Supporting Family Adaptation to Presymptomatic and ''Untreatable'' Conditions in an Era of Expanded Newborn Screening

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Objective As technology advances, newborn screening will be possible for conditions not screened today. With an expansion of screening, strategies will be needed to support family adaptation to unexpected and possibly uncertain genetic information provided shortly after birth. **Method** Although candidate conditions for expanded newborn screening will typically be associated with increased morbidity or mortality, for most there is no proven medical treatment that must be implemented quickly. Many will have clinical features that gradually emerge and for which the severity of impact is not predictable. Parents will seek guidance on information, support, and treatment possibilities. This article summarizes issues evoked by expanded newborn screening and suggests strategies for supporting families of identified children. **Results** We propose four components necessary to support family adaptation to pre-symptomatic and ''untreatable'' conditions in an era of expanded newborn screening: (1) accurate and understandable information; (2) formal and informal support; (3) active surveillance; and (4) general and targeted interventions. We argue that no condition is ''untreatable'' and that a well-designed program of prevention and support has the potential to maximize benefit and minimize harm. **Conclusions** Pediatric psychologists can play important roles in an era of expanded newborn screening by helping families understand genetic information, make informed decisions about genetic testing, and cope with the potential psychosocial consequences of genetic information.

Key words early identification; family support; newborn screening.

Newborn screening first emerged in the late 1960s when a screening test and treatment became available for phenylketonuria (PKU). Since then, the US has developed a broad state-based program of universal screening, a program that has continued to expand as new laboratory tests have been developed (leading to cheap and accurate identification of various metabolic and genetic disorders), and new treatments have been discovered (leading to reduced morbidity and mortality). Cross-state variability in the number of conditions screened led to a recent task force report recommending that all states screen for 25 conditions and ''report out'' 29 additional conditions that necessarily would be detected because of the technology used to identify the core conditions (Watson, Mann, Lloyd-Puryear, Rinaldo, & Howell, 2006).

Psychologists are rarely involved in newborn screening. Screening is considered to be a public health intervention and typically is done without parental consent. Most screened conditions have dire consequences for children, requiring urgent medical attention. But in the future, psychologists could play a more significant role in newborn screening, especially as screening expands to include a more diverse set of conditions, involves consent (requiring parents to make decisions about the types of information they would like to know about themselves or their child), or conveys information about genetic risk. Newborn screening is a practice context that exemplifies many of the larger issues facing psychologists in a new era of genomic information and technology (Bishop, 2006; Goldsmith et al., 2003; Patenaude, 2003; Patenaude, Guttmacher, & Collins, 2002).

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Introduction

All newborn screening is considered ''pre-symptomatic disease screening'' because the conditions are not discernable using neonatal physical or developmental evaluations. Most screened conditions have treatments known to be effective if provided early. For example, all states screen for congenital hypothyroidism (CH), an endocrine disorder resulting in decreased thyroid hormone production. CH is not obvious at birth, but is reliably detected through newborn screening. Early thyroxine replacement therapy (beginning in the first month of life) prevents otherwise irreversible central nervous system damage and intellectual impairment.

Efficacy of early treatment as exemplified in the case of CH is a long-standing principle underlying newborn screening and genetic testing. In the near future, however, advances in genetic technology will allow for simple and inexpensive screening for large numbers of genetic or chromosomal variations (Hacia & Collins, 1999) and will complicate public health decision making because many will not conform to the traditional standard of ''treatable'' conditions that require early intervention to see results (Green, Dolan, & Murray, 2006). Two examples of such conditions are fragile X syndrome (FXS) and Duchenne muscular dystrophy (DMD).

