REVIEW ARTICLE

Screening in Child Health

Studies of the Efficacy and Relevance of Preventive Care Practices

Peter Weber, Oskar Jenni

SUMMARY

Background: Pediatric screening enables the prevention or early detection of diseases and developmental disturbances in infancy and childhood. Screening is a standard component of pediatric practice in many countries, but its scientific basis is not well known.

Methods: The scientific justification for pediatric screening beyond the neonatal period is presented on the basis of a selective review of the literature on some aspects of pediatric screening.

Results: The level of evidence varies highly among pediatric screening interventions and can be difficult to determine because of confounding variables. Parent counseling is associated with improvements in child-raising competence, accident prevention, and reading behavior. The early detection of abnormalities in a child's motor, linguistic, mental, or social development is possible and often leads to effective early interventions. Cyanotic congenital heart defects can be detected with 63% sensitivity and 99.8% specificity; cerebral palsy can be diagnosed with 33% to 100% sensitivity and 52.3% to 100% specificity (different figures from multiple studies). Physical therapy seems to improve some manifestations of cerebral palsy. Motor development at 90 days is correlated with motor development at 57 months (72% sensitivity, 91% specificity). A developmental quotient above 85 in a two-year-old child is correlated with an intelligence quotient above 85 when the child is 7 years old.

Conclusion: There is an increasing amount of scientific evidence in favor of pediatric screening. Nonetheless, further epidemiological studies are needed.

► Cite this as:

Weber P, Jenni O: Screening in child health—studies of the efficacy and relevance of preventive care practices. *Dtsch Arztebl Int* 2012; 109(24): 431–5.
DOI: 10.3238/arztebl.2012.0431

Pediatric screening examinations are a preventive service that is provided by healthcare systems in many countries (1). In some countries—Sweden and the United Kingdom, among others—pediatric screening is provided by interdisciplinary medical groups, whereas in others—for example, in Germany and Switzerland—primary care providers, such as pediatricians or general practitioners, are responsible for such services (e1). Pediatric screening tests are funded through state subsidies or private insurance schemes.

In Germany, the utilization of pediatric screening tests is high during children's first two years of life but decreases afterwards. According to the Robert Koch Institute's German Health Interview and Examination Survey for Children and Adolescents (KiGGS), it fell from 95.3% in 2003 in the third screening examination (U3) to 86.4% in 2006 in the ninth screening examination (U9) (e2). Because screening rates are not complete, screening examinations cannot be used as instruments in health statistics. Pediatric screening examinations are individual medical measures; however, their epidemiological evaluation is desirable.

In addition to the early detection of diseases and developmental disorders in children, the screening examinations are also useful for providing anticipatory guidance to parents. In this setting, pediatric screening investigations are a combination of different levels of prevention. The question for the evidence base of preventive activities in pediatric practices can therefore not be answered for screening tests in general. Instead, individual services in primary and secondary prevention will have to be assessed separately. The evidence level for individual aspects of screening examinations in children is diverse, partly unsatisfactory and, because of multivariability on the part of the service provider and those receiving the service, it can be investigated only in large epidemiological studies.

Methods

This article summarizes what is currently known for selected areas of pediatric screening examinations. Our aim was to answer the question of how effective and relevant individual early detection and prevention measures are. Vaccinations/immunizations, vitamin prophylaxis, growth monitoring, hip screening, dental health, and early detection of deafness or partial hearing in neonates and infants are excluded from this article; we refer readers to the most recent literature (2).

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We conducted a literature search using the following databases:

- Embase
- PubMed
- Cochrane Database of Systematic Reviews (CDSR)
- Web of Science
- Database of Abstracts of Reviews on Effectiveness (DARE)
- clinicaltrials.gov

The search terms will be included in the individual sections on the screening areas that are discussed in the article. Generally we used the following terms for all screening areas: “primary care”, “well child visit”, “pediatrician practice”, “screening”, “early detection”, “early identification”, “early intervention”, each combined with “meta-analysis”, “systematic review”, “guidelines”, and “recommendation”. Only German-language or English-language articles were included in the review. All available meta-analyses and systematic reviews were used to assess the situation. Where no recent meta-analyses or systematic reviews were available for the years under study (1 January 2006 to 31 October 2011), we evaluated the results of individual studies.

The cited studies enable only conclusions about the effectiveness of the screening instruments used in those studies. The cited studies therefore do not enable any conclusions about the general quality of screening examinations in children in practice.

