Interventions to Improve Screening and Follow-Up in Primary Care: A Systematic Review of the Evidence

Jeanne Van Cleave, MD; Karen A. Kuhlthau, PhD; Sheila Bloom, MS; Paul W. Newacheck, DrPH; Alixandra A. Nozzolillo, MS; Charles J. Homer, MD, MPH; James M. Perrin, MD

From the Center for Child & Adolescent Health Research and Policy, MassGeneral Hospital for Children (Drs Cleave, Kuhlthau, and Perrin and Ms Bloom and Nozzolillo), National Initiative for Children's Healthcare Quality (Dr. Homer), Department of Pediatrics, Harvard Medical School (Drs. Van Cleave, Kuhlthau, Homer and Perrin), Boston Mass; and Philip R. Lee Institute for Health Policy Studies, University of California San Francisco (Dr Newacheck)

Address correspondence to Dr. Jeanne Van Cleave, MD, MassGeneral Hospital for Children, Center for Child & Adolescent Health Research and Policy, 15th floor C100, 100 Cambridge St, Boston, MA 02114 (e-mail: jvancleave@partners.org).

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ABSTRACT

BACKGROUND: The American Academy of Pediatrics and other organizations recommend several screening tests as part of preventive care. The proportion of children who are appropriately screened and who receive follow-up care is low.

OBJECTIVE: To conduct a systematic review of the evidence for practice-based interventions to increase the proportion of patients receiving recommended screening and follow-up services in pediatric primary care.

DATA SOURCE: Medline database of journal citations.

STUDY ELIGIBILITY CRITERIA, PARTICIPANTS, AND INTERVENTIONS: We developed a strategy to search MEDLINE to identify relevant articles. We selected search terms to capture categories of conditions (eg, developmental disabilities, obesity), screening tests, specific interventions (eg, quality improvement initiatives, electronic records enhancements), and primary care. We searched references of selected articles and reviewed articles suggested by experts. We included all studies with a distinct, primary care-based intervention and post-intervention screening data, and studies that focused on children and young adults (≤21 years of age). We excluded studies of newborn screening.

STUDY APPRAISAL AND SYNTHESIS METHODS: Abstracts were screened by 2 reviewers and articles with relevant abstracts received full text review and were evaluated for inclusion criteria. A structured tool was used to abstract data from selected articles. Because of heterogeneous interventions and outcomes, we did not attempt a meta-analysis.

RESULTS: From 2547 returned titles and abstracts, 23 articles were reviewed. Nine were pre-post comparisons, 5 were randomized trials, 3 were postintervention comparisons with a control group, 3 were postintervention cross-sectional analyses only, and 3 reported time series data. Of 14 articles with preintervention or control group data and significance testing, 12 reported increases in the proportion of patients appropriately screened. Interventions were heterogeneous and often multifaceted, and several types of interventions, such as provider/staff training, electronic medical record templates/prompts, and learning collaboratives, appeared effective in improving screening quality. Few articles described interventions to track screening results or referral completion for those with abnormal tests. Data were often limited by single-site, nonrandomized design.

CONCLUSIONS: Several feasible, practice- and provider-level interventions appear to increase the quality of screening in pediatric primary care. Evidence for interventions to improve follow-up of screening tests is scant. Future research should focus on which specific interventions are most effective, whether effects are sustained over time, and what interventions improve follow-up of abnormal screening tests.

KEYWORDS: mass screening; physician's practice patterns; preventive health services; quality of health care

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THE PREVENTION OF mortality and morbidity secondary to many conditions depends on effective screening and referral procedures in pediatric primary care.[1] For many conditions, such as iron-deficiency anemia, autistic spectrum disorder, and vision and hearing problems, early detection from broad-based, primary screening with timely follow-up care enables children with these conditions to receive treatment that affects long-term health outcomes. The American Academy of Pediatrics, *Bright Futures*, and other organizations recommend screening procedures for several specific conditions.[2,3]

Although many children receive some screening via public health or school-based mechanisms, most screening beyond the newborn period occurs within the context of the primary care office at well-child visits. Even with clear, readily-accessible recommendations, quality of screening in primary care is suboptimal,[4] leaving children at risk when conditions are not identified. Reasons for this quality gap include lack of knowledge of recommendations,[5,6] presumed patient refusal,[5] lack of time,[6] lack of office staff support,[6] inadequate reimbursement,[7] and inadequate referral resources for those found to have a problem detected through screening.[7]

Several interventions have potential to improve screening in primary care settings[8] and have been studied to some extent in adults.[9] However, which practice-level

interventions are most effective for improving screening in pediatric primary care is not known. Interventions in pediatrics may have a different impact compared with adult populations, for several reasons.[10] First, children generally seek health care and make decisions through a proxy, usually a parent. Second, children undergo more rapid developmental changes, and screening recommendations change with each well-child visit. Third, most conditions for which children are screened are not thought of as potentially life-threatening, in contrast to cancer screening in adults, which may affect the importance providers and parents place on screening in children. Examining interventions that improve receipt of recommended screening in pediatrics may help physicians and policymakers identify changes most likely to benefit a broader population and may inform a research agenda to address questions about how to improve the quality of screening in pediatric practices.

We undertook this systematic review as part of a larger project to examine evidence regarding 6 core objectives of the Maternal and Child Health Bureau[11] for care for children with special health care needs. Previously, we reviewed the evidence regarding receipt of family-centered care[12] and services to transition to adult providers[13]; having a medical home[14]; and having adequate health insurance coverage.[15] We now review evidence for the objective that all children are screened early and continuously for special health care needs. Because high-quality screening in primary care is necessary for this objective, we focused our review on office-based interventions to increase the proportion of children receiving recommended screening. Our specific research question was, what is the evidence for interventions to improve such screening in primary care settings? As a secondary objective, we also examined interventions to improve follow-up or referral completion, once screening tests identified concerns.