FXS is an inherited single-gene disorder on the X chromosome that affects the production of FMRP, a protein necessary for normal brain function (Reiss & Hall, 2007). Males with the full mutation typically have moderate to severe intellectual disability and a subset also have autism, seizures, or self-injury. However, several case studies have described males with intellectual ability in the mild or borderline range (Han, Powell, Phalin, & Chehab, 2006). Females with the full mutation are more mildly affected, and perhaps as many as one-half will have borderline or normal intellectual function due to cellular mosaicism and X inactivation (Migeon, 2006). Because most identified cases of FXS start with clinical symptoms, the true incidence rate of ''high-functioning'' individuals with the full mutation is unknown. Carriers are typically asymptomatic, but female carriers are at increased risk for primary ovarian insufficiency (Sherman, 2000) and male carriers for a late-onset tremor/ataxia disorder (Hagerman & Hagerman, 2004). FXS is never identifiable at birth except through DNA testing. Males with the full mutation are typically identified around 3 years of age as a result of developmental delays and behavior problems; females are usually identified later and many are probably never diagnosed (Bailey, Skinner, & Sparkman, 2003). No medical treatment currently exists, although recent theories could lead to targeted pharmacological interventions in the next few years (Bear, 2005).

DMD is an X-linked recessive disorder that results in the absence of the protein dystropin. A degenerative disease that primarily affects males, DMD typically has an onset between 2 and 6 years, and results in a gradual wasting of voluntary muscles. Survival beyond age 30 is rare. DMD is never identified at birth through clinical symptoms. No cure exists; corticosteroids are often used to prolong ambulation, but questions exist about when they should be administered and recent reviews indicate that little data would support the use of steroids before age 5 (Moxley et al., 2005). Ross (2006) points out that almost all children with DMD will have been identified with clinical symptoms by this age.

For both FXS and DMD there is general consensus that early identification has many potential benefits, but the value of newborn screening relative to other identification strategies is debated. If children were screened for these conditions at birth, parents would get information about a genetic or chromosomal variation that (a) is not readily apparent, (b) will range from no expression to severe effects; and (c) may or may not result in a range of secondary conditions. These conditions do not currently have medical treatments that must be provided during the first months of life. Newborn screening could provide parents with information about their child's status as an unaffected carrier of the condition or about their own reproductive risk. Both conditions are inherited and each bears implications for future reproductive risk for identified children.

We have argued that despite the lack of medical treatments, expanded newborn screening for conditions such as these could be justified on the basis of other presumptive benefits, such as psychosocial and educational interventions for children; information and support for families; and a better understanding of the early (presymptomatic) phases of the condition so that the nature and timing of treatments can be determined (Bailey, Skinner, & Warren, 2005). But concerns about expanded newborn screening have been prominent in the literature (Botkin et al., 2006). Some argue that early identification of ''untreatable'' conditions with uncertain impact could lead to heightened anxiety about parenting, oversensitivity to developmental or physical symptoms, or disruptions in parent-infant bonding. Others are concerned that screening could generate information of ambiguous value, identifying children for whom the presence or severity of clinical outcome is uncertain. In a recent paper (Bailey, Skinner, Whitmarsh, Davis, & Powell, 2008), we not only acknowledge the validity of these and other concerns but

also suggest that each could be prevented or at least minimized if screening were done with informed consent and adequate follow-up.

We assume that technology to screen for such conditions will be available in the future (Hacia & Collins, 1999), in state-mandated newborn screening programs, as part of a voluntary second-tier screening, or privately through commercial vendors. Any one of these scenarios raises a fundamental question: *if presymptomatic newborn screening identifies conditions with uncertain impairment and no medical treatment required early in life, what is needed to support identified children and their families?* Following a brief description of current practices we suggest four follow-up components required to support family adaptation to presymptomatic and ''untreatable'' conditions in an era of expanded newborn screening: (a) ongoing access to accurate and understandable information; (b) support from professionals and other parents; (c) active surveillance of child health, development, and behavior; and (d) general and targeted interventions mutually determined by parents and professionals. Psychologists could play important roles in each of these aspects of support. We conclude by arguing that these conditions are not ''untreatable'' and that a well-designed program of follow-up and support has the potential to maximize benefit and minimize harm.

Newborn Screening: Diagnosis and Management

In the 1960s, newborn screening for PKU began in the United States. Since then, the number of conditions detectable through newborn screening has dramatically expanded. However, the basic organization of newborn screening has not changed. Screening is a state public health function. Each state determines which conditions are included, develops screening systems, provides diagnostic confirmation, and starts the process of condition-specific treatment. But states typically rely on medical care providers outside of the public health system for both diagnosis and treatment. Because of the way newborn screening is organized, two important challenges have developed: physicians may not be prepared for providing care for those with a positive (i.e., abnormal) newborn screen and there is no coordinated system for long-term follow-up when a diagnosis is confirmed.

