

T1 recruitment of mothers was prospective over 18 months. The full population of mothers of CF screen positive infants seen at SickKids, aged 4 to 6 weeks (ie, confirmatory testing complete), were eligible to participate. Those facing extenuating perinatal circumstances, those undergoing adoption proceedings, mothers of multiples, and mothers facing a significant language barrier were excluded. The control sample (3:1 control:case ratio) included a random sample of mothers of infants in the population who screened negative for all disorders included in Ontario's NBS panel, resided within the SickKids catchment area (ie, according to postal code boundaries), and were 4 to 6 weeks old. Mothers of infants with an unsatisfactory bloodspot were excluded as were mothers of infants facing adoption proceedings, blood transfusion, prematurity (ie, gestational age <36 weeks), early death, or >60-day delay between date of birth and date of bloodspot collection.

Mothers of FP infants were notified of the study verbally and with a letter of introduction at the conclusion of their confirmatory sweat-testing appointment (4–6 weeks' postbirth). Four weeks after this notification, potential participants who had not opted out were mailed a survey package. One follow-up package was sent 1 month later. For screen

TABLE 1 Time 1 Recruitment

Wk Postbirth	4–6	6–8	8–10	10–12	12–14	14–16	16–18
Cases	x	—	x	X	x	X	—
Controls	x	X	x	X	x	Xx	x

x: original recruitment schedule; X: extended recruitment schedule; —, no recruitment activity.

TABLE 2 Psychosocial Response Tools

Scale	Item Format	Psychometric Properties	Domains of Use
STAI (20 item)[28]	4-point scale from "not at all" to "very much so"	Scores range from 20–80; mean (working women) is 34.79 (SD = 9.22); mean (14w postpartum women) 30.43; good construct validity, discriminating adults with generalized anxiety disorder[28]	Used in NBS research to measure anxiety[14,29–32]
BSI (53 items)[33]	5-point scale from "not at all" to "extremely"	Internal consistency, test–retest reliability, and validity demonstrated[33]	Used to assess impact of newborn diagnosis and as a measure of adjustment over time.[34–39] Has not been used in NBS research
CVS (8 items)[40]	4-point scale from "strongly disagree" to "strongly agree"	Total scores range from 0–24. In a clinical population, scores ≥10 indicate elevated perceptions of vulnerability; internal consistency, test–retest reliability, and validity are well demonstrated[40]	Used in NBS research to measure response to positive NBS results[41–43]
PPUS (4 items)[44]	5-point scale from "strongly agree" to "strongly disagree"	Measures the uncertainty parents experience related to their child's illness; higher scores indicate greater perception of uncertainty. Internal consistency, test–retest reliability, and validity demonstrated[44]; modified as per Table 3	Used to gauge perceived parental uncertainty between identification of symptoms in a child and point of diagnosis.[45–47] Has not been used in NBS research
MWS (10 items)48	4-point scale; worry "most of the time," "often," "sometimes," and "not at all"	Internal consistency, test–retest reliability, and validity demonstrated[48]; modified as per Table 3	Used for mothers of children with chronic illness.[48] Has not been used in NBS research

negative controls, mothers were notified of the study by mail, 4 weeks after birth. Potential controls who had not opted out were mailed a survey package and invited to participate, with 3 additional contacts (at 2-week intervals) for nonresponders (ie, modified Dillman method).[15] In response to a poorer than expected response rate (RR) at 3 months (presumed attributable to the young age of the infant at initial contact), the recruitment time lines were slightly extended (Table 1). The overall shorter recruitment time line for FP cases compared with controls reflects the differential burden appropriate to clinical and nonclinical study populations.[16–18] Completion of the questionnaire constituted consent to participate. At T2, 1 year after the completion or administration of the T1 survey, T1 responders and nonresponders were mailed a slightly modified second survey. The recruitment and survey administration process was the same as that used at T1 with FP notification mail.

