**SUPPLEMENT**

Psychological Interventions for Vaccine Injections in Children and Adolescents

**Systematic Review of Randomized and Quasi-Randomized Controlled Trials**

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**Background:** This systematic review evaluated the effectiveness of psychological interventions for reducing vaccination pain and related outcomes in children and adolescents.

**Design/Methods:** Database searches identified relevant randomized and quasi-randomized controlled trials. Data were extracted and pooled using established methods. Pain, fear, and distress were considered critically important outcomes.

**Results:** Twenty-two studies were included; 2 included adolescents. Findings showed no benefit of false suggestion (n = 240) for pain.

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**Vaccine injections are unique in that they are regularly experienced by children who are healthy as well as those who have chronic illness, making them the most common painful medical procedure performed worldwide.**

**Multipronged approaches to pain management include pharmacological, psychological, procedural, and physical strategies, all of which have been studied to reduce the pain and distress associated with vaccine injections.** Of these approaches, psychological interventions hold considerable appeal to families given that they capitalize on strategies that children and parents already engage in naturally to some extent (eg, distraction), and, due to their non-pharmacological nature, are generally met with higher acceptability by parents. Many psychological interventions are simple and require minimal or no training, are able to be implemented directly by children, parents, and immunizers, and are applicable across a wide age range. Furthermore, they generally capitalize on available resources, making them easy to implement across different clinical settings.

In a previous knowledge synthesis on this topic, support was found for several different psychological interventions for vaccination pain, including breathing exercises,
child-led or nurse-led distraction, and combined cognitive-behavioral interventions (ie, strategies aimed at modifying emotions, behaviors, and cognitions). These interventions were subsequently incorporated into a clinical practice guideline for childhood vaccination pain management. Since the original guideline was developed, additional research in the area has been published. Furthermore, the previous systematic review and meta-analysis grouped together infants and children, and omitted adolescents; this led to a gap in knowledge synthesis and recommendations for each pediatric population who present unique developmental considerations. Given recent evidence suggesting possible differences in treatment efficacy based on intervention characteristics, alternative approaches to examining the literature are warranted, in particular, the type of distracter used. Our previous synthesis examined the literature according to the individual directing the intervention. The current systematic review and meta-analysis was therefore undertaken to provide the evidence base for an update and expansion of the original guideline in the specific area of psychological interventions for children and adolescents undergoing vaccine injections and evaluated the data according to the type of distractor used.

This review reports the results for trials that evaluated the effect of any of the following psychological interventions for the management of vaccination pain and related outcomes: (1) false suggestion, (2) repeated reassurance, (3) verbal distraction, (4) video distraction, (5) music distraction, (6) breathing with toy, (7) breathing without toy, and (8) breathing intervention (cough). Separate papers explore the effectiveness of psychological interventions in young children (0 to 3 y) and adults, as well as pharmacological, physical, procedural, and process approaches for infants, children, adolescents, and adults.

**METHODS**

This systematic review was conducted as part of the Canadian multidisciplinary Help ELiminate Pain in Kids and Adults (HELPinKids&Adults) team, which was assembled with the goal of developing an evidenced-based clinical practice guideline, and undertaking knowledge translation activities, for reducing vaccination pain. As such, an identical methodological approach was applied across reviewed areas (psychological, pharmacological, physical, procedural, and process) for reducing vaccination injection pain. A separate manuscript describes this methodological approach in greater detail.

In brief, systematic review and meta-analytic methodologies were informed by GRADE (Grading of Recommendations, Assessment, Development and Evaluation) and the Cochrane Collaboration. The search was developed in consultation with an experienced librarian and included the following databases: EMBASE, Medline, Psychnfo, and CINAHL. Search results were screened for eligibility. Peer-reviewed publications (full or short report) and published academic theses/dissertations were included. Through a voting process, the HELPinKids&Adults team identified clinical questions (ie, psychological interventions) to be examined, as well as critical and important outcomes to be included in each review. Specifically, candidate questions were identified based on prior clinical practice guidelines, clinical experience, and knowledge of existing research. Clinical questions were retained if considered important by at least two-thirds of the HELPinKids&Adults team, and were modified as appropriate after preliminary review and discussion of the research evidence by the HELPinKids&Adults team. Two of the included clinical questions pertained to individuals across the lifespan (ie, use of false suggestion or repeated reassurance); however, evidence was only available from children.

This review focused on studies of psychological interventions including children (aged above 3 to 12 y) and adolescents (aged above 12 to 17 y) undergoing vaccination in any setting using randomized or quasi-randomized study designs. Only simple psychological interventions were sought for inclusion (ie, those involving distraction, and/or interactions between children and parent/nurse/immunizer). More complex psychological interventions, such as hypnosis, were not included, as they typically require special training to be implemented. Psychological interventions related to treating high needle fear are discussed in another review in this series.

Pain and fear were typically prioritized as critically important outcomes, respectively, defined as self-report of pain or self-report of fear during vaccination. The overall effectiveness of an intervention was determined according to the effects on critically important outcomes. Distress was also accepted as a critically important outcome if children below 7 years were included in the evidence base, due to the possibility that self-report was unreliable. Distress was defined as observer ratings of an individual’s behavioral response during vaccination (ie, pain, fear, distress). When available, other important outcomes included procedure outcomes (eg, procedure success, duration), parent fear, use of the intervention, compliance, memory, preference, and satisfaction.

As per the standard approach across reviewed content areas, outcomes that were assessed at multiple time-points during the vaccination procedure were analyzed as follows: (1) the preprocedure phase, which occurred post-intervention but before vaccine injection(s); (2) the acute phase (within the first minute of needle puncture and vaccine injection); and (3) the recovery phase (1 to 5 min after vaccine injection(s)). Phases were combined when outcomes were not assessed separately for each phase (eg, acute + recovery). Delayed onset of pain (ie, pain occurring hours to days after injection) was not considered. Data from multiple observers assessing the same outcome (eg, parent-rated child distress, clinician-rated child distress, observational behavior coding) was combined into a single point estimate and associated variance before inclusion in the meta-analysis using established methods.

Attempts were made to contact study authors when data necessary for pooling were not included in published papers (ie, means, SDs). An emphasis was placed on including data from all possible studies. As such, when means and SDs were not available, they were estimated from medians, ranges, SEs, 95% confidence intervals (CIs), or graphs. This was done only as needed, on a very restricted predefined basis, and followed established methods.