METHODS

To guide our search strategy (Table 1) (Appendix), we constructed a logic model (Fig. 1)[16] that depicts the health conditions for which screening tests are recommended, interventions, and outcomes of interest. In developing and refining the model, we held a conference with relevant experts, including policymakers, family advocates, and researchers in the field of improving care for children with special health care needs. The purpose of this panel was to guide the systematic reviews around the Maternal and Child Health Bureau core objectives, and the panel discussed and made recommendations for our logic model and search strategy.

SCREENING TESTS

To select the screening tests and corresponding specific conditions for inclusion in our search, we reviewed recommendations for preventive care screening from Bright Futures/American Academy of Pediatrics, the U.S. Preventive Services Task Force, and the Centers for Disease Control. We selected screening tests for conditions such as developmental delay, mental health conditions, vision problems, hearing problems, lead poisoning, anemia, hypertension, sexually transmitted infections, and obesity. We did not include conditions detected by newborn screening or prenatal screening because testing procedures and much of the follow-up occurs not in primary care but in hospitals and in conjunction with state public health authorities.

INTERVENTIONS

We chose search terms to capture primary care interventions designed to improve receipt of recommended screening and follow-up. Specific activities were derived from a review of the literature of interventions to improve

Table 1. Specific Search Terms to Identify Articles Testing Practice-Based Interventions to Increase the Quality of Screening In Pediatric Practices*

Screening/Specific Disorders	Setting	Interventions/Outcomes
Mass screening	Primary health care	Physician's practice patterns
Population surveillance	Community health centers	Child health services
Preventive health services	Managed care programs	Medical records systems, computerized
Child development	Group practice	Decision support systems, clinical
Developmental disabilities		Information systems
Language disorders		Education, medical
Child behavior disorders		Education, medical, continuing
Cerebral palsy		Insurance, health, reimbursement
Autistic disorder		Total quality management
Mental retardation		Quality assurance, health care
Vision disorders		Referral and consultation
Hearing loss		Primary prevention
Lead poisoning		Health care disparities
Anemia		Health care costs
Iron deficiency		Quality of health care
Hypertension		Outcome assessment
Obesity		Process assessment
Depression		
Tuberculosis		
Sexually transmitted infections		

*In PubMed, language was limited to "English" and population was limited to "All child: 0−18 years".

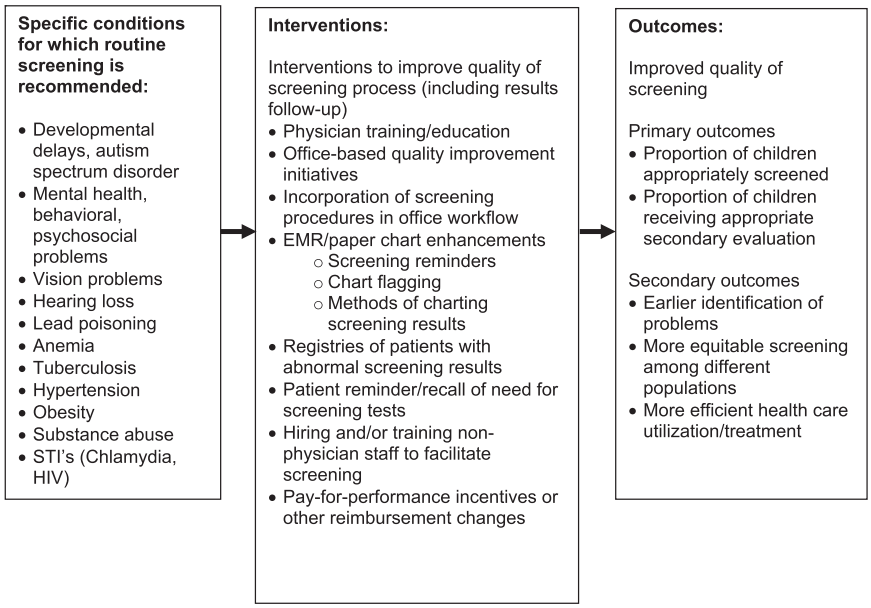

Figure 1. *Logic model for core objective: practice-based interventions to improve screening.*

quality of other functions of primary care practices (eg, vaccination) and recommendations from our expert panel.

Interventions included practice-level initiatives such as provider/staff education sessions and materials, quality improvement initiatives, and improvements in office workflow. Our search included interventions to improve patient identification for screening, particularly changes that led to automated identification, such as chart flagging, electronic medical record (EMR) reminders, and patient registries. We also searched for interventions that involved pay-for-performance initiatives targeted toward screening.

Outcomes

Our primary outcomes were the proportion of children appropriately screened and proportion of children with abnormal screening results who received follow-up care. Appropriateness of screening was determined by the individual studies. Because follow-up care can vary among patients as the result of family preferences and available referral options, we broadly defined follow up care as any action by the provider that would advance a plan for additional screening, evaluation or treatment prompted by an abnormal result. This definition included discussing abnormal results with parents and patients, retesting patients, and referring to specialists or community resources for further treatment or evaluation. We also included search terms to capture secondary outcomes derived from the Institute of Medicine domains of health care quality.[17]

Database Search

We conducted a systematic search of Medline (Jan 1961−Aug 2010) for titles and abstracts relevant to our research question. We queried for articles containing MeSH terms in each of the columns in Table 1, that is, containing terms that represented a condition, a setting, and an outcome/intervention. We also reviewed bibliographies of selected articles, as well as bibliographies of review articles related to our search. For the bibliography reviews, when we found a potentially relevant title that was missed during the previous search, we obtained the article's Medical Subject Heading (MeSH) terms from the Medline citation to determine why the article was missed. We then refined the search to include omitted MeSH terms, reran the search and reviewed the additional abstracts. We limited our search to English-language articles studying children and youth ages 0 to 18 years.