Data Collection and Analysis: Survey

The survey package included (1) a team-developed, self-administered questionnaire gauging CF knowledge, understanding of screening result, experiences with the notification process, (2) 5 self-administered measures of psychosocial response, (3) demographic questions, and (4) a study information sheet, a consent to recontact form for the qualitative interview, and a small financial incentive ($2 coffee coupon). The questionnaire was adapted from existing instruments developed for and literature related to NBS and CF research[9–15,19–48] and pilot tested with new parents recruited from the Greater Toronto Area (N = 15) through an online mothers' group. The core of the questionnaire was consistent across FP and control groups; nonapplicable FP-related content was removed from the control group questionnaire. The measures of psychological response included: (1) the State Subscale of the State Trait Anxiety Inventory (STAI) as a measure of anxiety,[28–32] (2) the Brief Symptom Inventory (BSI) as a measure of distress,[33–39] (3) the Child Vulnerability Scale (CVS) as a measure of maternal perception of infant vulnerability,[40–43] (4) a modified version of the Parental Perceptions of Uncertainty in Illness Scale (PPUS) as a measure of perceived uncertainty related to childhood illness,[44–47] and (5) a modified version of the Maternal Worry Scale (MWS) as a measure of maternal worry[48] (Table 2).

Questionnaire data were manually entered into IBM SPSS Statistics version 18 (IBM Corporation, Armonk, NY). Where the data entry error rate was >0.50%, full double data entry was performed. We report cross-sectional analyses for T1 and repeated measures

analyses for the subsample of respondents who completed both T1 and T2 questionnaires. We quantified the overall pattern of responses, reporting proportions with 95% confidence intervals for discrete variables and means with SDs for continuous variables, for each of the FP and screen negative groups; *t* tests were performed on log-transformed STAI, CVS, and PPUS scale data and on BSI *t* scores. Because MWS scores were highly skewed and did not respond favorably to power transformation, nonparametric tests were used to gauge group differences. For T1 data, linear regression was performed to examine the association of FP status with anxiety, distress, vulnerability, and uncertainty, controlling for maternal characteristics where there was a difference between groups. Given multiple comparisons in the regression models, a more stringent *P* value ($P < .01$) was used to determine statistical significance. We then performed 2-factor mixed analysis of variance to gauge the effect of time on anxiety, distress, vulnerability, and uncertainty. Maternal worry was analyzed separately because data were concentrated at a score of 10. We subtracted 10 from each score and treated the data as count data to compare screen negative and FP groups at each time point. Negative binomial regression was used for the subsample for whom we had T1 and T2 worry data (total $n = 255$), adjusting for the same confounders as the T1 linear regressions. At T2, a repeated measures negative binomial regression was performed on worry data.

Data Collection and Analysis: Interviews

After our receipt of completed questionnaires, we conducted semistructured, open-ended interviews with all mothers of FP infants who agreed (by checking a box on the questionnaire). Interviews were conducted by telephone where face-to-face was not preferred, or because of excess cost of travel to a distant location. The interview guide queried mothers' experiences receiving results, and their understanding of screen positive and confirmatory sweat testing results. Interviews were taped, transcribed, and coded. We used a thematic approach, applying and modifying preexisting codes from the interview guide pertaining to the experience of receiving FP results, and allowed new themes to emerge from the data by using constant comparison. Through an iterative process, codes were refined and inconsistencies were resolved through discussion.[49,50] We used T1 interviews to identify themes and then searched for confirming/disconfirming evidence and persistence of experience in T2 interviews.

RESULTS

Quantitative Findings

Characteristics of Survey Respondents

Of 246 eligible mothers of infants who received FP NBS results, 134 responded (RR = 54.5%) to the survey, and of 869 eligible mothers of screen negative infants, 410 responded (RR = 47.2%). Among mothers of FP infants, we report on 134 mothers (T1) of whom 82 (T2) completed T1 and T2 surveys. According to mothers, 141 (65.2%) of these infants were confirmed to be carriers, 44 (20.4%) were confirmed noncarriers, and for 31 (14.4%), carrier status was unknown. Among screen negative infants, we report on 410 mothers (T1) of whom 179 (T2) completed T1 and T2 surveys.

The characteristics of our survey samples are reported in Table 3. At T1, compared with controls, a greater proportion of mothers of FP infants reported living in rural areas ($P < .05$), fewer had completed undergraduate (or higher) degrees ($P = .02$) and more reported that the index infant was their first child ($P = .01$). Compared with an Ontario-based CF population, our participants were similar in education and income levels.[51]

Psychosocial Outcomes

In both the FP and control groups at T1 and T2, mean anxiety, distress, and vulnerability scores were low relative to reference means or clinical cutoffs where these were available from the literature (Tables 2 and 4), and not significantly different between groups (Table 4). Although uncertainty scores were significantly different between groups at T1, the control group reported more uncertainty than the cases ($P = .03$; Table 4). Results of linear regression revealed that FP status did not predict anxiety, distress, vulnerability, or uncertainty at T1, controlling for relevant maternal characteristics (Table 5). Repeated measures analyses indicated no change in psychosocial response over time, except that uncertainty scores remained higher among controls at T2 ($P = .03$; data not shown).