Data was pooled using RevMan (version 5.2, Cochrane Collaboration, Copenhagen, Denmark), and effects of interventions were expressed as a standardized mean difference (SMD) with accompanying 95% CI or relative risk and CI, as appropriate. Separate analyses were conducted for children (above 3 to 12 y old) and adolescents (above 12 to 17 y old) when possible. A random effects model was used for all analyses. Statistical heterogeneity was assessed using $I^2$ and $\chi^2$ tests. Additional post hoc analyses were carried out to examine the effects of study methodology and/or heterogeneity. Risk of bias was
assessed for critical outcomes for all included studies using the Cochrane risk of bias tool (https://bmg.cochrane.org/assessing-risk-bias-included-studies).

Evidence profiles and summary of findings tables were created using the GRADE profiler software (version 3.6.1). When analyses demonstrated a consistent benefit of the intervention across critically important outcomes, it was said to have “benefit across all measured outcomes.” Findings were described as “mixed” when results were inconsistent across critically important outcomes, and were described as having “no evidence of a benefit” when any statistical evidence of benefit was lacking.

RESULTS

Database searches returned a total of 114,251 citations, including 32,155 duplicates. An additional 138 citations were identified from manual searches. The remaining 82,234 citations were reviewed for eligibility by 2 members of the HELPinKids&Adults (Help ELiminate Pain in Kids and Adults) Team: Taddio, A., McMurtry C.M., Chambers C.T., Pillai Riddell R., Shah V., Noel M., MacDonald N.E., Rogers J., Bucci L., Mousmanis P., Halperin S.A., Bowles S., Halpert C., Ipp M., Rieder M., Robson K., Asmundson G.J.G., Antony M., Alexander D., Appleton M., Dubey V., Hanrahan A., Lockett D., Scott J., Votta Bleeker E.). Twenty-two studies investigating psychological interventions in children and/or adolescents were identified and included in the review.18-39 In 1 case, there were multiple publications emanating from the same study, including a dissertation and published manuscript of the same data.37 Most studies used a between-subjects (parallel) design (n = 20), with 2 studies using a within-subjects (cross-over) design.23,38 Data were provided for 2 or more treatment groups from all trials. Three trials examined multiple psychological interventions, with different treatment groups included in their respective clinical questions.27,29,33 Twenty studies included children only (above 3 to 12 y old), 1 study included adolescents only (above 12 to 17 y old), and 1 study included both children and adolescents. Two studies were excluded due to the: (1) study design not being randomized or quasi-randomized (n = 1)40; and (2) intervention was not psychological (n = 1).41 See Figure 1 for a flowchart depicting study identification, screening, and inclusion. Table 1 outlines the clinical questions and critically important and important outcomes. Table 2 describes characteristics of included trials for each clinical question examining psychological interventions in children and/or adolescents.

Quality of Studies and Risk of Bias

Assessment of risk of bias for all included trials for critically important outcomes are reported in Table 3. All trials had high overall risk of bias, primarily due to lack of blinding of: participants, clinicians administering the intervention, and/or individual providing the ratings of critically important outcomes of pain, fear, and/or distress.

Overall Quality of Evidence and Treatment Effects

For all clinical questions, results for critically important outcomes only are described below, and are summarized...
TABLE 1. Clinical Questions and Outcomes

| Clinical Questions                                                                 | Critical Outcomes* | Important Outcomes                                                                 |
|-----------------------------------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------|
| Psychological interventions                                                        | Pain, distress,    | Procedure outcomes, parent fear, compliance, memory, preference, satisfaction    |
| Should false suggestion be used during vaccine injections in individuals of all ages? | fear                |                                                                                  |
| Should repeated reassurance be used during vaccine injections in individuals of all ages? | Pain, distress, fear |                                                                                  |
| Should verbal distraction be used during vaccine injections in children >3-12y?     | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |
| Should video distraction be used during vaccine injections in children >3-12y?       | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |
| Should music distraction be used during vaccine injections in children >3-12y?       | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |
| Should music distraction be used during vaccine injections in adolescents >12-17y?  | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |
| Should breathing with a toy (blowing bubbles, pinwheel) be used during vaccine injections in children >3-12y? | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |
| Should breathing interventions (cough) be used during vaccine injections in children >3-17y? | Pain, fear         | Distress, procedure outcomes, parent fear, use of intervention, compliance, memory preference, satisfaction |

*Distress was considered when data were only available from young children (below 7y old) with whom self-report is less reliable.

in Table 4. More detailed GRADE Evidence Profiles and Summary of Findings tables (Tables, Supplemental Digital Content 1 to 9, http://links.lww.com/CJP/A183, http://links.lww.com/CJP/A184, http://links.lww.com/CJP/A185, http://links.lww.com/CJP/A186, http://links.lww.com/CJP/A187, http://links.lww.com/CJP/A188, http://links.lww.com/CJP/A189, http://links.lww.com/CJP/A190, http://links.lww.com/CJP/A191 and accompanying Forest plots (Figures, Supplemental Digital Content 1 to 9, http://links.lww.com/CJP/A192). No other important outcomes were assessed.

Should False Suggestion be Used During Vaccine Injections in Individuals of All Ages?

Two trials including 240 children aged 4 to 7 years investigated the impact of false suggestion,26,27 In both trials, children were told by the immunizer or researcher that something was being done to help make the injection easier or less painful. Depending on the treatment group, this was accompanied by a potentially pain reducing intervention (ie, music distraction or vaporcoolant) or a placebo (ie, wearing headphones with no music or aerosol spray). There was low quality of evidence for the critically important outcome of pain, largely due to inconsistent blinding of immunizer and outcome assessor, as well as selective outcome reporting (Table, Supplemental Digital Content 1, http://links.lww.com/CJP/A183). Both trials found no benefit of suggestion for the critically important outcome of pain: SMD $-0.21$ ($-0.47, 0.05$). Findings were consistent with and without the data from false suggestion with placebo intervention groups. No trials examined the critically important outcome of fear. Given the young age of participants, distress was also examined for the 1 trial containing these data,26 which showed no benefit of suggestions for preprocedural distress: SMD $-0.28$ ($-0.91, 0.34$) (Table, Supplemental Digital Content 1, http://links.lww.com/CJP/A184 and Figure, Supplemental Digital Content 10, http://links.lww.com/CJP/A192). No other important outcomes were assessed.