Selection of Articles

Two reviewers (J.V. and A.A.K.) screened titles and abstracts for inclusion in the group of articles for full-text review. Abstracts were selected if the study examined a recommended screening practice and the study was performed in a primary care setting in the United States. Some returned studies included both adults and adolescents, and we included articles if >50% of participants were under age 21 years. Abstracts that lacked detail to make this determination also underwent full-text review. If the abstract was not appropriate for inclusion in the review but possibly referenced relevant articles, the full-text version was obtained and the bibliography scanned. The reviewers met to resolve discrepancies by discussion and mutual agreement. Each reviewer then abstracted a subset of articles with the use of a structured form to report interventions, populations, settings, and outcomes.

After abstraction, reviewers finalized the list of articles to be included in the review through discussion and agreement. Reviewers overlapped on a random selection of approximately 20% of abstracted articles. Abstractions were qualitatively reviewed to assess for agreement, and abstracted screening rates and descriptions of the interventions were verified through a second review of the full text articles. We did not contact authors of the studies for further details. No formal assessment of study quality

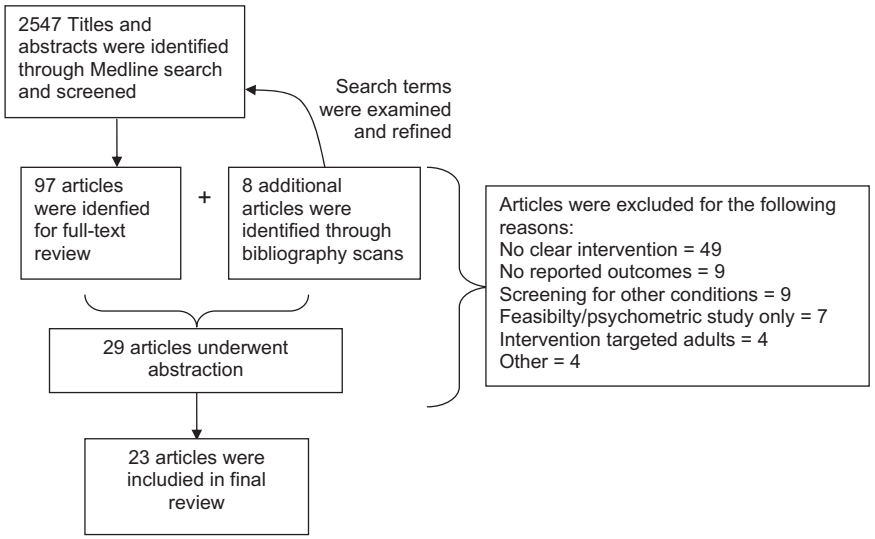

Figure 2. *Flow of titles, abstract, and articles included in review.*

was done with standardized tools, but we grouped studies using a hierarchy of study design quality (eg, randomized controlled trials, designs with control groups, and uncontrolled studies) and reported elements of potential bias in our description of the studies.

Specific Categories of Excluded Studies

We excluded studies to validate screening tools and studies that documented poor-quality screening or follow-up without interventions. We also excluded studies that assessed only feasibility of screening in primary care practices without specific attention to long-term, generalizable changes within the practice (eg, studies where the intervention was limited to research assistants performing screening procedures). We excluded articles that lacked explicit outcomes related screening or follow-up care.

Results

The final search strategy identified 2547 titles (Fig. 2). After we reviewed titles and abstracts, 105 articles underwent full-text review. Eight articles that underwent full-text review initially were identified from bibliographies of selected articles. Reviewers completed data abstraction for 29 of the 105 full-text articles. Of these 29 articles, 23 met criteria for inclusion in the final review (Table 2).[18–40] Common reasons for exclusion were because no intervention was tested, the proportion of patients screened was not measured, or the patient population was primarily adult-aged. The included 23 articles were 5 randomized controlled trials and 18 observational studies. Among the randomized trials, the practice was usually the unit of randomization. Among the observational studies, 9 used pre-post designs, 3 were postintervention comparisons with a concurrent control group, 3 reported findings using time-series design in which the outcome was measured at regular intervals after the intervention was initiated, and 3 were postintervention, cross-sectional analyses with no comparison group. The diversity of interventions and outcomes prevented any meta-analysis.

Types of Interventions

The studies described several different types of interventions. The most common interventions were 1) changes to office systems, usually part of a formal quality improvement program such as a learning collaborative; 2) physician and staff education, sometimes facilitated by a physician championing a specific screening test; 3) electronic medical record enhancements (eg, prompts); and 4) distribution of additional tools for physicians to use when screening or counseling patients. Many studies combined intervention types. In some studies in which several practices were enrolled in a quality improvement initiative, specific changes were chosen by each practice. In several studies, quality of preventive care screening was measured along with other preventive care outcomes (eg, immunizations, preventive care visit attendance, etc).