Maternal worry scores were significantly higher among mothers of FP infants compared with controls at T1 and T2 ($P = .002$, $P = .004$; Table 4). When the worry scale item related to carrier children having a harder time making reproductive choices was removed (worry_revised), the significance of this effect disappeared. Adjusting for maternal characteristics, the negative binomial regression at T1 (using the 10-item worry scale) revealed that FP status did not predict worry. Over time, worry decreased ($P = .01$), and there was no difference between FP and controls on T2 worry scores (data not shown).

Self-Reported Experiences

With respect to the notification system itself, 61% of mothers in

TABLE 3 Overall Sample Characteristics

	Time 1			Time 2		
	False-Positive, *n* (%)	Screen Negative, *n* (%)	χ^2 *P*	False-Positive, *n* (%)	Screen Negative, *n* (%)	χ^2 *P*
Age	*n* = 134	*n* = 405		*n* = 82	*n* = 179	
25 and younger	9 (6.7)	26 (6.4)	.54	3 (3.7)	3 (1.7)	.73[a]
26–30	28 (20.9)	110 (27.2)		14 (17.1)	36 (20.1)	
31–35	59 (44.0)	160 (39.5)		33 (40.2)	72 (40.2)	
36+	38 (28.4)	109 (26.9)		32 (39.0)	68 (38.0)	
City of residence, population size	*n* = 133	*n* = 410		*n* = 81	*n* = 179	
100 000+	93 (69.9)	330 (80.5)	.02*	54 (66.7)	141 (78.8)	.045*
<100 000	40 (30.1)	80 (19.5)		27 (33.3)	38 (21.2)	
First child	*n* = 134	*n* = 315		*n* = 82	*n* = 179	
Yes	72 (53.7)	127 (40.3)	.01*	46 (56.1)	82 (45.8)	.14
No	62 (46.3)	188 (59.7)		36 (43.9)	97 (54.2)	
Marital status	*n* = 134	*n* = 410		*n* = 82	*n* = 179	
Married or common law	123 (91.8)	380 (92.7)	.71	79 (96.3)	166 (92.7)	.29
Other	11 (8.2)	30 (7.3)		3 (3.7)	13 (7.3)	
Education, highest level completed	*n* = 134	*n* = 408		*n* = 82	*n* = 179	
High school or less	18 (13.4)	57 (14.0)	.02*	9 (11.0)	23 (12.8)	.25
College or CEGEP	54 (40.3)	107 (26.2)		29 (35.4)	42 (23.5)	
Undergrad	27 (20.1)	112 (27.5)		20 (24.4)	55 (30.7)	
Grad or professional	35 (26.1)	132 (32.4)		24 (29.3)	59 (33.0)	
Annual household income	*n* = 129	*n* = 398		*n* = 78	*n* = 163	
Under $80 000	52 (40.3)	180 (45.2)	.36	22 (28.2)	58 (35.6)	.26
$80 000+	77 (59.7)	218 (54.8)		56 (71.8)	105 (64.4)	

[a] Fisher's exact test.

* $P < .05$.

TABLE 4 T1 Cross-Sectional and T2 Longitudinal Maternal Psychosocial Response

	Time 1[a]			Time 2[a]		
	Mean Scores (SD)		*t* test *P*	Mean Scores (SD)		*t* test *P*
	FP	Screen Negative		FP	Screen Negative	
Anxiety	31.23 (10.30)	32.39 (8.94)	.12	31.48 (9.03)	32.74 (10.23)	.41
Distress[b]	55.35 (9.90)	56.03 (10.67)	.52	53.85 (10.46)	53.79 (11.21)	.97
Vulnerability	4.79 (3.49)	5.53 (4.16)	.26	4.59 (3.60)	5.23 (3.68)	.22
Uncertainty[c]	8.04 (2.41)	8.61 (2.64)	.03*	7.57 (2.37)	8.19 (2.50)	.051
Worry[d]	10.81 (2.51)	10.71 (2.27)	.002**	10.73 (2.30)	10.39 (1.40)	.004**
Worry_revised	9.49 (2.42)	9.66 (2.08)	.314	9.46 (2.27)	9.36 (1.26)	.41

t tests performed on log-transformed scale data, and descriptive statistics reported on raw data.