Should Repeated Reassurance be Used During Vaccine Injections in Individuals of All Ages?

Two trials including 82 children aged 3 to 7 years investigated repeated reassurance by parents during vaccination.29,33 Parents were trained before the procedure through oral instruction, modeling, and practice; during the vaccination, parents were repeatedly prompted to engage in reassurance. For example, saying reassuring statements such as “You’re ok” or “It’s almost over.” There was low quality of evidence for the critically important outcome of pain, and very low quality of evidence for the critically important outcome of fear, largely due to inconsistent blinding of participants, immunizers, and outcome assessors, and contamination of treatment effects in the control group (ie, parents engaging in reassurance) (Table, Supplemental Digital Content 2, http://links.lww.com/CJP/A184). One trial29 found no benefit for the critically important outcome of pain (SMD $-0.18$ [$-0.92, 0.56$]), whereas the other trial33 found no benefit for the critically important outcome of preprocedural fear (SMD $-0.18$ [$-0.71, 0.36$]). Given the young age of participants, distress was also examined (preprocedure, acute, and recovery distress combined) and showed no benefit of repeated reassurance in both trials: SMD $0.10$ [$-0.33, 0.54$] (Table, Supplemental Digital Content 2, http://links.lww.com/CJP/A184 and Figure, Supplemental Digital Content 11, http://links.lww.com/CJP/A193). Other assessed important outcomes included parent fear and parent use of intervention.
| First Author       | Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|--------------------|---------------|-------------------|--------------------------------------|--------------|-------------------|
| **Should false suggestion be used during vaccine injections in individuals of all ages?** |               |                   |                                      |              |                   |
| Eland 1981         | (1,2),26 USA  | DPT 0.5 mL, IM; 25 G, 5/8-inch needle; vastus lateralis | N = 40; children 4-5 y; between-groups design; single center, pediatric clinic | Refrigerant topical anesthetic spray (Frigiderm) plus cognitive information: child told by the nurse “I’m going to spray something on your leg before your shot that will not hurt, will make your leg feel cool, and the spray will make this shot hurt less than other shots you’ve had” (n = 10) or Refrigerant topical anesthetic spray (Frigiderm) plus no cognitive information: child told the nurse was “going to spray something on their leg before their shot” (n = 10) or Aerosol air spray plus cognitive information (n = 10) or Aerosol air spray plus no cognitive information: spray applied 3-5 s on the leg before vaccination (n = 10) | Pain: Adapted Eland’s Color Assessment Tool |
| Fowler-Kerry       | (1,3),27 Canada | DPT; no injection details | N = 200; children 4-7 y; between-groups design; multicenter, community health clinic | Suggestion: child told that the experimenter was going to help them when they had their injection. They wore headphones but no music was played (n = 40) or No treatment: 2 control groups combined: (1) child wore headphones (n = 40); (2) child did not wear headphones (n = 40) (n = 80 total) or Suggestion plus music distraction: child told that the experimenter was going to help them when they had their injection. Child wore headphones and listened to music immediately before and during the injection (n = 40) or Music distraction only: child wore headphones and listened to music immediately before and during the injection (n = 40) | Pain: VAS |
| Gonzalez 1993      | (2),29 USA    | Vaccine NR; no injection details | N = 42; children 3-7 y; between-groups design; single center, hospital primary care clinic | Reassurance: before the immunization, parents received oral instructions and audiocassette modeling on how to reassure, time to practice, and were reminded to engage in reassurance every 10 s throughout the procedure by a researcher (n = 14) or Distraction: before the immunization, parents received oral instructions and audiocassette modeling on how to distract, time to practice, and were reminded to engage in distraction every 10 s throughout the procedure by a researcher (n = 14)* | Pain: Oucher |
| First Author, Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|-----------------------------|-------------------|--------------------------------------|--------------|------------------|
| Manimala 2000 (2), 33 USA   | Vaccine NR; no injection details | N = 82; children 4-6 y; between-groups design; single center, county health department | Reassurance: before the immunization, 10 min of training including rationale, examples of reassurance and when to use it during the procedure; researchers acted as role models then parent and child also role played procedure (n = 27) or Distraction: before the immunization, 10 min of training including rationale, example techniques (eg, drawing, puzzles, talking about other things), asked to coach child to use a party blower throughout procedure; researchers acted as role models then parent and child also role played procedure (n = 28)* or Control: before the immunization, parents listened to a lecture and an audiocassette on transportation to the hospital and discussed transportation with a researcher (n = 14) | Fear: Faces Scale or Pain: Oucher |
| Should verbal distraction be used during vaccine injections in children >3-12 y? Gonzalez 1993 (1), 29 USA | Vaccine NR; no injection details | N = 28; children 3-7 y; between-groups design; single center, hospital (primary care clinic) | Reassurance: before the immunization, 10 min of training including rationale, examples of reassurance and when to use it during the procedure; researchers acted as role models then parent and child also role played procedure (n = 27) or Distraction: before the immunization, 10 min of training including rationale, example techniques (eg, drawing, puzzles, talking about other things), asked to coach child to use a party blower throughout procedure; researchers acted as role models then parent and child also role played procedure (n = 28)* or Control: before the immunization, parents listened to a lecture and an audiocassette on transportation to the hospital and discussed transportation with a researcher (n = 14) | Fear: Faces Scale or Pain: Oucher |
| O’Laughlin 1995 (1), 36 USA | Vaccine NR; no injection details | N = 36; children 4-5 y; between-groups design; single center, private pediatric practice | Mothers present for injection, no training; assisted nurse by holding the child when necessary (n = 11) or Mother absent for injection (n = 9)* or Mother present for injection, instructed to watch only (n = 9)* | NA (this study was not included in the meta-analysis for critical outcomes) |