Twelve articles from 10 separate studies[18–29] used interventions based largely on learning collaborative methods, including plan-do-study-act cycles and facilitated contact with other intervention practices. Typically, small teams of practitioners and staff from intervention practices addressed barriers related to office system design, provider and staff knowledge gaps, and workflow. Specific changes included chart flagging or routine chart review by nonphysician staff to identify patients behind in testing. For some studies, multiple practices participated, multiple screening tests and other preventive care elements were targeted for improvement, and practices were at liberty to choose from several recommended changes those they deemed most likely to work in their practice. Thus, the specific changes associated with the global intervention varied among individual practices. Postintervention screening ranged from 39% to 94% of patients screened appropriately. Improvement from baseline varied widely, from 0% to 80%. Improvement tended to be greater if preintervention screening was low or nonexistent and if the focus of the intervention was narrowed to specific screening tests or a specific area, such as the study reported by King et al. from a learning collaborative on developmental screening and services.[24]

Five articles[30–34] described interventions to implement screening using provider training and/or tools for facilitating conversations with parents, such as provider sheets to prompt screening questions or patient questionnaires. These interventions focused on screening for obesity, developmental or mental health problems, or adolescent risky behaviors. Post-intervention screening ranged from 28% (for BMI calculations)[32] to 94% (vision screening).[34]

In 2 articles[35,36] investigators examined associations between implementing the Healthy Steps program and screening. Healthy Steps is designed for first-time parents and provides co-located developmental specialists to enhance well-child visits.[35] Parents also receive home visits, telephone access for developmental questions, written materials, and linkages to community resources. Screening of patients enrolled in Healthy Steps was compared to screening of same-aged patients not enrolled in Healthy Steps (eg, second-born children) after implementation. Screening for lead poisoning and anemia did not markedly change, but developmental screening doubled, from 41% to 43% to 82% to 84%.

In 3 studies[27,37,38] investigators examined the effect of EMR enhancements, such as EMR templates and reminders, with varying results. With EMR templates to prompt providers to elicit developmental concerns, screening improved to 65% to 73% of patients for various areas of development, which were significant increases from baseline.[37] EMR reminders enabled near universal screening (99%) of patients if providers were able to obtain lead levels at the visit, but only 41% for patients required by insurance to have levels drawn off-site.[38] For Chlamydia screening, reminders had no effect compared with patient charts without reminders.[27]

In 2 studies,[39,40] a nurse and a nurse practitioner were employed to identify and track patients in need of screening. Both interventions involved protocols for identifying and tracking which patients were due for testing or follow up of abnormal tests. Hull et al[39] found that a nurse-driven protocol to identify and screen patients was highly effective and achieved essentially universal screening in one practice. Block et al[40] found that a similar intervention achieved improved documentation of a follow up plan for elevated lead levels, but smaller improvements for follow-up testing and parent education.

Interventions to Increase Follow-Up of Abnormal Screening Results

We found little evidence about interventions to improve post-visit follow-up or referral completion once screening tests identified concerns. As mentioned, Block et al[40] examined the effect of a nurse-driven protocol to increase retesting and parent education for abnormal lead levels. Retesting increased to 65% of those with abnormal levels, and 32% of families with persistently high levels received education. In 2 other studies[31,33] investigators examined discussions with patients and parents after screening tests for behavior problems or risky behaviors. In both studies, they found that patient/provider handouts facilitated a discussion of problems detected when formal assessment tools were used. Schonwald et al.[30] demonstrated that referrals for developmental evaluation remained the same, despite increases in the use of formal screening tools.

Discussion

Three key findings emerged from this review of interventions to improve the quality of preventive care screening in pediatric primary care settings. First, most studies reported improved quality of screening after intervention, usually a modest improvement, although differences varied across and within studies. Second, because of these varying findings, heterogeneous interventions, and relatively few studies with control groups, we could not discern whether a particular type or form of intervention was superior for improving screening. However, we saw patterns in which successful interventions tended to emphasize collaborative learning, office-systems changes, and tracking progress over time. Third, we found few interventions that aimed to improve follow-up of abnormal screening results, which offers opportunities for further investigation.

From the articles reviewed, we found screening in pediatric offices generally improved after interventions were implemented. In studies in which pre- and postintervention outcomes with statistical testing were reported, more than 80% of interventions demonstrated improvement in at least one area of screening. However, results varied, ranging from no change to an 8-fold increase in the proportion of children screened, and many studies could not control for secular trend with their study designs. The magnitude of the impact of interventions seemed greater when preintervention screening was low and multifaceted interventions implemented through a learning collaborative structure appeared to be, of all intervention types, more robustly studied and relatively effective. Otherwise, this review identified little regarding the patterns of variable effects or reasons for them, including type of screening or type of intervention. In addition, results varied among practices implementing similar interventions; even when an intervention was introduced in multiple practices as a single study, effects typically varied from practice to practice. No study objectively measured contextual factors (eg, practice's motivation to change, staff capacity for the intervention), although some studies included qualitative discussion on contextual reasons for variability in findings across practices (eg, physician champion left the practice).

With the exception of 4 studies, fewer than 85% of patients were appropriately screened postintervention, with most studies reporting postintervention screening between 50% and 75%. This finding, which mirrors findings in adult studies,[41] suggests that some patients miss screening despite often intensive office-based improvements. Studies in our review that examined characteristics of patients who were not screened found various associations with less screening, including non-English speaking parents, parents who did not have time to complete the screening tool before seeing the physician, and having to

Table 2. Interventions to Improve Screening and Follow-Up of Abnormal Screening Tests in Pediatric Primary Care, by Type of Study Design