Anticipatory guidance

We report some of the results from two Anglo-American review articles (1, 2) and evaluated the data on the importance and evidence of anticipatory guidance in pediatric practice by using the key words “anticipatory” AND “guidance” AND “infants” or “children”, combined with “accident”, “prevention”, “read”, “speech development”, “language development”, “sleep behavior”, and “nutrition”.

Several authors have shown that children consult the emergency departments of pediatric hospitals more often and are admitted as inpatients more often if they do not participate in screening programs (60% higher risk, 95% confidence interval [CI] 40 to 90) (e4). The results of a meta-analysis show that, for example, furnishing parents with guidance on how to prevent the risk of injury in the domestic setting significantly reduces the risk of accidents for children (mean risk reduction 18%, 95% CI 5 to 29, in nine randomized studies) (3). However, a limitation of this finding is the fact that only two of the studies included in the meta-analysis were based on interventions in pediatric practices. The remaining studies used a children’s residential home intervention program.

A controlled clinical trial showed a correlation between reducing anticipatory guidance for socially disadvantaged parents with infants in the context of a pediatric screening examination relating to measures to prevent accidents with a higher risk of injury (e5).

However, the effects of intensive guidance on how to prevent accidents are less obvious in families with low income, according to a randomized clinical trial (4). The limitations of accident prevention counseling under the aspect of psychosocial circumstances were investigated in a systematic review (e6). High costs, a lack of understanding of risk mechanisms, individual cultural backgrounds, mistrust of publicly funded programs, and difficult living environments were identified as the most common barriers to effective prevention measures.

A recommendation from a pediatrician to read out loud to preschool children improves children’s language competence. Several studies have shown that delivering books and explaining the importance of reading together in the context of pediatric screening visits resulted in changed reading behaviors (40% of children read more, compared with 16% in the control group) and general improvements in the children’s language/speech development in early childhood (see also the review article by Zuckerman et al. [e7] and [5, e8, e9]). Such measures are particularly important for children from socially disadvantaged families.

Anticipatory guidance during screening examinations increases parents’ educational competencies (6). Two controlled trials—one randomized and one including a historical control group—showed that guidance on the sleeping behavior of infants and provision of information materials in the context of pediatric screening visits improved the children’s sleeping behavior (less nocturnal waking in 36% in the intervention group compared with controls ([e10, e11]).

Nutrition counseling in the context of pediatric screening examinations seems to have a positive influence on children’s dietary habits in the long term and counteract the development of overweight (e12). Expert panels therefore request the implementation of anticipatory dietary guidance in screening visits (7).

Early detection

Pediatric screening provides an opportunity for early detection of physical disorders and developmental processes that deviate from the norm. In the following sections we describe the data for different screening areas.

Additional neonatal screening

According to the circumstances for metabolic neonatal screening, an early detection examination is indicated only if abnormal findings can be collected with a high sensitivity and specificity and differentiated from standard variants, and if effective therapeutic interventions are available. An example for neonates is extending the clinical examination by including pulse oximetry screening, in order to rule out cyanotic congenital heart defects (e13). A meta-analysis of 8 prospective controlled trials including some 36 000 newborns showed a sensitivity in the detection of cyanotic congenital heart defects of 63% (95% CI 39 to 83) and a specificity of 99.8% (95% CI 99 to 100), with a false-positive rate of

0.2% (95% CI 0 to 1) (8). These results have been confirmed in recent prospective studies under routine clinical conditions (e14, e15).

The effectiveness of newborn hearing screening for the purpose of early identification of bilateral hearing disorders—which in 2001 was still the subject of critical debate (e16)—has been confirmed with regard to making an exact diagnosis and effectiveness of early treatment by means of cochlear implants for the child's speech/language development and school development (e3, e17, e18).

Motor development

The objective of early detection of motor abnormalities includes the identification of pathological muscle hypotension as a possible precursor of a developmental coordination disorder (ICD-10 F82) as well as the identification of cerebral palsy (ICD-10 G80–81). The search terms explained earlier were combined for this section with the search terms “developmental coordination disorder”, “benign hypotonia”, “cerebral palsy”, “physiotherapy”.

Most controlled studies of the validity of screening and prognostic importance of early diagnosis of pathological processes in motor development and of the effectiveness of early interventions were conducted in cohorts of premature babies or other high-risk cohorts, such as asphyctic children.