(Continued)
| First Author Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|---------------------------|-------------------|--------------------------------------|--------------|------------------|
| Cassidy 2002, Canada      | DPTP 1 mL IM; 25 G, 1.5-cm needle; 90-degree angle; mid-deltoid | N = 59; children 5 y; between-groups design; 2 centers, urban pediatric setting | Parent present for injection, instructed to coach child in using distraction: counting, rhyme, or poem recitation, singing, or looking at an object (n = 7) | Pain: Faces Pain Scale |
| Cohen 1997 (1,2), USA     | DPT and MMR; no injection details | N = 92; children 4-6 y; between-groups design; single center, rural health center | Video distraction with immunizer training: nurses received 15-min training involving role-playing of coaching behaviors. They were instructed to prompt the child to select a movie to view and taught to use questions, comments and direct commands during the movie (n = 31) or Control: child watched blank TV screen (n = 28) | Pain: Faces Pain Scale |
| Cohen 1999 (1), USA       | Hepatitis B; no injection details | N = 34; children 8-11 y; cross-over design; single center, school health clinic | Lidocaine-prilocaine cream 2 g 1 h before the procedure (n = 34)* or Movie distraction plus nurse coaching: nurse received a 15-min training program in distraction then encouraged child while they were distracted by a video before, during, and after the injection (n = 34) or Typical care: nurse instructed to interact according to her own routine (n = 34) | Pain: VAS Fear: VAS |
| Cohen 2015 (1), USA       | DPTP, MMR, varicella; no injection details | N = 90; children 4-6.5 y; between-groups design; single center, pediatric clinic | Distraction: parents provided with laptop installed with parent-led computer game to use in waiting room. A portable DVD player with a selection of movies was provided for use during the procedure (n = 30) | Pain: FPS-R |

(Continued)
### TABLE 2. (continued)

| First Author       | Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|--------------------|---------------|-------------------|--------------------------------------|--------------|------------------|
| Luthy 2013         | (2),32 USA    | Vaccine NR; no injection details | N = 68; children 2-12 y; between-groups design; single center, pediatric office | Distraction (DVD before, during and after the procedure) (n = 27) or Vapocoolant spray for 3-7 s before the procedure (n = 18)* or Control (no intervention) (n = 22) | NA (this study was not included in the meta-analysis for critical outcomes) |
| Fowler-Kerry 1987  | (2,4),27 Canada | DPT; no injection details | N = 200; children 4-7 y; between-groups design; 3 centers, community health clinic | Music distraction only: child wore headphones and listened to music immediately before and during the injection (n = 40) or No treatment: 2 control groups combined: (1) child wore headphones (n = 40); (2) child did not wear headphones (n = 40) (n = 80 total) or Music distraction plus suggestion: child told that the experimenter was going to help them when they had their injection. Child wore headphones and listened to music immediately before and during the injection (n = 40) or Suggestion: child told that the experimenter was going to help them when they had their injection. They wore headphones but no music was played (n = 40) | Pain: VAS |
| Megel 1998,34 USA  |              | Vaccine NR; IM or SC; vastus lateralis | N = 99; children 3-6 y; between-groups design; single center, general pediatric clinic | Music distraction: 9 musical compositions and 9 verbal lullabies were available. Children were allowed to choose the lullaby they wished to hear and listened via headphones. Accompanied by parent (n = 50) or Control: given immunization as usual with parent present (n = 49) | Pain: Oucher |
| Noguchi 2006       | (1,2),35 USA  | At least one of DTaP, IPV; MMR, Hepatitis A, Hepatitis B, or PPD; IM; upper arm or thigh | N = 62; children 4-6 y; between-groups design; multicenter, medical clinic | Music distraction: children listened to musical story using headphones and pointed to accompanying photos (n = 21) | Pain: Faces Pain Scale (Continued) |
### TABLE 2. (continued)

| First Author Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|----------------------------|-------------------|---------------------------------------|--------------|------------------|
| **Spoken distraction: children listened to a spoken story using headphones and pointed to accompanying photographs (n = 21)** or **Standard care (n = 20)** | | | | |
| Yinger 2012, USA | At least one of DPT, IPV, MMR, varicella, or influenza; no injection details | N = 56; children 4-6 y; between-groups design; 3 centers, family medicine practice or pediatric practice at hospital | Music therapy: single session music therapy intervention, including live music and cognitive-behavioral techniques as procedural support. Information about the procedure provided to children via song and story; and also taught deep breathing. Music used to distract before and after procedure. Child took deep breaths and focused on the music therapist during procedure (n = 29) or **Standard care (n = 20)** | NA (this study was not included in the meta-analysis for critical outcomes) |
| **Should music distraction be used during vaccine injections in adolescents >12-17 y?** | | | | |
| Kristjansdottir 2011 (1,2), Iceland | Vaccine NR; no injection details | N = 118; children 13-15 y; between-groups design; single center, school-based health clinic | Music distraction (with headphones): adolescents were told the purpose of listening to music and were asked to concentrate on and “disappear into” the music. They were given a choice of CD and volume setting. Adolescents listened to music through headphones (n = 38) or Music distraction (without headphones): adolescents were told the purpose of listening to music and were asked to concentrate on and “disappear into” the music. They were given a choice of CD and volume setting. Adolescents did not wear headphones (n = 41) or **Standard care: described as nurses maintaining normal modes of caring by comforting and guiding adolescents verbally (n = 39)** | Pain: VAS |
| **Should breathing with a toy (blowing bubbles, pinwheel) be used during vaccine injections in children >3-12 y?** | | | | |
| Beran 2013, Canada | Influenza vaccine 0.5 mL IM; 25G, 1-inch needle; deltoid muscle | N = 57; children 4-9 y; between-groups design; single center, pediatric hospital clinic | Robot condition: included a humanoid robot who talked to the child before, during, and after the immunization procedure. The robot asks the child to blow on dusty toy during the immunization (n = 28) or **Control: child seated with their parent, and in front of the nurse with several toy objects on a table. The nurse administered the vaccine using current immunization guidelines (includes minimal distraction) (n = 29)** | Pain: FPS-R |
| Blount 1992, USA | Vaccine NR; no injection details | N = 60; children 3-7 y; between-groups design; | Coping Skills Training: parent coached and rehearsed with research | Pain: Faces Scale (this study was)