Author, Year, Design	Condition(s) Being Screened and Screening Test(s)	Preintervention or Control Group Screening (% of Patients Screened, Unless Otherwise Specified)	Postintervention or Experimental Group Screening (% of Patients Screened, Unless Otherwise Specified)	Significance Testing (*P* Value Unless Otherwise Specified)	Nature of the Intervention, Setting/Population, and Other Comments About the Study
Randomized controlled trials					
1. Margolis et al (2004) RCT[20]	*Lead poisoning, anemia, and tuberculosis:*				*Intervention:* Process improvement methods (aka "knowledge translation") to improve office systems around preventive care services. • Formation of practice-based improvement teams • Ongoing academic detailing by project staff • Plan-Do-Study-Act cycles with goal setting, workflow mapping, audit/feedback. *Setting/population:* 44 practices in North Carolina were randomized to intervention vs usual care; n = ~660 each for postintervention control and experimental groups; children aged 24–30 months. *Other comments:* Data were collected pre- and post-intervention for both control and experimental group practices. Tuberculosis screening was PPD, Mantoux test, or risk assessment
	Serum lead level:				
	Intervention	23%	68%	<0.05	
	Control	18%	30%		
	Hematocrit:				
	Intervention	65%	79%	<0.05	
	Control	64%	71%		
	Tuberculosis screening:				
	Intervention	34%	54%	<0.05	
	Control	30%	32%		
2. Minkovitz et al (2003) RCT[35]	*Developmental problems:* Parent-reported developmental assessment	41%–43%	82%–84%	<0.001	*Intervention:* Healthy Steps (HS) program Co-located developmental specialists to enhance well-child visits; also conducted home visits, provided telephone information line for parents about development, written materials, parent groups, linkages to community resources *Setting/population:* 15 practices randomized in 14 states; experimental n = 2021 patients, control n = 1716 patients; post-intervention data were collected for children aged 30−33 months. *Other comments:* Parents reported any developmental screening questions (not specifically whether a formal tool was used)
3. Scholes et al (2006) RCT[27]	*Chlamydia infection:* Urine Chlamydia screening	*Practice-level intervention:* 37.5% *EMR reminder:* 40.8%	39.6% 42.6%	0.31 0.27	*Intervention:* Practice and patient-level interventions • Practice-level intervention—Use of peer opinion leader teams; 1 day training session around implementing screening guidelines; quarterly feedback reports on screening quality • Patient level intervention—EMR point-of-care reminder to screen sexually active adolescent females *Setting/population:* 23 practices in Washington state; experimental n = 3511 patients, control n = 3649 patients; females aged 14–20 years.
4. Shafer MA et al (2002) RCT[23]	*Chlamydia infection:* Urine Chlamydia screening	21%	65%	<0.001	*Intervention:* Quality improvement initiative within managed care network • Practices formed improvement teams; monthly meetings to strategize about solutions to self-identified barriers to screening, using Plan-Do-Study-Act cycles; performance monitoring • Intervention targeted preventive care visits *Setting/population:* 10 pediatric practices in California; experimental n = 1017 patients, control n = 1194 patients; sexually active adolescent females.

5. Tebb et al (2009) RCT[29]	*Chlamydia infection:*				*Intervention:* Quality improvement initiative within managed care network • Practices formed improvement teams; monthly meetings with focus on workflow, performance monitoring using Plan-Do-Study-Act cycles • Intervention targeted urgent care visits *Setting/population:* 10 pediatric practices in California; n was not reported; sexually active adolescent females *Other comments:* Data were collected pre- and post-intervention for both control and experimental group practices.
	Urine Chlamydia screening				
	Intervention	26%	42%	<0.001	
	Control	32%	30%		
Pre-post intervention design					
6. Adams et al (2003) Pre-post[37]	*Developmental problems, anemia, lead poisoning, hearing and vision problems:*			*Relative risk (95% confidence interval):*	*Intervention:* EMR template with prompts to improve preventive care services • Prompts were age-specific milestones regarding development in social, fine/gross motor, and language skills, with checkboxes and normal ranges. • Other prompts were for anticipatory guidance and screening for psychosocial problems. *Setting/population*: One practice in Massachusetts with >28,000 visits/year; preintervention n = 235 patients; post-intervention n = 986 patients; children aged 0–5 years *Other comments:* Preintervention group had paper charts with well-child visit templates; sample for specific tests varied because some tests are recommended only for a subset based on age.
	Language development	65.1%	70.0%	1.07 (0.97−1.09)	
	Behavior/social development	26.4%	65.7%	1.16 (1.04−1.28)	
	Motor development	63.8%	73.9%	2.49 (2.00−3.10)	
	Hematocrit	82.5%	85.3%	1.03 (0.91−1.17)	
	Serum lead level	66.7%	79.1%	1.19 (0.99−1.43)	
	Vision	42.9%	50.0%	1.17 (0.80−1.70)	
	Hearing	33.3%	48.3%	1.45 (0.92−2.28)	
7. Applegate et al (2003) Pre-post[33]	*Behavior, developmental and emotional problems:*				*Intervention:* Provider education and support tools to implement Pediatric Symptom Checklist (PSC); intervention was 2 stages • Stage 1: Provider training session about screening tool, importance of screening; screener placed on medical chart • Stage 2: Implementation of provider and patient handouts that followed the structure of the PSC and were designed to address specific subgroups of symptoms. *Setting/population:* One academic pediatric practice; pre-intervention n = 16 patients; post-intervention n = 38 patients; children aged 6–16 years. *Other comments:* No significance testing reported
	Discussion about behavior, developmental or emotional problems (no. items discussed per visit)	1.6 items	10.4 items per visit after Stage 1; 9.9 items per visit after Stage 2		
	Intervention for behavior and emotional problems (# of interventions per visit)	0 interventions	0.125 interventions per visit after Stage 1; 1.9 interventions per visit after Stage 2		
8. Block et al (1996) Pre-post[40]	*Follow up of elevated lead levels:*				*Intervention:* Nurse-led protocol to follow up elevated lead levels • Case management performed by a nurse • Nurse-initiated physician education on specific cases • Electronic tracking of patients within the practice • Joint tracking of patients with public health department *Setting/population:* One academic family medicine practice in Pennsylvania; preintervention n = 22 patients with abnormal lead levels, postintervention n = 99 patients with abnormal lead levels *Other comments:* No significance testing reported
	Follow up plan in chart	32%	100%		
	Follow up serum lead level done	9%	65%		
	Parent education about reducing exposure, if persistently high levels	Not measured	28%		
9. Bordley et al (2001) Pre-post[22]	*Anemia, lead poisoning, tuberculosis:*				*Intervention:* Quality improvement intervention to improve preventive care: • Practice improvement teams
	Hematocrit	45%	67%	0.001	
	Lead screening	12%	48%	0.001	