Initial Follow-up after an Abnormal Newborn Screen

Screening begins in the hospital, when blood spots are collected from newborns. These blood spots are sent to a state-designated laboratory, usually a public health laboratory but sometimes a contracted private laboratory. Laboratory results are usually not known until after discharge. All states have systems to assure that families are notified about positive screening results. These systems are based on notifying the child's physician of record, who contacts the family and proceeds with the diagnostic work-up and management. Finding out about a positive newborn screening result, even before confirmation, can be upsetting to a family.

To complicate matters, families often first learn about an abnormal screening result from their child's primary care provider. Since most screened conditions are relatively rare, many pediatricians and family physicians are not knowledgeable about each condition or what steps need to be taken after an abnormal newborn screen (Kemper, Uren, Moseley, & Clark, 2006). The American College of Medical Genetics (2007) has developed materials to help guide this process. State public health officials also are available for consultation in the process of diagnosis and initial management. Data collected by states demonstrate that nearly all children with a positive newborn screen receive timely diagnostic evaluation. However, few data are available regarding how information is provided to families about the meaning of a positive screen. As newborn screening expands, so too does the possibility of more false positive screens (Howell, 2006). Research shows that parents can experience heightened anxiety during the time between a positive screen and a diagnosis verifying whether a condition actually is present (Gurian, Kinnamon, Henry, & Waisbren, 2006; Hewlett & Waisbren, 2006). Assuring high quality information exchange and ongoing supports will be especially critical for those conditions that are currently considered ''untreatable'' to minimize the harm of screening, especially if manifestation of the condition is variable and the possibility of a false positive result grows.

Long-term Follow-up

All of the conditions currently identified through newborn screening are chronic. To maximize the benefits of newborn screening, a coordinated and accessible system is needed to assure appropriate care after diagnosis and throughout the lifespan (Watson et al., 2006). Unfortunately, follow-up after diagnosis is variable, and there is no standard for follow-up care (Hoff, Hoyt, Therrell, & Ayoob, 2006). Ideally, all identified infants should have a medical home to assure appropriate care. The medical home should be family-centered, culturally sensitive, accessible, and play a central role in the coordination of all primary and subspecialty health care

services (American Academy of Pediatrics, 2002). However, there are no data available regarding the degree to which infants identified through newborn screening have such a medical home. Families must also contend with the lack of availability and maldistribution of knowledgeable subspecialists (e.g., geneticists, endocrinologists, and neurologists) (James & Levy, 2006). Similarly, the educational system may not have adequately trained personnel to care for children with rare or specialized needs. Other challenges include transitioning from childhood to adult care services and maintaining health insurance. Insurance may not cover specific health care needs such as pharmacotherapy, durable medical goods, or special therapy (e.g., physical therapy or occupational therapy).

Four Recommended Components of Follow-up

The current state of newborn screening follow-up is not well-positioned to support rapid expansion of the number of conditions screened. But that is partly due to the ''medical emergency'' model on which newborn screening historically has been built (Grosse et al., 2006); follow-up is based on the assumption that urgent medical treatments must be provided in the first few days or weeks of life. The system is ill-prepared to support families of children with conditions such as FXS or DMD for which there is no medical emergency and no medical treatments that must be provided early in life if they are to be effective.

With only a few exceptions (Waisbren, Rones, Read, Marsden, & Levy, 2004), newborn screening has not been discussed in the psychological literature. Psychologists are not part of the normal newborn screening follow-up program, and debates about expanded newborn screening have primarily involved medical geneticists, pediatricians, bioethicists, and health economists. But psychology has a rich history of supporting child and family adaptation and providing assistance with medical decision making. Pediatric psychologists have a unique opportunity to play a key role in newborn screening and in other medical contexts where individuals or families must deal with complicated genetic information or make decisions about screening or treatment options (Patenaude, 2003). Here, we describe four forms of such support that have been well-established as helpful for families and children. These and other forms of support could form the basis for a new model of follow-up in an era of expanded newborn screening.