Systematic studies of the accuracy of capturing mild motor developmental disorders in children with an uncomplicated history are scarce. Only very few controlled studies of the subject have been reported (9). A systematic review investigated the predictive relevance of motor oriented investigative instruments in the first few months of life for the detection of cerebral palsy. In the 30 studies that were evaluated in the review, the first evaluation was carried out at a median of 4 months of age (range 26th week of gestation to 12th month of life); the assessment with regard to cerebral palsy was carried out at a median of 24 months of age (range 12th month of life to age 5.7 years). Depending on age and measuring instrument, a sensitivity of 33–100% (median 83.3%) and a specificity of 52.3–100% (median 81%) were observed (10).

This assessment had to be revised later in only 5% of children in whom a diagnosis of cerebral palsy was made during the first two years of life (11). Initial signs can usually be recognized from the 6th month of life (e19). The effectiveness of early initiation of physiotherapy cannot be ascertained conclusively. Physiotherapy is not assumed to prevent cerebral palsy, but it seems to improve individual elements of motor function and strength in affected children (12, 13, e20–e22). All reviews emphasize the need for further randomized controlled trials, especially for specific physiotherapeutic measures. An example of a specific therapeutic method is hippotherapy, which in a meta-analysis was found to have a positive effect size on balance and trunk control (odds ratio 25.4; 95% CI 4.4 to 148.5) (14).

The predictive relevance of standardized motor examinations in infancy and early childhood has been researched only for high-risk groups—for example, babies born prematurely (e23).

Controlled follow-up studies of motor abnormalities detected early on have shown that the natural course of muscle hypotension in infancy is less favorable than is suggested by the term “benign hypotonia in infancy” (9, e24). Standardized motor examination instruments can detect motor abnormalities, which are highly correlated with later deviations in motor development. In a study reported by Kolobe et al. (15), motor development at age 90 days correlated significantly with motor performance at a mean age of 57 months (range 47 to 65 months). Using standardized examination methods showed, at age 90 days, a sensitivity of 72% (95% CI 59 to 83) and a specificity of 91% (95% CI 83 to 99) resulting in a correct prediction of 87% to motor status in the 5th year of life (15).

In a systematic review of the effect of early intervention on motor development, most of the studies showed a benefit for motor quality. However, the authors, Riethmuller et al. (16), pointed out the poor methodological quality of the included studies and the high variability between independent variables taken into account, such as the study participants' age, duration and intensity of the intervention, setting or inclusion of parents in the intervention strategy (16).

Mental development

The search terms explained earlier were combined with the search terms “mental retardation” and “developmental delay”. Although methods of early intervention in mental developmental delay are heterogeneous, their effectiveness for the medium-term cognitive result has been shown. For this purpose, the developmental/intelligence quotient scores of standardized testing methods were determined in the high-risk group of prematurely born children (mean gain in infancy of 0.42 standard deviation points [95% CI 0.33 to 0.52; $p < 0.001$] and in toddlers of 0.46 standard deviation points [95% CI 0.33 to 0.59; $p < 0.001$]) (17) as well as in children without particular risk factors (18). The increase in the IQ score in the long-term observation up to school age did not reach significance (increase by 0.02 standard deviation points; 95% CI –0.1 to 0.14; $p = 0.71$). In sum, early intervention in this area can be assumed to be evidence based (19, e25).

The question of what the best diagnostic instruments are poses a problem. Earlier studies showed that clinical assessment alone does not have a high enough sensitivity in detecting a mental developmental disorder, and that using standardized developmental tests contributes to improving the detection rate of mental developmental delays (20, e26). This means that standardized developmental diagnostic methods should be available in (pediatric) clinical practice. Most development tests have sufficient sensitivity and specificity, of 70% to 90% (21). Their prognostic importance in the speech/language and cognitive areas is high. Of

children who have reached a developmental quotient score of >85 by the age of 24 months, 98.6% will have an intelligence quotient score of >85 by the age of 7 years (e27). In spite of appropriately supported recommendations, such methods find too little use in pediatric clinical practice, at least in the USA (e28), even though their increased use (22) as well as their feasibility and effectiveness in the context of outpatient practice have been confirmed (23, e26). Using standardized developmental tests in pediatric screening examinations is potentially associated with a primary increase in costs (e29).

Using standardized questionnaires is a relatively cost-saving method to capture a developmental delay (e29). Improvements to making a diagnosis by using standardized questionnaires, rather than standardized developmental tests, are the subject of controversy (e30, e31).