(Continued)
| First Author, Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|-----------------------------|-------------------|---------------------------------------|--------------|------------------|
| Bowen 1999 (1,2), USA       | Vaccine NR; no injection details | N = 80; children 3-6 y; single center, local health department | Party blower: nurse provided party blower to child and instructed them to blow as hard as they could (n = 29) or Pinwheel: nurse provided pinwheel to child and instructed them to blow as hard as they could (n = 30) or Standard care (n = 21) | Fear: Faces Scale |
| Krauss 1997, USA            | DPT and MMR; IM or SC | N = 50; children 4-7 y; single center, local health department | Treatment group: before immunization, the child and parent watched a brief videotape of a child using a party blower during immunization. The video encouraged parents to engage their child in the use of the technique during the procedure (n = 25) or Control: standard immunization procedures (n = 25) | NA (this study was not included in the meta-analysis for critical outcomes) |
| Manimala 2000 (1), USA     | Vaccine NR; no injection details | N = 55; children 4-6 y; single center, local health department | Reassurance: before the immunization, 10 min of training including rationale, examples of reassurance and when to use it during the procedures; researchers acted as role models then parent and child also role played the procedure (n = 27)* or Distraction: before immunization, 10 min of training including rationale, example techniques (eg, drawing, puzzles, talking about other things), asked to coach child to use a party blower throughout procedure; researchers acted as role models then parent and child also role played procedure (n = 26) or Control: 10 min discussion with research on child’s medical history and how parent typically interacted with child during medical procedures (n = 27) | Fear: Faces Scale |
| Sparks 2001 (2)            | DTP (n = 22) or DTaP (n = 83) ± oral polio | N = 105; children 4-6 y; single center, local health department | Stroking before and during injection with instruction to “keep thinking” | Pain: Oucher |

(Continued)
Should Verbal Distraction be Used During Vaccine Injections in Children >3 to 12 Years?

Two trials including 46 children aged 3 to 7 years investigated the impact of verbal distraction. Verbal distraction involved an adult attracting the child’s attention away from the needle by using their voice only; no additional physical, visual, or auditory distracter is used. In both trials, verbal distraction was provided by mothers who received instruction (written or oral) about how to engage in distraction with their child during the vaccine injection (eg, talking, counting, singing, reciting a poem/rhyme). There was low quality of evidence for outcome data pertaining to all assessed outcomes, largely due to lack of blinding of immunizers and/or outcome assessors (Table, Supplemental Digital Content 3, http://links.lww.com/CJP/A185). Only 1 trial examined the critically important outcome of pain and found no benefit of verbal distraction: SMD -0.27 (−1.02, 0.51).

**TABLE 2. (continued)**

| First Author | Year, Country | Injection Details | Population Enrolled, Design, Setting | Intervention | Critical Outcomes |
|--------------|---------------|-------------------|--------------------------------------|--------------|-------------------|
| Sparks 1998 thesis | USA | (preinjection) 0.5 mL IM; 22 G, 25-mm needle; vastus lateralis muscle, right or left leg | multicenter, school clinics and walk-in public health clinic | about how nice that feels” by immunizer (n = 35)* or Bubble blowing: child blew bubbles just before and during immunization (n = 35) or Control (n = 35) | Pain: Faces Scale Fear: Faces Scale |
| Cohen 2002a, b | USA | DPT and MMR; no injection details | N = 61; children 3-6 y; between-groups design; single center, rural health department | Coping skills: before immunization, child watched a 7-min video of a researcher and child providing instructions/modeling deep breathing and other coping skills (eg, positive self-statements). Child then given time to practice skills (n = 31) or Control: before immunization, child watched a 7-min video where researcher explained that people cope with immunizations in various ways. Did not provide specific suggestions. Showed child sitting quietly and getting immunization (n = 30) | Pain: Faces Scale |
| French 1994, 28 | USA | DPT; no injection details | N = 75; children 4-7 y; between-groups design; multicenter, public health immunization clinics | Blowing plus teaching: child was told what to expect and that it was OK to cry. Child then practiced blowing out air before the immunization and was coached to blow by investigator during immunization (n = 39) or Control plus teaching: child was told what to expect and that it was OK to cry (n = 36) | Pain: VAS |
| Wallace 2010, 29 | USA | DTaP or IPV (children); Tdap or meningococcal conjugate (adolescents); no injection details | N = 68; children 4-5 y and adolescents 11-13 y; crossover design; single center, outpatient pediatric clinic in a large public hospital | “Cough trick”: child was told to cough twice; the injection was delivered with the second cough (n = 68) or Treatment as usual: nurses were not instructed regarding what strategies to use, and the procedures varied to some extent (n = 68) | Pain: VAS |

Studies were identified using the following notation: “First Author” “Year of Publication” “Country” (eg, Taddio 2014, Canada). If studies contributed to multiple analyses, then “(#)” was added to enable their discernment (eg, Taddio 2014 [1]). If the same author published more than 1 study in the same year, then a lower case letter was added after the first article in the same year by the same author (eg, Taddio 2014a [1]).

See cited papers for details.

*Data not included in the analysis.

Route: DTaP, tetanus toxoid-reduced diphtheria toxoid-acellular pertussis; IM, intramuscular; SC, subcutaneous. Outcomes: FPS-R, Faces Pain Scale-Revised; VAS, visual analog scale. Vaccines: DPT, diphtheria, pertussis, tetanus; DPTP, diphtheria, pertussis, tetanus, polio; DTaP, diphtheria, tetanus, acellular pertussis; IPV, inactivated polio vaccine; MMR, measles, mumps, and rubella; NA, not applicable; NR, not reported; PPD, purified protein derivative (tuberculin skin test).
TABLE 3. Assessment of Risk of Bias of Included Trials for Critical Outcomes