Ongoing Access to Accurate and Understandable Information

For families the need for information about how to foster their child's health and development and how to access support services is paramount (Bailey & Powell, 2005). With expanded newborn screening, both families' and professionals' need for information will intensify. Newborn screening's disclosure that a child has a genetic or chromosomal abnormality will initiate for many families a long-term search for information. They will want to learn more about (a) the genetics of the diagnosis, its associated symptoms, and prognosis for their child's health and development; (b) reproductive risks for themselves, their children, and relatives; (c) potential treatments and interventions; (d) how to find professionals who are knowledgeable about the disorder; and (e) how to locate and communicate with other families who have children with the same diagnosis. Helping families gain access to accurate and understandable information on these dimensions is an important component of support.

Traditionally, the child's pediatrician or family physician has been a trusted source for medical information, and the child's teacher or early intervention specialist a resource for educational and therapeutic guidance. However, most genetic conditions are rare and general practitioners may have had little if any exposure to a particular condition. They may find themselves in a position of conveying complex genetic information, some of which is ambiguous and difficult to interpret (Hall, Abramsky, & Marteau, 2003; Whitmarsh, Davis, Skinner, & Bailey, 2007). One study of families of children with genetic disorders indicated that parents did not expect their child's teacher or pediatrician to be aware of every rare genetic condition, but they did expect them to be willing to learn more about their child's condition and incorporate that knowledge into how they taught or cared for the child (Skinner & Schaffer, 2006). They also expected ''specialists'' to have more expertise about their child's condition and expressed frustration when they did not (Schaffer, Kuczynski, & Skinner, 2008). Parents sometimes report learning about a disorder from their pediatricians who portray the condition as excessively negative and present misinformation (Whitmarsh et al., 2007). These studies suggest that both generalists and specialists need training on the most appropriate way of sharing information with families.

Families generally are not passive recipients of information, but partners in the communication process and often coproducers of what and how information is

disseminated. One major change in the ways families search for and coproduce information has come about with widespread usage of the Internet. A recent study found that parents who had received genetic counseling considered counseling as only one source of information (Schaffer et al., 2008). Most families used the Internet to supplement or clarify information received from counselors; build up their own scientific or genetic literacy so they could better communicate with service providers; read about research or treatments; and communicate with other families or advocacy groups formed around a specific condition. Through these activities, parents came to value their knowledge of the disorder and their own experiential knowledge of their child. Some of them came to believe they were more knowledgeable than most professionals about their child's condition, and saw their role as educating and negotiating with professionals about appropriate treatments or services.

However, this expertise did not come without costs. As other studies have shown (Hardey, 1999; Taylor, Alman, & Manchester, 2001; Ziebland, 2004), some parents became overwhelmed with information, questioned their ability to understand what they found, or worried that they might miss crucial information if they stopped searching. They found some information ambiguous or suspect, but did not always know how to evaluate it or ascertain if it was from a reputable source. For most parents, the Internet and other sources of information did not take the place of a well-informed medical expert who could help them manage their child's health care and make sense of a wide array of information (Skinner & Schaffer, 2006).

A major challenge is the generally low level of genetic literacy across societies (Johnson, Case, Andrews, & Allard, 2005). With expanded newborn screening, families from a wide range of educational, socioeconomic, and cultural backgrounds will need access to comprehensive, yet comprehensible information in a range of formats on the condition that affects their child. Professionals will need to be more aware of how to share this information with these diverse families. Bailey et al. (2008) point out that lower economic, minority, or immigrant groups may experience less access to genetic counseling and medical specialists with knowledge of the condition, and that these disparities in access may vary across states (Fant, Clark, & Kemper, 2005; Kim, Lloyd-Puryear, & Tonniges, 2003). More research is needed on the informational materials and communication processes diverse families need to make informed decisions about their child's care and health.

Support from Professionals and Other Parents

In addition to information about their child's condition, families will need other forms of support to cope with and use information obtained from newborn screening. A large and expansive body of research consistently shows that families with strong support systems are able to handle challenges more effectively than families with few supports (Horwitz, Briggs-Gowan, Storfer-Isser, & Carter, 2007; Mistry, Stevens, Sareen, De Vogli, & Halfon, 2007). Here, we differentiate support—perceived beneficial emotional and functional assistance provided from a trusted source (c.f., Armstrong, Birnie-Lefcovitch, & Ungar, 2005)—from professional services such as therapy or medical advice.