(*Continued*)

Table 2. Continued

Author, Year, Design	Condition(s) Being Screened and Screening Test(s)	Preintervention or Control Group Screening (% of Patients Screened, Unless Otherwise Specified)	Postintervention or Experimental Group Screening (% of Patients Screened, Unless Otherwise Specified)	Significance Testing (*P* Value Unless Otherwise Specified)	Nature of the Intervention, Setting/Population, and Other Comments About the Study
	Tuberculosis screening	50%	52%	NS	• Specific changes to workflow were individualized by practices and included: ○ sending patient reminder cards; ○ chart screening prior to patient being seen; ○ chart flagging; and ○ using flowsheets and medical record templates. *Setting/population:* 8 practices in North Carolina, pre-intervention n = 339 patients; post-intervention n = 300; children aged 24–30 months *Other comments:* Lead and tuberculosis screening was risk assessment and laboratory/skin testing, if indicated
10. Dunlop et al (2007) Pre-post[32]	*Obesity:*				*Intervention:* Provider training and support tools for obesity. 2-stage intervention: • Stage 1: 2-hour provider training explaining guidelines for assessing and managing overweight and counseling framework (AIM—Advise, Identify, Motivate); training on using BMI calculator and growth charts • Stage 2: 3 month supply of tools—parent screening tool/counseling guide, body mass index charts, "prescription pad" for nutrition/physical activity *Population/setting:* 6 academic family medicine and pediatric practices in Georgia; pre-intervention n = 466; Stage 1 n = 538, Stage 2 n = 344; children aged 2–17 years
	BMI percentile documented in chart	12%	15% after Stage 1 28% after Stage 2	NS <0.05	
	Nutrition and activity history	50%	56% after Stage 1 81% after Stage 2	NS <0.05	
	Nutrition and activity counseling	33%	35% after Stage 1 47% after Stage 2	NS <0.05	
11. Lannon et al (2008) Pre-post[21]	*Developmental problems*				*Intervention:* Bright Futures Training Intervention Project: learning collaborative/quality improvement initiative to improve preventive care services • Key practice-level changes included: ○ structured developmental screening (PEDS or ASQ); ○ chart prompts; ○ patient recall/reminder; and ○ linkages with community agencies • Used practice improvement teams and Plan-Do-Study-Act cycles *Population/setting:* 15 practices in 9 states; experimental n = 305 patients, control n = 171 patients; children aged 0–5 years Other comments: No participating practices used formal developmental screening tools preintervention.
	PEDS or ASQ	30% (received any developmental screening)	45% (using structured tool, eg, ASQ)	NS	
12. Polacsek et al (2009) Pre-post[25]	*Obesity:*				*Intervention:* Learning collaborative • Teams of physician, nurse and administrator from each practice; 3 1.5-day learning sessions for teams; practices set goals around nutrition and physical activity screening and counseling. • Patient screening instruments and provider decision support tools for obesity management
	BMI documented in chart	38%	94%	<0.001	
	Screening with pre-visit, self-administered tool to assess patient's behavior around nutrition and physical activity	Not measured	82%	<0.001	