| References       | Adequate Sequence Generation | Allocation Concealment | Blinding of Participants and Personnel | Blinding of Outcome Assessment | Incomplete Outcome Data Addressed | Free of Selective Reporting | Free of Other Bias | Overall Risk |
|------------------|------------------------------|-------------------------|----------------------------------------|-------------------------------|----------------------------------|---------------------------|-------------------|-------------|
| Should false suggestion be used during vaccine injections in individuals of all ages? |
| Eland 1981 (1,2)26 | Unclear                      | Unclear                 | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| Fowler-Kerry 1987 (1,3)37 | Unclear                      | Unclear                 | No                                     | No                            | Yes                              | Unclear                   | High              | High        |
| Should repeated reassurance be used during vaccine injections in individuals of all ages? |
| Gonzalez 1993 (2)39  | Unclear                      | No                      | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| Manimala 2000 (2)33 | No                           | No                      | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| Should video distraction be used during vaccine injections in children >3-12y? |
| Gonzalez 1993 (1)39  | Unclear                      | No                      | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| O’Laughlin 1995 (1)36 | No                           | Unclear                 | Yes                                     | No                            | Yes                              | Yes                       | Low              | Low         |
| Should music distraction be used during vaccine injections in children >3-12y? |
| Fowler-Kerry 1987 (2,4)27 | Unclear                      | Unclear                 | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| Megel 199834       | Yes                          | Unclear                 | No                                     | No                            | Yes                              | Yes                       | Yes               | High        |
| Noguchi 2006 (1,2)35 | Yes                          | Unclear                 | No                                     | No                            | No                               | No                       | No                | High        |
| Yinger 201239      | Unclear                      | No                      | No                                     | No                            | Yes                              | No                       | Yes               | High        |
| Should music distraction be used during vaccine injections in adolescents >12-17y? |
| Kristjansdottir 2011 (1,2)31 | Yes                          | Yes                     | No                                     | No                            | Yes                              | Yes                       | No                | High        |
| Should breathing with a toy (blowing bubbles, pinwheel) be used during vaccine injections in children >3-12y? |
| Beran 201338       | Yes                          | Unclear                 | No                                     | No                            | No                               | No                       | No                | High        |
| Blount 199239      | Unclear                      | No                      | No                                     | No                            | Yes                              | No                       | No                | High        |
| Bowen 1999 (1,2)20 | No                           | No                      | No                                     | Yes                            | No                               | No                       | No                | High        |
| Krauss 199730      | Yes                          | No                      | No                                     | No                            | Yes                              | No                       | No                | High        |
| Manimala 2000 (1)33 | No                           | No                      | No                                     | Yes                            | No                               | Yes                      | No                | High        |
| Sparks 2001 (2)37  | No                           | No                      | No                                     | No                            | Yes                              | No                       | No                | High        |
| Should breathing without a toy (blowing, deep breathing) be used during vaccine injections in children >3-12y? |
| Cohen 2002a34      | No                           | No                      | No                                     | No                            | Yes                              | Yes                      | No                | High        |
| French 199438      | No                           | No                      | No                                     | Yes                            | Yes                              | Yes                      | No                | High        |
| Should breathing interventions (cough) be used during vaccine injections in children >3-17y? |
| Wallace 201038     | Unclear                      | Unclear                 | No                                     | No                            | No                               | No                       | No                | High        |

0.47). No trials examined the critically important outcome of fear. Given the young age of participants, distress was also examined, which contained data from both trials (preprocedure, acute, and recovery distress combined) and showed a significant benefit of verbal distraction: SMD −1.22 (−1.87, −0.58) (Table, Supplemental Digital Content 3, http://links.lww.com/CJP/A185 and Figure, Supplemental Digital Content 12, http://links.lww.com/CJP/A194). Other assessed important outcomes included parents’ use of the intervention.

Should Video Distraction be Used During Vaccine Injections in Children >3 to 12 Years? Five trials including 328 children aged 2 to 12 years investigated the impact of video distraction.21–23,25,32 In these studies, interventions generally involved having the child watch an age-appropriate movie on a television screen or portable DVD player. In 3 trials, children were able to choose from a selection of movies and received additional distraction coaching while watching the movie from a nurse and/or parent.22,23,25 There was very low quality of evidence for outcome data pertaining to critically important outcomes of pain and fear, largely due to lack of blinding of immunizers and/or outcome assessors, inclusion of crossover and quasi-randomized trials, and possible contamination of treatment effects in control groups (eg, engaging in distraction) (Table, Supplemental Digital Content 4, http://links.lww.com/CJP/A186). Four trials21–23,25 found no benefit for the critically important outcome of pain: SMD −0.88 (−1.78, 0.02). Only 1 trial23 examined the critically important outcome of fear and also found no benefit of video distraction: SMD 0.08 (−0.25, 0.41). The important outcome of distress was also considered given the younger age of children (below 7 years old) providing self-report in 3 of 4 trials, the reliance on data from a single cross-over study for self-reported fear, as well as the inclusion of 1 trial that did not examine critically important outcomes of pain or fear.32 All 5 trials examined distress during at least 1 phase of treatment, with evidence of benefit of video distraction during the preprocedure (SMD −0.65 [−1.18, −0.12]), acute (SMD −0.96 [−1.85, −0.08]), and preprocedure + acute + recovery (SMD −0.58 [−0.82, −0.34]) phases (Table, Supplemental
TABLE 4. Summary of Results for Critically Important Outcomes

| Clinical Questions | Critical Outcomes* | Benefit of Intervention† | Quality of Evidence‡ |
|--------------------|--------------------|--------------------------|----------------------|
| Psychological interventions | Pain, distress, fear | No | Low |
| Should false suggestion be used during vaccine injections in individuals of all ages? | Pain, distress, fear | No | Very low |
| Should repeated reassurance be used during vaccine injections in individuals of all ages? | Pain, fear | Mixed§ | Low |
| Should verbal distraction be used during vaccine injections in children >3-12 y? | Pain, fear | Mixed§ | Very low |
| Should video distraction be used during vaccine injections in children >3-12 y? | Pain, fear | Yes | Low |
| Should music distraction be used during vaccine injections in children >3-12 y? | Pain, fear | No | Low |
| Should music distraction be used during vaccine injections in adolescents >12-17 y? | Pain, fear | Mixed | Very low |
| Should breathing with a toy (blowing bubbles, pinwheel) be used during vaccine injections in children >3-12 y? | Pain, fear | No | Very low |
| Should breathing without a toy (blowing, deep breathing) be used during vaccine injections in children >3-12 y? | Pain, fear | No | Low |
| Should breathing interventions (cough) be used during vaccine injections in children >3-17 y? | Pain, fear | No | Low |

*Includes results for the critical outcomes that were evaluated in included studies only.
†The results for the effect of the intervention have been summarized across all evaluated critical outcomes, and are expressed using the following notation: Yes, benefit was observed across all evaluated critical outcomes; Mixed, benefit was observed for 1 or more but not all evaluated critical outcomes; No, no evidence of benefit was observed for any of the evaluated critical outcomes.
‡Reflects the lowest quality of evidence rating across all evaluated critical outcomes, whereby rankings range from high to moderate to low to very low.
§Reflects inclusion of important outcome of distress in evaluating the effect of the intervention.