Professionals can serve as one source of support if their work is family-centered and sensitive to individual family needs and concerns. Unfortunately, a recent survey reported that parents of children with disabilities were least satisfied with their physician's ability to understand the impact of disability on the family or to link them with other families (Liptak et al., 2006). Many publications across a variety of disciplines have advocated that professionals and families would be better off if services were responsive to family needs and supportive of their values and preferences, an approach typically referred to as family-centered (Denboba, McPherson, Kenney, Strickland, & Newacheck, 2006; McWilliam & Scott, 2001; Rondero-Hernandez, Selber, & Tijerina, 2006). Dunst, Trivette, & Deal (1994) suggest that professionals act in supportive ways when they (a) enhance a sense of community so that families feel that professionals care about and support them; (b) help mobilize resources so families have what they need for their child and can proceed with a more normalized family life; (c) assume that program planning and service delivery is a two-way process that calls for collaboration between professionals and families; (d) protect family integrity, respect beliefs and values, and try not to impose goals or services inconsistent with those beliefs; (e) build on family strengths rather than correcting ''deficiencies;'' and (f) solicit family input and organize services to promote family quality of life. A recent meta-analysis of 47 studies concluded that family-centered practices were consistently associated with better outcomes for families, with the strongest relationships found when exchanges between professionals and parents were family-centered (Dunst, Trivette, & Hamby, 2007).

Parents get support from sources other than professionals, and research clearly shows the power of informal supports. Since most conditions screened are rare, parents often want to find other parents who have children with

similar conditions. These interactions can occur spontaneously or almost anonymously, as in the case of Internet conversations or ''virtual communities,'' or more systematically in the form of support groups or parent-to-parent programs (Santelli, Poyadue, & Young, 2001; Skinner & Schaffer, 2006) that pair parents of newly identified children with ''veteran'' parents of children with similar conditions. Parent-to-parent programs can be highly effective, but work best when there is an appropriate match with parent mentors trained and supervised so that the quality of support is high (Singer et al., 1999).

Perhaps the strongest source of support is received from less formal sources—friends, neighbors, family members, or a spouse. Bailey, Nelson, Hebbeler, and Spiker (2007) showed that family and community support for families of young children with disabilities were stronger predictors of family confidence in parenting and optimism about the future than was the quality of professional services. Perceived marital quality and satisfaction with support from one's spouse are consistently shown to be highly predictive of parental well-being, especially for mothers (Kersh, Hedvat, Hauser-Cram, & Warfield, 2006).

In an era of managed care and limited resources for both health care and early intervention services, professionals may not realize the roles they can play in helping families build and strengthen informal supports. However, an extensive body of research has shown that professionals can facilitate family adaptation both directly through formal supports and interventions, and indirectly by using family-centered practices to help families build their own informal support systems (Dunst et al., 2007; Shonkoff, Hauser-Cram, Krauss, & Upshur, 1992; Singer, Ethridge, & Aldana, 2007).

Active Surveillance of Child Health, Development, and Behavior

One historical criterion used to determine whether a condition should be included in newborn screening is that the natural history of the condition should be known (Wilson & Jungner, 1968). Unfortunately, for many conditions understanding natural history and developing treatments cannot occur until a screening test is developed and implemented in a population. Recent reports (Watson et al., 2006) have pointed out these difficulties, particularly for rare conditions where expert opinion represents the entire scope of knowledge about natural history and treatment. There is clearly a chicken-egg problem; using a screening test in a newborn screening program for conditions that have an uncharted course and no known treatment creates a burden for states, pediatricians, and families, but unless newborn screening is initiated, the natural history of a condition may never be known.

Active surveillance of children (periodic screenings or developmental assessment of children) can reassure parents about their child's development and reveal the possible need for services or interventions. Dworkin (2000) describes emerging models of preventive health care that rely on developmental surveillance and anticipatory guidance as two key components. Developmental surveillance entails regular observations of children by knowledgeable professionals. But when children are seen only in pediatric visits or home visits, professionals will not have a representative view of the child's activities of daily living. The value of developmental surveillance can be enhanced when it uses systematic screening and recognizes the value of parents' observations (Glascoe, 2005; King & Glascoe, 2003).