[a] T1 participants completed survey when infants were 2 mo of age; T2 survey completed 1 y later.

[b] BSI, *t* scores reported; measured 15 items to gauge general distress, using the depression and obsessive behaviors subscales and 14 additional items to generate Global Severity Index.[33, 37–39]

[c] PPUS, eliminated items related to medical treatment, attitudes toward health care providers, and items not specifically about uncertainty in health and illness; revised items to be about infants and to be CF-specific.

[d] MWS, changed "health condition" to "health," removed 4 items specific to being sick/using medication, and added 3 items to suit context of genetics; Mann-Whitney *U* test performed due to the nonparametric nature of data; MWS means reported for consistency with other measures; MWS_revised, 9-item version with the item re: worry about children's choices about having children removed.

* $P < .05$.

** $P < .019$.

the FP group were notified of their results from their primary care provider and 39% were notified by a genetic counselor. Only 13% indicated that they would have preferred to receive this notification from someone else; of those 47% indicated a preference for their primary care provider and 53% indicated a preference for a counselor from the screening program. Finally, when prompted by a survey question, 87% of mothers agreed that the time between being notified about the positive screen and learning the final results "was the scariest time of my life." At the time of the second survey, only 14% agreed with this fear.

Qualitative Findings

Characteristics of Interview Participants

Thirty-one mothers who received FP results for their infants were interviewed at T1 and 35 mothers were interviewed 1 year later, at T2. Of those interviewed at T2, 23

TABLE 5 Psychosocial Response Regression Results at Time 1

	Anxiety, β (SE)	Distress, β (SE)	Vulnerability, β (SE)	Uncertainty, β (SE)
FP (ref: control)	−0.013 (0.013)	−0.405 (1.129)	−0.024 (0.036)	−0.033[a] (0.014)
First child missing (ref: no)	0.023 (0.015)	0.954 (1.308)	0.005 (0.041)	0.013 (0.017)
First child, yes (ref: no)	−0.012 (0.012)	0.093 (1.026)	−0.035 (0.033)	0.023 (0.013)
City size, 100 000+ (ref: <100 000)	0.000 (0.013)	0.435 (1.129)	0.012 (0.036)	−0.010 (0.014)
Education: college/CEGEP (ref: grad/ professional)	0.012 (0.014)	1.213 (1.194)	−0.053 (0.038)	0.009 (0.015)
Education: undergrad (ref: grad/ professional)	−0.003 (0.014)	0.611 (1.215)	−0.073 (0.039)	−0.017 (0.016)
Education: high school	0.012 (0.017)	−1.071 (1.504)	−0.067 (0.047)	−0.008 (0.019)

Each β coefficient represents the difference between the average psychosocial response score for 1 level of a predictor variable (eg, FP) compared with the average psychosocial response score for the reference level of this predictor variable (eg, screen negative); β are unstandardized.

[a] $P = .02$.

were new participants and 12 were interviewed at T1 and comprise a longitudinal subsample.

The Lived Experience

From 31 T1 qualitative interviews, we identified 2 major themes. The first relates to the nature of the distress that was experienced. From mothers' perspectives, receiving the notification telephone call was frightening. Having been home from hospital with an apparently healthy infant and having perceived their discharge and noninvolvement with the health care system as a "clean bill of health," it was alarming to learn that their child might have a chronic illness. Mothers reasoned that receiving this news on the heels of their own postpartum recovery likely added to the intensity of their response. After receipt of this unexpected information, mothers attributed unusual newborn behavior (eg, congestion, spit up, raspy breathing) to a possible diagnosis of CF, described a process of symptom seeking (eg, licking the infant to gauge "saltiness"), and a fear of living a life with a child with a chronic illness (Table 6). Among 23 new participants interviewed at T2, most reported similar distress in retrospect, but few reported ongoing distress. Of the 12 longitudinal participants, 3 reported a persistence of the distress that was reported at T1.