Digital Content 4, http://links.lww.com/CJP/A186 and Figure, Supplemental Digital Content 13, http://links.lww.com/CJP/A185. Other assessed important outcomes included parent fear, immunizer fear, parent and child preferences, and use of intervention by children, parents, and/or immunizers.

Should Music Distraction be Used During Vaccine Injections in Children >3 to 12 Years?

Four trials including 417 children aged 3 to 7 years investigated the impact of music distraction in children.27,34,35,39 In 3 of these studies, children listened to music using headphones27,34,35; in 1 study, children engaged in live music with a music therapist.39 There was low quality of evidence for outcome data pertaining to the critically important outcome of pain and important outcome of distress, largely due to inconsistent blinding of participants, immunizers, and outcome assessors (Table, Supplemental Digital Content 5, http://links.lww.com/CJP/A187). Three trials that could be pooled for the critically important outcome of pain27,34,35 found a benefit of music distraction: SMD = −0.45 (−0.71, −0.18) (Table, Supplemental Digital Content 5, http://links.lww.com/CJP/A187 and Figure, Supplemental Digital Content 14, http://links.lww.com/CJP/A196). No trials examined the critically important outcome of fear.

Given the young age of participants, the important outcome of distress was also considered and was assessed in 2 trials at various phases of the procedure. There was a beneficial effect on preprocedure distress (SMD = −0.48 [−0.86, −0.10]) and acute distress (SMD = −0.49 [−0.87, −0.11]). Whereas, there was no benefit on distress during the acute plus recovery phases combined (SMD = −0.27 [−0.65, 0.10]), or during the recovery phase only (SMD = −0.09 [−0.46, 0.29]) (Table, Supplemental Digital Content 5, http://links.lww.com/CJP/A187 and Figure, Supplemental Digital Content 14, http://links.lww.com/CJP/A196). Other assessed important outcomes included procedure duration, parent preferences, and child use of intervention.

Should Music Distraction be Used During Vaccine Injections in Adolescents >12 to 17 Years?

One trial including 118 adolescents aged 13 to 15 years investigated the impact of music distraction in adolescents.51 In this trial, adolescents listened to music of their choice from an available selection. Half of adolescents who received the intervention wore headphones, whereas the other half did not. There was low quality of evidence due to lack of blinding of participants, who reported no benefit of the intervention for the critical outcome of pain: SMD = −0.04 (−0.42, 0.34) (Table, Supplemental Digital Content 6, http://links.lww.com/CJP/A188 and Figure, Supplemental Digital Content 15, http://links.lww.com/CJP/A197). No data were available for the critically important outcome of fear or other important outcomes.

Should Breathing With a Toy (Blowing Bubbles, Pinwheel) be Used During Vaccine Injections in Children >3 to 12 Years?

Six trials including 368 children aged 3 to 9 years investigated the impact of breathing with a toy in children.18,19,20,30,33,37 In all studies, children were directed to blow on a toy (ie, party blower, pinwheel, bubbles, small toy). One study provided instruction from a robot to blow on a dusty toy,18 and in 3 trials, children were supported with additional rehearsal or coaching from parents,
researchers, or immunizers. There was very low quality of evidence for outcome data pertaining to critically important outcomes of pain and fear, largely due to lack of blinding of immunizers, participants, and/or outcome assessors, inclusion of quasi-randomized trials, and possible contamination of treatment effects in control groups (Table, Supplemental Digital Content 7, http://links.lww.com/CJP/A189).

Two trials, found a benefit of breathing with a toy for the critically important outcome of pain: SMD = 0.49 (−0.85, −0.13), whereas 2 different trials found no benefit of breathing with a toy for the critically important outcome of fear preprocedure (SMD = 0.53 [−1.07, 0.01]) or acute fear (SMD = 0.60 [−1.22, 0.02]).

Given the young age of participants, the important outcome of distress was also considered. Two trials found a benefit of breathing with a toy for acute distress: SMD = 0.80 (−1.17, −0.42); and 4 trials found a benefit for preprocedure + acute + recovery phases combined: SMD = 0.55 (−0.82, −0.28) (Table, Supplemental Digital Content 7, http://links.lww.com/CJP/A189 and Figure, Supplemental Digital Content 16, http://links.lww.com/CJP/A198). Other assessed important outcomes included parent fear, child and parent use of intervention, and child and parent preferences.

Should Breathing Without a Toy (Blowing, Deep Breathing) be Used During Vaccine Injections in Children >3 to 12 Years?

Two trials including 136 children aged 3 to 7 years investigated the impact of breathing without a toy in children. In 1 study, children were taught deep breathing, in addition to coping skills; in the other study, were instructed to blow out air during the injection. In both trials, children were given time to practice the skills before the injection. There was very low quality of evidence for outcome data pertaining to critically important outcomes of pain and fear, largely due to lack of blinding of participants and outcome assessors, inclusion of quasi-randomized trials, and selective outcome reporting (Table, Supplemental Digital Content 8, http://links.lww.com/CJP/A190). Both trials found no benefit of breathing without a toy for the critically important outcome of pain: SMD = 0.27 (−0.61, 0.07). One trial examined the critically important outcome of fear and found no benefit of the intervention: SMD = 0.36 (−0.86, 0.15). Given the young age of participants, the important outcome of distress was also considered. Distress was examined in both trials, although the phase of procedure was unclear. No benefit of breathing without a toy was observed: SMD = 0.27 (−0.61, 0.07) (Table, Supplemental Digital Content 8, http://links.lww.com/CJP/A190 and Figure, Supplemental Digital Content 17, http://links.lww.com/CJP/A199). No other important outcomes were assessed.

Should a Breathing Intervention (Cough) be Used During Vaccine Injections in Children >3 to 17 Years?