The value of systematic surveillance leading to new treatments is exemplified by sickle cell disease (SCD), a complex condition resulting from the combination of abnormal hemoglobin genes. These combinations cause abnormal concentrations of hemoglobin S that promotes deoxygenation of hemoglobin, leading to a sickling of the red blood cell that ultimately results in vaso-occlusion and organ damage (National Institutes of Health, 2002). Until the early 1980s, SCD was managed symptomatically, with no known cure. However, several states began newborn screening for SCD, which resulted in early, presymptomatic identification (Botkin, 2005). Newborn screening made possible a 15-year natural history study of a newborn cohort, the Cooperative Study of Sickle Cell Disease-CSSCD, (Gaston & Rosse, 1982) that defined the full range of symptoms (Gill et al., 1995), helped identify critical time points for outcomes of SCD (Platt et al., 1994), and ultimately led to the development of new interventions (Armstrong, 2006). The prophylactic use of penicillin was initiated to prevent overwhelming bacterial infection (Gaston et al., 1986), dramatically reducing mortality and changing life expectancy. The CSSCD also tracked cognitive and brain development and established early stroke risk (Ohene-Frempong et al., 1998). Data showing that nearly 22% of the children would have infarction of the blood vessels in the central nervous system by age 15 (Armstrong et al., 1996) promoted the use of transcranial Doppler ultrasound screening and treatment with chronic transfusion (Adams, 2000). Even some children with no obvious abnormalities on magnetic resonance imaging had significant declines in IQ between

age 6 and 16 (Wang et al., 2001). The careful surveillance that followed newborn screening stimulated research to understand disease mechanisms that in turn led to the examination of new treatments such as hydroxyurea (Kinney et al., 1999) and bone marrow and stem cell transplantation (Walters et al., 2000).

By establishing a systematic clinical surveillance system for newborn screening follow-up, not only can the natural history of the condition be described, but also infants and families can benefit from existing services, short and long-term health outcomes can be identified, novel interventions developed, and public policy decision making improved (Howell & Engelson, 2007). Awareness of delays observed in children with various metabolic disorders (Staba et al., 2004) or leukodystrophies (Escolar et al., 2005) has led to aggressive intervention using stem cell transplantation, and continued surveillance of behavior and CNS development using neuroimaging has generated models that may predict later challenges or developmental successes. Such surveillance is critical when a newborn appears typical, yet for whom a developmental process related to a detectable genetic pattern could result in significant developmental delay at some point in the future.

Fragile X exemplifies this issue. With the exception of a few small studies, most of which are retrospective interviews of mothers, the natural history of FXS is not known for the period from birth to recognition of behavioral/developmental symptoms. Careful surveillance that includes tracking observed behaviors, neuroimaging, and biologic markers associated with typical development from birth to onset of developmental symptoms would provide critical natural history data. Surveillance might also provide further insights into mechanisms that result in cognitive impairment, possibly leading to new interventions.

Substantial effort has been devoted to the development of screening tests for genetic conditions, and the sensitivity and specificity of these tests have permitted the expansion of newborn screening panels in many states. However, the emphasis on surveillance, description of natural history, and close follow-up with access to available interventions and supports has not progressed as rapidly as laboratory development of screening tests (Howell & Engelson, 2007). The National Institute of Child Health and Human Development (NICHD) is in the process of establishing a national newborn screening translational research network (NBSTRN) to build the research infrastructure to support all aspects of the newborn screening program. One of the featured objectives of the NBSTRN will be follow-up of screened and treated patients so that the natural history of conditions can be better understood and effectiveness of treatments and long-term outcomes determined (Alexander & Hanson, 2006).