13. Shaw et al (2006) Pre-post[19]	*Lead poisoning, anemia, tuberculosis, hypertension:*				*Population/setting:* 12 practices in Maine; n = 600 patients with visits during both pre and post intervention periods; children aged 5–18 years. *Interventions:* State-wide learning collaborative with 4 1-day learning sessions • Practices formed teams (physician, nurse, administrator) and chose preventive care outcomes to address through practice improvements. • Included periodic statewide gatherings for QI training, collaborative telephone calls, audit/feedback to practices *Population/setting:* 31 practices in Vermont; pre- and post-intervention n = each approx 930 patients; children aged 2–4 years *Other comments:* Tuberculosis and lead screening were risk assessment and laboratory/skin testing, if indicated.
	Lead screening	72%	85%	0.001	
	Hematocrit	70%	74%	NS	
	Vision screening	62%	75%	0.013	
	Tuberculosis screening	18%	39%	0.001	
	Blood pressure	85%	82%	NS	
14. Young et al (2006) Pre-post[18]	*Anemia, vision problems, hypertension, obesity:*				*Intervention:* Learning collaborative • Practices chose aspects of preventive care to focus improvement efforts. Included QI methodology training, conference calls with participating practices, and chart audit/feedback *Population/setting:* 14 practices in Utah; preintervention n = 544 patients; post-intervention n = 517 patients; children aged 2–4 years
	Hematocrit	49%	57%	0.36	
	Vision screening	46%	75%	0.007	
	BP screening	59%	74%	0.010	
	BMI recorded	32%	45%	0.078	
Postintervention with and without a control group					
15. Gioia (2001) Post intervention without control group[38]	*Lead poisoning:*				*Intervention:* EMR with point-of-care reminders displayed on screen *Population/setting:* Single practice in New York; n = 208 patients; children born in 1998
	Serum lead level	Not measured	81%		
16. Hartmann et al (2006) Postintervention without control group[34]	*Vision disorders: monocular visual acuity and stereopsis*				*Intervention:* Vision screening with specific tools for assessing monocular visual acuity and stereopsis. • Provided written guidelines for referral, follow-up based on screening results. • Physician and staff training, either in group sessions or one-on-one training Initiative included both Head Start and primary care practices *Population/setting:* 28 practices in Ohio and Tennessee; n = 627 patients; children aged 3–4 years.
	3 year olds	Not measured	70%–85%		
	4 year olds	Not measured	93%–94%		
17. Hull et al. (2008) Postintervention with concurrent control group[39]	*Lead poisoning, anemia, hearing, vision:*				*Intervention:* Nurse-led protocol • EPSDT screening, carried out by a nurse with a specific preventive care role, using protocol attached to medical record. *Population/setting:* One academic practice received intervention; control group was sample of children from other practices. Intervention group n = 514, control n = 115 patients; children aged 0–17 years
	"Laboratory testing" (serum lead level and hematocrit)	74%	100%	<0.001	
	Hearing	12%	100%	<0.001	
	Vision	23%	100%	<0.001	
18. Niederman et al (2007) Postintervention with concurrent control group[36]	*Anemia and lead poisoning:*				*Intervention:* Healthy Steps (HS) program implemented in a resident continuity clinic. *Population/setting:* One academic practice in Illinois; experimental n = 71, control n = 192 patients; children aged at least 18 months *Other comments:* Control group was patients in the practice but not enrolled in HS
	Hematocrit	77%	73%	NS	
	Serum lead level	64%	67%	NS	
19. Ozer et al. (2005) Postintervention with concurrent control group[31]	*Adolescent health risk behaviors:*				*Intervention:* Provider training, patient questionnaire, and prompts to facilitate communication about adolescent risk behaviors 2-stage intervention:
	Adolescent health screening questionnaire	Not measured	80%	NA	

(*Continued*)

Table 2. Continued

Author, Year, Design	Condition(s) Being Screened and Screening Test(s)	Preintervention or Control Group Screening (% of Patients Screened, Unless Otherwise Specified)	Postintervention or Experimental Group Screening (% of Patients Screened, Unless Otherwise Specified)	Significance Testing (*P* Value Unless Otherwise Specified)	Nature of the Intervention, Setting/Population, and Other Comments About the Study
	Provider asked about alcohol use during visit	67%	82% after Stage 1	<0.01	• Stage 1: 8-hour provider training workshop around knowledge and skills regarding adolescent preventive care
			83% after Stage 2	<0.001	• Stage 2: Introduction of patient questionnaire and provider form to screen for and document discussion and counseling regarding risky behaviors.
	Provider counseled on alcohol use during visit	59%	77% after Stage 1	<0.01	
			81% after Stage 2	<0.001	*Population/setting:* 4 practices in California (2 practices received the intervention); experimental n = 1717, control n = 911 patients; adolescents aged 14–17 years
					Other comments: Control practices' screening did not differ over study period
20. Schonwald et al (2009) Post-intervention without cuncurrent control group[30]	*Behavior and development problems:* PEDS	Not measured	61%		*Intervention:* Implementation of developmental screening using PEDS • 1-hour provider and staff training; physician champion who was available to answer questions from providers and staff. • Offered as option for referral a second-stage screening service at the practice staffed by an educational specialist *Population/setting:* 1 practice in Massachusetts; pre-intervention n = 338 patients, post-intervention n = 278 patients; children aged 20−40 months *Other comments:* Use of structured developmental assessments was not routine preintervention; authors reported an increase in developmental concerns identified post-intervention (21% vs 26%, *P* = 0.05); proportion of children referred for developmental concerns did not change postintervention (10% vs 11%).
Time series					
21. Earls et al (2006) Time series[28]	*Developmental problems:* ASQ	24%	62% at year 2; 76% at year 5		*Intervention:* Quality improvement initiative to improve child development services: • Practices completed Plan-Do-Study-Act cycles • Emphasized physician champion, workflow map, staff involvement, and periodic data review • Part of a larger state-wide initiative that involved state-level policy changes around child developmental services • *Population/setting:* Several practices in North Carolina; sample size was not reported *Other comments:* No significance testing reported
22. King et al (2010) Time series[24]	*Development problems:* PEDS or ASQ	Not measured	67% at 1 month; 85% at 9 months		*Intervention:* Provider and staff education, physician champion identification • One-day workshop for practice teams. Practices teams were a group of three key stakeholders within each practice (physician champion, staff member, and another person). • AAP-sponsored national pilot project to implement guideline-adherent developmental screening

23. Pomietto et al (2009) Time series[26]	*Obesity:* BMI and weight classification documented in chart	Not measured	49% at 1 month; 94% at 9 months	*Intervention:* Learning collaborative, combined with community and policy-level interventions. • Practices participated in 3 8-hour training sessions, monthly phone calls, and practice-based coaching in QI, which included on-site visits to practices • Coincided with community-level efforts to better manage chronic conditions, including obesity *Population/setting:* 8 practices in Washington state. Chart audits of 20 pediatric patients per month per practice were tracked for 9 months. Age range of patients was not reported. *Other comments:* No significance testing reported

HS = Healthy Steps; LC = learning collaborative; BMI = body mass index; BP = blood pressure; QI = quality improvement; HMO = health maintenance organization; PEDS = parents' evaluation of developmental status; EMR = electronic medical record; EPSDT = early periodic screening, diagnosis, and treatment; ASQ = ages and stages questionnaire; AAP = American Academy of Pediatrics; RCT = randomized controlled trial.

go off-site to complete screening tests.[30,37,38] Furthermore, this finding suggests a "ceiling effect" similar to that found with interventions to increase rates of vaccine coverage and well-child visit attendance.[42,43]

The quality of the studies varied, with many using non-randomized study designs, a limited number of practice sites, and with little account for context of the practices receiving intervention. However, 5 articles reported on randomized trials with consistent positive effects. Most studies were pre-post designs without randomization, and some lacked comparison groups, making it difficult to assess the effect of natural trends over time. Most studies involved multiple practices, but seven studies used only one practice site, limiting the ability to draw conclusions about how broader-based improvement efforts would increase the quality of screening. Because office staff motivation and technological savvy can play a large role in the success of interventions,[44] practices differing in these contextual factors would likely have different results.