Language/speech development

For this section we used the search terms mentioned earlier, combined with the search terms “language disorder” or “speech disorder”.

Language/speech as an expression of cognitive and social development is a key characteristic in children’s development. Even though studies of speech melody (intonation) and phonological awareness have shown that children at risk of a delay in speech/language development can be identified as early as in their 1st year of life—the age of pre-verbal speech development—the assessment of speech/language development is included in the range of pediatric screening examinations only from the age of 15 months. Depending on the study, 2% to 20% of children are affected by a delay in speech/language acquisition (e32). Thus far it has not been satisfactorily documented in speech/language development screening that using standardized screening instruments—for example, defined parental questionnaires such as FRAKIS (*Fragebogen zur frühkindlichen Sprachentwicklung*, a questionnaire on speech/language development in early childhood) or ELFRA (*Elternfragebogen für die Früherkennung von Risikokindern*, a questionnaire for parents on the early detection of at-risk children)—is superior to pediatricians’ individual examination methods. It is important to consider a child’s medical history as reported by the parents and all receptive and expressive speech dimensions (prosody, semantics, lexical comprehension, syntax) (e33).

Early speech therapy partly improves the expressive power of speech with effect sizes for phonology of 0.44 (95% CI 0.01 to 0.86), for vocabulary of 0.98 (95% CI –0.59 to 2.56), and for syntax of 0.7 (95% CI –0.14 to 1.55) (24). More intensive and longer interventions have greater effect sizes. The therapeutic effect with regard to receptive specific developmental disorders with effect sizes for phonology of 0.53 (95% CI –0.01 to 1.16) and for syntax of –0.04 (95% CI –0.64 to 0.56) is, however, uncertain, as is the effect of active therapeutic inclusion of the parents (25, e34).

Childhood socioemotional development

We additionally used the search terms “autism”, “behavioral disorders”, “internalizing disorders” and “externalizing disorders”.

Early symptoms exist in early childhood autism (e35–e47) and externalizing and internalizing behavioral disorders (e48–e52) that enable early diagnostic evaluation in the context of screening examinations. The effectiveness of early interventions for these developmental areas is well documented.

Conclusion

Pediatric screening examinations are important because they enable the early identification of abnormal developmental processes and therefore the early initiation of interventions whose effectiveness in many areas is evidence based. Specialists in pediatric and adolescent medicine train mainly in hospitals, often in hospitals providing the complete range of clinical medical services, where no screening examinations are carried out. In Switzerland, the Swiss institute for medical education (Schweizerisches Institut für ärztliche Weiter- und Fortbildung, SIWF), the professional association of pediatricians in Switzerland (Berufsverband der Schweizer Kinderärztinnen und Kinderärzte), and the Swiss Society of Pediatrics (Schweizerische Gesellschaft für Pädiatrie) have acknowledged this situation by making participation in systematic further medical training courses in developmental pediatrics obligatory for all doctors, which includes specific seminars on screening examinations. Furthermore, in 2010 The SIWF established “developmental pediatrics” as a new thematic priority in pediatric and adolescent medicine. In our opinion, this new focus does not only contribute to improved practical clinical healthcare in the area of pediatric prevention but also forms the basis for intensified research into the subject area of screening examinations.

Conflict of interest statement

Professor Weber has received honoraria for acting as an adviser from Lilly and for speaking from Desitin, Lilly, and Janssen-Cilag. He has received author fees from Mepha-Pharma and attendance fees for conferences/educational events from Lilly and UCB Pharma.

Dr Jenni declares that no conflict of interest exists.

Manuscript received on 26 April 2011, revised version accepted on 17 April 2012.

Translated from the original German by Dr Birte Twisselmann.

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KEY MESSAGES

- The uptake of screening examinations in children is satisfactory in the first two years of life but drops afterwards.
- The evidence level of the different aspects of pediatric screening examinations is heterogeneous—further epidemiological studies are needed.
- Anticipatory guidance during screening examinations has been shown to improve parents' educational competencies and to have positive effects on several areas such as accident prevention, speech/language competence, sleep behavior, or prevention of obesity.
- For many developmental areas, early detection of abnormalities is possible by means of pediatric screening, especially when standardized examination instruments are used. This enables effective early intervention.
- Training in how to carry out and evaluate screening examinations should be part of specialist medical training in pediatric and adolescent medicine.

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