The second major theme relates to how the screening and tertiary care systems, and various players within this coordinated system, were valued by mothers and worked to mitigate the distress that was experienced. Mothers placed tremendous value on the fact that time to confirmatory testing was quick (generally ≤48 hours). They valued the active coordination of their care; specifically, being given a time and location to attend for confirmatory testing. Although mothers had mixed views about the importance of pretest NBS education, mothers valued what they experienced as clear, calm, and sensitive communication from the involved heath care providers at both notification and confirmatory points in time (Table 6).

DISCUSSION

Using mixed methods, we provide a unique contribution to unresolved questions of psychosocial response to FP NBS results. A first key finding is that measures of psychosocial harm related to anxiety, distress, vulnerability, and uncertainty were not increased in mothers of infants with FP results in the early newborn period or 1 year later. Although no signal of harm was detected on these psychometric tools, a majority of mothers agreed that the FP experience had been the "scariest time in their lives" and reported worry about future family planning for their carrier infants. Similarly, in interviews, mothers of infants with FP results recalled distress during the notification and diagnostic follow-up periods, stemming from the unexpected nature of the information, symptom-seeking, and a fear of chronic disease. For most, distress did not persist 1 year later.

Our second key finding relates to the NBS system itself. Given longstanding concern about the risk of psychosocial harm in families of infants with FP results, NBS programs seek to mitigate potential distress.[7,15,25,52–55] Specifically, Ontario has developed a notification system that aims to minimize delay to confirmatory testing, provides point of care fact sheets to health professionals who are communicating results to parents and responding to questions, and aims to achieve a partnership with primary care providers who often play an initial notification role. Our qualitative data indicate that parents valued this carefully structured screening system and perceive its role in mitigating FP-related distress. More specifically, parents valued the short waiting period preceding confirmatory testing. Although measurable psychosocial distress has been identified among parents of screen positive infants, this may be associated with the longer waiting periods for confirmatory testing that were experienced in earlier years of CF NBS.[9,20,56,57] The absence of such distress on similar tools used herein underscores the importance of