Most interventions were multifaceted, involving several alterations in office workflow, physician and staff education, and changes in staff time allocation. Although multifaceted interventions generally had more success, as did interventions tailored to best fit specific practices, no systematic approach examined which elements provide the greatest benefit, or why the same intervention performed better in some practices than others. Findings from such a systematic approach could be used to design more efficient interventions and advance the field of quality improvement research.

Few studies examined the quality of follow-up care, and few interventions contained elements specifically targeting follow-up of abnormal tests. However, the few studies that did have follow-up as an outcome found 35% to 65% of patients did not receive follow-up care after an abnormal screening result. This finding indicates the need to include outcomes related to follow-up in studies of screening and that measuring screening alone may overestimate changes in identification and treatment of conditions.

We found no studies testing the effects of performance incentives or physician feedback. This strategy has been studied more in adult settings for screening[9,45] and in pediatrics for immunizations, attendance at well-child visits, and management of chronic conditions.[46] Another review of adult cancer screening interventions focused on motivating patients and reducing barriers to care.[47] These reviews found variable effects among similar interventions, with most interventions associated with some increase in screening.

The review has several limitations. Many quality improvement interventions do not reach publication, which could have limited identification of informative studies. The search terms used may not have captured all relevant studies, particularly studies examining quality of follow-up care, for which search terms were difficult to define. Many studies tested heterogeneous interventions that were modified for each practice; some interventions were multifaceted so that practices could choose specific elements to implement. This so-called "cafeteria" approach makes comparing interventions in separate

studies difficult and may limit reliability and generalizability. However, tailoring the intervention to the context of the practice likely increased the chance of the desired effect, and is more representative of how it would be applied in actual practice.

CONCLUSION

Although the quality of studies varied, we found a moderate level of evidence that interventions are effective in improving screening in pediatric practices. This review also reveals several avenues for future study that will guide policy makers and practitioners in what specific interventions provide the most value.

Interventions reviewed here appeared to have ceiling effects, which invites the question, given the broad aims of pediatric primary care, what should be the goals for screening, and is there a point of diminishing return in which a practice's extra efforts exceed the value of the gain? Policies around reimbursement based on screening performance should match the right amount of effort to achieve the right rate. Also, improving screening rates from a high baseline will likely require different interventions; near-perfect screening may not be achievable without a large degree of automation and standardization and multiple layers of double-checks performed by nonclinicians or through electronic mechanisms. Finally, when aiming for high proportions of children appropriately screened, defining the right denominator becomes increasingly important and worth measuring accurately and thoughtfully. A denominator measured by well child visits, versus empanelled patients, might drive different interventions with ultimately different outcomes.

No single type of intervention arose as consistently more effective in increasing screening quality, and few authors addressed the critical issue of assuring adequate follow-up. This review did not identify specific interventions that work better than others; however, multifaceted, practice-tailored interventions with ongoing outcome assessment seemed to be effective, and most comprehensively evaluated. Policies supporting such interventions broadly will likely lead to earlier detection and more effective treatment for a large population of children. Quality improvement activities are now required for maintenance of board certification, and many local health systems and payers ask or require practices to participate. Medical societies, such as the American Academy of Pediatrics, can help provide infrastructure to encourage efforts by individual practices.

This review leaves several additional questions: Which components of interventions add to effectiveness, and which are ineffective? What interventions improve follow-up care? How sustainable are the effects of these interventions? Are different interventions more effective for different types of screening procedures (eg, questionnaires versus blood draws)? How is practice context best measured, and how is it associated with the success of interventions? Such future avenues for research will help refine interventions to move toward effective, efficient screening in primary care pediatrics.

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APPENDIX

SEARCH

(mass screening [MeSH Terms] or population surveillance [MeSH Terms] or preventive health services [MeSH Terms] or child development or developmental disabilities or language disorders or child behavior disorders or cerebral palsy or autistic disorder or mental retardation or vision disorders or hearing loss or lead poisoning or anemia, iron deficiency or hypertension or obesity or depression or sexually transmitted diseases) and (primary health care [MeSH Terms] or community health centers [MeSH Terms] or managed care programs [MeSH Terms] or group practice [MeSH Terms]) and (physician's practice patterns [MeSH Terms] or Child Health Services [MeSH Terms] or Medical Records Systems, Computerized [MeSH Terms] or Decision Support Systems, Clinical [MeSH Terms] or Information Systems [MeSH Terms] or Education, Medical [MeSH Terms] or Education, Medical, Continuing [MeSH Terms] or Insurance, Health, Reimbursement [MeSH Terms] or Total Quality Management [MeSH Terms] or Quality Assurance, Health Care [MeSH Terms] or Referral and Consultation[MeSH Terms] or Primary Prevention [MeSH Terms] or Healthcare Disparities [MeSH Terms] or Health Care Costs [MeSH Terms] or Quality of Health Care [MeSH Terms] or Outcome Assessment [MeSH Terms] or Process Assessment [MeSH Terms]).