Incorporating Longitudinal Surveillance Into the Delivery of Pediatric Screening Services

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Screening activities aim to identify well-defined diseases at a time when early or presymptomatic identification could lead to better health outcomes compared with identification after symptoms become apparent. For example, newborns are screened for congenital hypothyroidism because they are usually asymptomatic at birth and early detection allows for thyroxine treatment before signs or symptoms develop, leading to the prevention of significant intellectual disability.1 Screening recommendations are formulated around specific conditions with highly specified algorithms and follow-up recommendations for those identified through screening as having the targeted condition.

The primary source of preventive services recommendations followed by pediatricians is the American Academy of Pediatrics Bright Futures periodicity schedule, which outlines the specific services to be included as part of routine preventive care for children and adolescents.2 The periodicity schedule includes the recommendations for routine screening (ie, A or B recommendations) from the US Preventive Services Task Force (USPSTF)3 and other recommendations endorsed by the American Academy of Pediatrics, including some screening services for which the USPSTF either has not evaluated or found insufficient evidence to evaluate (ie, I statement). Examples of periodicity schedule recommendations with a USPSTF I statement include screening for autism spectrum disorder, developmental screening, lead screening, and screening for dyslipidemia. The periodicity schedule does not include any preventive services that the USPSTF has recommended against (ie, D recommendations).

Screening for targeted conditions at prescribed age intervals is appealing because it facilitates and standardizes the implementation of these preventive services into practice. By screening for only 1 condition or group of closely related conditions at a time, the steps needed in follow-up are usually clear. Most screening tests yield only either positive or negative results, making it easier for busy clinicians to know what to do next and facilitating tracking for patient management or quality improvement activities. Results that do not cross a predefined threshold, even if close, are not considered to be abnormal. In this paradigm, screening tests that are repeated at different ages are usually not interpreted with respect...
to a previous negative screening test result. For example, a blood lead level measured at 24 months of age that is above the reference value (5 \( \mu g/dL \)) is elevated, regardless of the blood lead level at 12 months of age.\(^4\)

This dichotomized approach based on screening results at a single point in time also simplifies the approach to analyzing the effectiveness of screening interventions. Most screening studies are cross-sectional. Such studies typically evaluate test characteristics (eg, sensitivity, specificity) by comparing the results of a screening test to a diagnostic standard conducted at the same time or shortly after the screening test. The impact of screening is often inferred through other observational studies in which some subjects were detected early through screening and other subjects were detected through usual clinical care after signs or symptoms developed. Considering trends over time in screening values and the development of condition would require longitudinal studies that would be significantly more complex.

**AN OPPORTUNITY TO IMPROVE SCREENING RECOMMENDATIONS**

A hallmark of pediatrics is the evaluation of the complex developmental and physiologic changes that patients experience as they age. Astute clinicians synthesize their knowledge of an individual’s physical, cognitive, behavioral, and social development to personalize the care to patients who they have known over time. A key feature of *Bright Futures* guidelines\(^5\) beyond the periodicity schedule is the importance of monitoring patterns over time, also referred to as surveillance. Surveillance is an assessment of deviation from the expected trend in development based on population-level expectations or the individual’s previous trajectory. Neither the USPSTF recommendations nor the periodicity schedule incorporates surveillance into their screening recommendations. We reviewed USPSTF recommendations for routine screening and the I statements to identify screening recommendations that could potentially be enhanced by including aspects of surveillance and trending.

**USPSTF Recommendations for Routine Screening**

The USPSTF recommends screening for obesity in children and adolescents \( \geq 6 \) years of age to identify those with an age- and sex-specific BMI at or above the 95th percentile.\(^6\) This is the most straightforward example of how surveillance can change how screening results are interpreted. Although the USPSTF recommendation does not provide a screening interval because of insufficient relevant studies, it does recognize that height and weight are routinely measured as part of routine preventive care.\(^6\) There was no consideration of trends in the BMI percentile below the 95th percentile as an indicator of obesity risk. By applying concepts of surveillance, instead of using a fixed threshold for identifying obesity, a child could be considered to have a positive screen result if the growth trajectory suggests that the child was on course to cross the 95th percentile on the basis of the BMI slope. This approach would lead to earlier initiation of treatment and could change the recommendation to focus more on screening for primary prevention.