General and Targeted Interventions Mutually Determined by Parents and Professionals

Although most conditions that could be identified through expanded newborn screening will not have unique, condition-specific treatments (as in the case of PKU or CH), this does not mean that such conditions are ''untreatable.'' A wide range of educational and therapeutic interventions and supports are potentially available. A good example of such an approach is the US program of early intervention services for infants and toddlers at risk for developmental disabilities. The 1986 federal law that enabled this system requires that children with an ''established condition'' likely to lead to a delay receive services even if a developmental delay is not yet apparent. While services vary by state, they generally include family support and parent training. There is a broad consensus on the principles that guide this system (Bailey, Aytch, Odom, Symons, & Wolery, 1999; Guralnick, 2005): (a) intervention should support family needs, desires, and priorities; (b) participation is voluntary; (c) services should be individualized and unique to the needs of each child and family; (d) services should fit into family routines and maximize family participation in the community; and (e) intervention should be collaborative and integrated across disciplines.

Much research is needed on issues related to the effectiveness of early intervention. Nevertheless, positive effects of early intervention have been shown for young children with a wide range of delays and disabilities, in most cases irrespective of etiology and severity (Kavale & Forness, 1999). Early intervention can have broad general effects as well as targeted effects on specific domains such as communication (Warren et al., 2006) or motor development (Horn, Warren, & Jones, 1995).

Depending on the goal, there is also evidence that important effects can be obtained with even relatively small amounts of intervention. A good example is the provision of optimal levels of maternal responsivity to children. At the most general level, maternal responsivity refers to a ''healthy, growth-producing relationship consisting of such caregiver characteristics as warmth, nurturance, stability, predictability, and contingent responsiveness'' (Spiker, Boyce, & Boyce, 2002). There is a substantial and growing

body of evidence that cumulative exposure to appropriate levels of maternal responsivity from birth onward is associated with a variety of important child benefits in terms of language, cognitive, emotional, and social development (Landry, Smith, Swank, Assel, & Vellet, 2001). The degree of parental responsiveness has also been shown to be predictive of important outcomes in young children with intellectual and developmental disabilities (Hauser-Cram, Erickson-Warfield, Shonkoff, & Krauss, 2001), including language outcomes for young children with FXS (Warren, Brady, Sterling, & Fleming, 2008). Young children with highly responsive mothers have also been reported to make greater gains to targeted communication interventions (Yoder & Warren, 2001) and in social competence (Baker, Fenning, Crnic, Baker, & Blacher, 2007). Recent research suggests that young children with borderline intelligence, a risk factor for several conditions that could be screened at birth, may be especially at risk for unresponsive parenting, further exacerbating developmental risk (Fenning, Baker, Baker, & Crnic, 2007).

Although fathers play critical roles in child development and family adaptation, the literature has focused almost entirely on the role of mothers in enhancing children's development. Maternal responsivity can be enhanced through relatively modest parent training efforts, often in as few as eight 1-h training sessions (Girolametto, 1988; Wilcox & Shannon, 1998). Reviews of the extant literature indicate that, while results vary in terms of strength of the effect, the evidence supports the premise that interventions designed to improve maternal responsivity can enhance children's language, social, emotional, and cognitive development in substantial ways (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003: Warren & Brady, 2007; Yoder, Warren, McCathren, & Leew, 1998).

While all children are likely to benefit from cumulative exposure to high parental responsivity, many young children with developmental delays are in clear need of specific interventions aimed at motor, sensory, communication, and other skill domains. Individualization is a central tenet of early intervention. The overall effectiveness of many specific intervention approaches remains uncertain (Mahoney, Robinson, & Fewell, 2001), but there is evidence that some targeted interventions achieve clinically significant effects even at low intensity levels. For example, Fey et al. (2006) found in a randomized clinical trial that young children with developmental delays who receive ~1 h per week of direct prelinguistic communication intervention in combination with a modest amount of parental responsivity training showed a significant increase in paralinguistic communication after 6 months. However, more recently Warren et al. (in press) reported that these same children showed no lasting effect of this intervention after it was withdrawn. These results reinforce a central finding of the early intervention literature: the greatest general and specific effects are likely to be achieved when intervention is begun early and continues for at least 1–2 years.

While there is substantial evidence for the general effectiveness of early intervention with children under age 3, much research remains to be done. For example, there has been virtually no carefully controlled research on the effects of different intensities of either general or specific interventions (Warren, Fey, & Yoder, 2007). Many studies have relatively small numbers of children who participate for relatively short amounts of time. Nevertheless, published reports of carefully controlled randomized treatment trials have increased. The primary research focus now is not whether early intervention can be effective, but how it can be optimized. All children, and especially those with borderline and mild delays, can substantively benefit from a cumulative exposure to highly responsive parenting and the rich milieu of learning opportunities this provides (Landry, Smith & Swank, 2006).