TABLE 6 Qualitative Themes and Illustrative Statements

Theme	Illustrative Statement
Mothers experience distress in the early days	
The news is distressing	Just as you think everything is going so perfectly, you hear this… it is so scary; you always think it happens to other people… (205)
	I just shut down. I didn't hear anything. She kept talking and I could tell she was trying to calm me down, but I couldn't hear anything she was saying. (015)
	Well, I guess it kind of blew me out of the water…we signed the form in the hospital… but didn't know anything really about it, so forgot about it. So, when the call came it knocked me on my butt… (050)
The news triggers symptom monitoring	All I kept saying was "she's got cystic fibrosis. That's why…" She was really congested… I said, "oh my god, this is why she's this. This is why this happened. This is why she keeps throwing up when she eats." (015)
	No, we just spent the 2 days looking up symptoms, trying to find reasons that would explain… his behavior because he was eating a lot…. had raspy breath. So, I thought, oh my god, those are symptoms. We licked him. And then, I swaddled him up and made him sweat some and licked him more… (052)
	But you worry… you start to think of every little cough… she tends to drink a lot of milk, chugs it and then spurts it all up and, you know, is that her drowning in mucus cause she can't drink it properly? Your brain just goes. (234)
The news leads to fearing a life of chronic illness	But you know, my husband was sitting there in the waiting room, nervous and, and looking at all these other poor children that are there for different reasons, you know, are really, really sick and, and you start to really think about, this could be my reality (173)
	As soon as I got there it was even more stressful because I was, like, "oh my god, I'm going to be coming here for the rest of my life"…. it was really stressful… I walked in there and I'm seeing other kids with, like… I don't know what you call those long stick things with, like, the drippies on them. And, I'm, like, "oh god, I'm going to… that's going to be my kid" (017)
	Really it was just fear, but it was fear for different people as well. Like, it wasn't just a fear for her. It was a fear for my older son and if she suddenly had a condition that required a lot of specialists and doctor's appointments, what did that mean for him and our family? (141)
The system response helps to mitigate the distress that is experienced	
It was quick and prescribed	Was great that we didn't have to wait because…waiting like 2 or 3 weeks for an appointment… You would have just made yourself sick with worry…48 hours is long enough… if you had to wait like 2 weeks, then you know, you really get your anxiety level up… [173]
	So I was thrilled with that approach…..to have her just tell us, "show up at this time"… we didn't have to do anything. So that eliminated a whole other set of questions in what do we do now and who do I call? And, we didn't have to do any of that. (129)
Communication was effective and sensitive from notification to confirmation	She had a really, really positive outlook. And, she was really calm. And, you know, I don't… it wouldn't have made it any worse or better hearing it from my family doctor or something, or somebody that I knew… You know, the way she presented the information I think made a huge difference even though I didn't… I've never spoken to her before. (153)
	You could tell that she just knew what she was doing, very routine. She was comfortable with babies. Like, she was excited. She was talking to our son. Like, we hadn't even started talking to our kid. And, it was just a very, like, upbeat feeling. And, she was, like, "yeah, stay in here as long as you need to" and, like, just very warm…and comfortable." (035)
	And, it was certainly my experience that everybody was sensitive… I felt completely supported. And, I felt like for all I knew [she] could have been there only for me; and that's the way she made you feel. Like, "I'm just here for you and it doesn't matter; anybody can walk into my office right now. It doesn't matter. I'm talking to you. And, I think she was great at that. And, I think if your other folks are making a… are like her, I don't think you have a problem. And, I mean, doctors or whoever making that call, as long as parents feel supported and that you care and it's not a… this is not routine. It may be routine to you; it's not routine to me. That's the only thing. (141)
The role of early information about newborn screening outcomes is unresolved	You know, if my OB would have sat down with me and spoken to me for 5, 10 minutes about what the results would be and, you know, potential results and what would happen, what the steps would be if this or that happened; yes, the pregnant woman freaks out, but it's almost… it's better to be kind of forewarned I think. It gives you time to think about it. I don't know. Instead of just somebody coming in and, you know, doing the prick test and then 2 weeks later you get a phone call, ta da! (153)
	And, I've thought a lot about this since. I'm not so sure I would have had it any other way. That's kind of the problem because you kind of forget about it. But, if nothing was wrong, so say with the second child, I'm not so sure I'd want to be thinking about, you know, a phone call that may come. Of course I will now because I've gone through it, but I'm not so sure what the right answers are. At first I thought it would have been nice to be reminded when we left the hospital that those… that screening was being completed, but now that I've sat and thought about it I'm not so sure I would have wanted to know that either. So, I would say we were completely shocked. I guess part of the problem too is when we signed that form we didn't really know what was being tested either. And, you know, we could have looked it up for sure and I've since looked it up, but I had no idea what we were even… was the potential to come up. (050)

short waiting periods (ie, <48 hours) for optimal patient experience. Additionally, mothers were content to defer to the screening system for logistics pertaining to follow-up and reflected favorably on provider communication and education strategies, whether offered by primary care providers or NBS program-affiliated genetic counselors.

We acknowledge several limitations. Because our study attracted a well-educated cohort of mothers who may have been better equipped to understand this experience, our findings may not be generalizable to mothers with less education. Others have reported an important link between knowledge/understanding of NBS results and psychosocial response,[9,15] so our findings must be considered in this light. Moreover, mothers of FP infants who are confirmed to be carriers may respond favorably to the receipt of this reproductive risk information.[10] The majority of our cohort represents the experience of mothers of carrier infants, possibly limiting the generalizability of these results to mothers of FP noncarriers. Second, our qualitative interviews were designed as 2 cross-sectional interviews, so did not actively probe change over time. Finally, the results may not be applicable to other disease screen positive populations.

Limitations notwithstanding, our mixed methods approach enables an enhanced understanding of maternal response to FP NBS results. Although our findings from selected psychometric tools align with previous studies that reveal minimal adverse psychosocial sequelae,[9–11] other survey and qualitative findings suggest that parents experience distress and depend on the support provided by a well-structured screening system. Parental reflections on the role of the screening system in mitigating potential distress are novel and confirm the need for investment in centralized, well-coordinated, efficient screening systems in all jurisdictions to optimize patient experiences and outcomes.

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ABBREVIATIONS

BSI: Brief Symptom Inventory
CVS: Child Vulnerability Scale
CF: cystic fibrosis
FP: false-positive
MWS: Maternal Worry Scale
MWS_r: Maternal Worry Scale Revised
NBS: newborn bloodspot screening
PPUS: Parental Perceptions of Uncertainty in Illness Scale
RR: response rate
STAI: State Trait Anxiety Inventory
T1: Time 1
T2: Time 2

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