The USPSTF recommended screening adolescents aged 12 to 18 years for major depressive disorder but was not able to include specific recommendations regarding a screening interval.\(^7\) Compared with screening for obesity, it is more complex to apply the concept of surveillance to depression screening because there are no defined trajectories related to depression. None of the 5 screening studies included in its review considered repeat screening over time.\(^8\) However, depression symptoms can grow and remit over time\(^9\) and interventions such as collaborative care can be effective for depressed adolescents who do not meet the criteria for major depressive disorder. Future research to better understanding patterns of depression, the implications of a subthreshold screening result, and trends over time in screening results could better inform the optimal cadence of screening and identify opportunities to study novel preventive interventions.

**USPSTF I Statements**

One important area in which the periodicity schedule and USPSTF recommendations diverge is related to developmental screening. The periodicity schedule recommends that pediatricians consider many different aspects of cognitive and social development together, combining surveillance with repeated use of broadband screeners. When development is not consistent with the expected pattern, a more complete evaluation is conducted, which can then identify a wide range of specific developmental problems. This approach is significantly different from how the USPSTF considers screening, in which specific screening tests are evaluated for a well-defined group of conditions.

The only 2 aspects of child development that the USPSTF has evaluated is speech and language delay or disorders and autism. Both of these are I statements. For speech and language delay or disorders, the USPSTF found gaps in evidence
related to the accuracy of the screening tests in primary care and the benefit of identification through screening. Autism screening, which is specifically included in the periodicity schedule, did not receive a positive recommendation from the USPSTF because of a lack of evidence that identification through screening would lead to improved outcomes compared with when children might be identified on the basis of the concerns of caregivers or clinicians. There are often subtle findings suggesting developmental problems, such as the speed at which milestones are obtained or subtle developmental regression occurs. Because of the heterogeneity and complexity of developmental disorders and variations in the approach to identification and diagnosis, only longitudinal studies of large populations of children can be used to evaluate the effectiveness of different strategies of screening and surveillance on improving meaningful long-term outcomes. Until such studies are available, incorporating surveillance into practice for autism and other developmental problems could allow for shared decision-making regarding the need for and timing of referrals for subspecialty care and community-based interventions.

The USPSTF found insufficient evidence regarding screening for elevated blood pressure, elevated lipid levels, and obesity among children ≤5 years. The overarching goal of screening for these 3 conditions is to decrease the risk of future adverse cardiovascular outcomes; however, each one was considered separately by the USPSTF. Each of these 3 screening tests also yields continuous measures. Integrating these measures together over time might allow clinicians to provide different levels of intervention on the basis of risk, trajectories, and patient preference. As with the detection of developmental conditions, developing this approach to reducing cardiovascular risk would need large-scale longitudinal research.

CONCLUSIONS
The current approach of considering screening tests for specific conditions in isolation as dichotomous outcomes without reference to previous results has the advantage of being easy to implement in busy clinical settings. However, this simplification also likely misses a tremendous opportunity to improve health outcomes by tailoring interventions, taking into account the relationships among health conditions, the continuous nature of many screening tests, and the complex process of child and adolescent development. We believe that future research to evaluate how to use repeated continuous measures over time would benefit child and adolescent preventive services delivery is needed. A first step would be to leverage large data sets of electronic medical records to link groups of measures with relevant outcomes. Simulation research could inform the impact of moving from a screening to surveillance model of care delivery. Ultimately, however, we believe that future prospective studies of clinical preventive services should specifically include consideration of surveillance trends over time.

ABBREVIATION
USPSTF: US Preventive Services Task Force

REFERENCES


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