Summary and Conclusions

Concerns about the potential risks of screening newborns with conditions that are rare, ill-defined in terms of natural history, or for which there is no current medical treatment have been clearly articulated (Botkin, 2005; Howell & Engelson, 2007). Because of these concerns, it seems logical that the path from genomic discovery to newborn screening should follow a carefully prescribed agenda in which agreed-upon stages of sequential research eventually lead to assurances of safety, efficacy, and acceptability, after which translational efforts (sometimes heroic in scope) are needed to assure that affected individuals benefit from genomic knowledge (Khoury et al., 2007). Nonetheless, there is evidence from a number of conditions that have been included in newborn screening programs that the process of screening often leads, rather than follows, the development of surveillance, understanding of natural history, and the development of effective interventions. Ultimately, such processes are inevitably transactional, as Bishop (2006) argues in demonstrating ways that psychology and genetics can be mutually informative. Throughout this process, families must be key participants in determining how

information is acquired and used, and what expectations for intervention are reasonable.

We suggest that many, if not most, of the concerns about a voluntary expansion of newborn screening can be alleviated if families are provided specific supports, including (a) assuring that they have accurate and understandable information, (b) providing formal and informal support; (c) making it possible for them to participate in active surveillance; and (d) offering them the opportunity to participate in research on general and targeted interventions and providing access to these interventions as they become available. While each of these components represents an area of research focus, they all are part of a larger intervention approach that makes it possible for professionals and families to better deal with the societal, ethical, technological, and logistic concerns associated with emerging newborn screening applications.

There is a substantial opportunity for pediatric child and family psychologists to make significant contributions to alleviating concerns about newborn screening by developing, evaluating, and implementing models of effective and sustained family support. Psychologists could play important roles in helping families understand, cope with, and make decisions based on genetic information or opportunities to learn about genetic status. However, this will require that psychologists themselves understand this information. Although some training programs are now incorporating genetics into the curriculum (Goldsmith et al., 2003), most practicing psychologists have a limited understanding of genetics. Patenaude et al., (2002) recommend that to be effective, psychologists must learn basic principles of genetics, understand the potential psychosocial consequences of genetic testing, and keep up with changes in medical genetics; they suggest revamping competencies expected of psychologists in line with the recommendations of the National Coalition for Health Professional Education in Genetics (Jenkins et al., 2001).

Much of the infrastructure to achieve these recommendations already exists. However, the lack of a national infrastructure for newborn screening means that progress towards improving follow-up will occur on a state-by-state basis (Therrell & Hannon, 2006). Federal leadership and support will be needed to minimize cross-state disparities and standardize follow-up practices (Green et al., 2006). Optimal outcomes can only occur with full implementation of recommended practices such as a family-centered medical home (American Academy of Pediatrics, 2000, 2002) and ongoing developmental screening of all children in pediatric practice (American Academy of Pediatrics, 2001). Incorporating psychologists, developmental specialists, and enhanced developmental services in pediatric care for infants, as exemplified by the Healthy Steps for Young Children program, has been shown to have lasting and positive effects on family satisfaction with care, enhance the receipt of anticipatory guidance, reduce use of severe discipline strategies, and increase the likelihood of reporting a clinical or borderline concern about behavior (Minkovitz et al., 2007). Professional organizations and advocacy groups need support to develop reliably accurate Internet-based resources for families at varying levels of genetic literacy and interests. The trend for states to either eliminate or restrict the ''at-risk'' eligibility criteria for participation in early intervention programs needs to be reversed so that children with genetic variations of unknown severity and their families can participate. Finally, incentives, mechanisms, and supports are needed to assure that the current disparate and uncoordinated array of programs is more fully integrated into an efficient and transparent system of services. This system should be characterized by a family-centered ethic of parent–professional partnerships and cross-agency collaboration that eliminates redundancies, maximizes efficiencies, uses common eligibility criteria and terminology, and provides equitable and affordable access to quality services for all families.

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