One trial including 136 children (aged 4 to 5 y) and adolescents (aged 11 to 13 y) investigated the impact of a breathing intervention (cough). Children and adolescents were asked to cough once before and once at the time of the injection. There was low quality of evidence for outcome data pertaining to the critically important outcome of pain, largely due to lack of blinding of participants and inclusion of a cross-over trial (Table, Supplemental Digital Content 9, http://links.lww.com/CJP/A191). No benefit was found for the critically important outcome of pain: SMD = 0.17 (−0.41, 0.07). No data were available for the critically important outcome of fear (Table, Supplemental Digital Content 9, http://links.lww.com/CJP/A191 and Figure, Supplemental Digital Content 18, http://links.lww.com/CJP/A200). Other assessed important outcomes included distress and child satisfaction.

DISCUSSION

This systematic review was conducted to investigate the effectiveness of various psychological interventions used by children, adolescents, their parents, and/or immunizers to reduce adverse effects from vaccine injections including pain and pain-related outcomes. Only simple psychological interventions were considered, such as those including distraction and/or interactions between children and parents, nurses, and/or immunizers. There was some evidence to support the following interventions in children: verbal distraction, video distraction, music distraction, and breathing with a toy. Available evidence was insufficient to support the following interventions with children: false suggestion, repeated reassurance, and breathing without a toy. There was insufficient evidence to support use of breathing intervention (cough) with children or adolescents, or use of music distraction with adolescents.

The only psychological intervention with consistent evidence supporting its use across pain and pain-related outcomes was music distraction in children younger than 12 years old. Benefit was shown in studies that used age-appropriate recorded music delivered to children using headphones, as well as more involved live music distraction interventions provided by a music therapist. Behavioral distraction (eg, telling children to do something distracting) is a generally effective coping strategy in young children, and in most of the included trials, children received additional support to engage fully with the music. The positive benefit of music in children is promising, as it can rely on minimal resources and no training to be implemented effectively by parents or immunizers. In general, music seems to be an effective pain management strategy for children, with supportive evidence from other types of medical procedures.

The results were mixed regarding the benefit of verbal distraction in children. Child ratings of pain indicated no benefit from the intervention, whereas observer ratings of the child’s distress were reduced. In both trials, mothers received instruction on how to verbally distract their child by counting, singing, or talking about topics other than the vaccine injection. This pattern of findings, including benefit for reducing observed child distress but not self-reported pain, has been noted in studies examining parent-led distraction for other types of needle procedures. Although providing instruction to parents was shown to increase their use of distraction with their child during vaccine injections, equivocal findings with regards to self-reported pain may be explained due to the mix of parent behaviors observed in both the distraction intervention and the control group.

More specifically, some mothers in the distraction intervention group also engaged in behaviors that have been shown to increase children’s pain (ie, reassurance), and some mothers in the control group naturally engaged in distraction. Although not examined in the included trial, increased doses of verbal distraction from parents have been associated with greater reduction of pain and distress.
in children undergoing other needle procedures regardless of training in verbal distraction.46 Furthermore, not all parents are effective distraction coaches. In particular, highly distressed parents seem less able to successfully distract their child.47,48 None of the included studies examined nurse-led verbal distraction; however, other nurse-led psychological interventions have previously been shown to be effective for vaccine injections,2 and may pose a reasonable alternative when parents are highly distressed. Relatively minor resources are needed to instruct parents in use of verbal distraction (eg, providing a pamphlet).36 Furthermore, parents are typically present at vaccine injections with young children, making this a very feasible intervention to implement.

The results were also mixed for video distraction with demonstrated benefit of reduced distress across all procedure phases (pre, acute, and recovery), but not reduced pain or fear. Given that distraction is most effective when it is interesting, enjoyable, and engaging, the child’s ability to choose and interact with the video distracter may be critical.49 The reviewed video distraction interventions generally relied on older technology (ie, DVD players and televisions). This may pose some impediment to clinical settings when required resources are limited or unavailable for families to use. Readily available smartphones and smart devices offer a feasible and promising alternative, and are already being used by some in clinical practice to manage pediatric procedural pain.50 In support of this hypothesis, a recent nonrandomized study reported reduced distress in children aged 2 to 5 when iPads were used to distract them during immunizations; however, it should be noted that lack of randomization makes this study at high risk of bias.40 Interactive distraction interventions show some evidence for increased efficacy over more passive distraction for reducing distress during pediatric needle procedures.5 Given the many highly interactive videos and games available on smart devices, their use for vaccine injections is worthy of future research.

Findings showed mixed benefit for the use of breathing with a toy, but no support for breathing without a toy or for a breathing intervention (cough). The type of breathing children and/or adolescents were instructed to do as part of these interventions (ie, blowing out air, coughing) may have been insufficient to induce any sort of relaxation response and/or distract children on their own. Research has shown that relaxation during breathing is an important mechanism for modulating physiological responses to stress and influencing pain perception, as compared with simply attending to the breath in the absence of efforts to relax.51 It is likely that the small toys that assisted children during the “breathing with a toy” interventions also served as distracters (eg, bubbles, pinwheel, party blower), thereby potentially bolstering the effectiveness of the intervention on pain. As is noted in this review and in others, distraction is a generally effective strategy for reducing pain and pain-related outcomes during pediatric medical procedures.5,49,52 Thus, the availability of a toy may have enhanced the efficacy of breathing alone by enhanced distraction. However, no trials provided a head-to-head comparison of breathing with and without a toy, making it difficult to conclude what components of the intervention were the most effective.

Behaviors of parents and other adults (eg, nurses) have received extensive study in the context of pediatric medical procedures, and have been shown repeatedly to exert helpful and unhelpful influences on children’s pain and distress.53 Although seemingly counterintuitive, a generally consistent finding is that reassurance seems to be unhelpful for children when they are in pain.54,55 One reason may be because children perceive adults as being worried when they reassure, which may in turn increase child distress.45 Although there may be forms of reassurance that are more helpful than others,45 the lack of benefit for repeated reassurance found for vaccine injections in this review is consistent with extant research, and is thus, not recommended when other adult behaviors, such as distraction, are helpful. Although the evidence base consisted of children only, the counterintuitive relationship between reassurance and increased distress has been found in infants54,56,57; furthermore, although in a different context, medically focused reassurance has also been shown to be ineffective for adults with high levels of health anxiety.58

Included trials also assessed the impact of an adult (nurse or researcher) suggesting to the child that something was being done to help make the injection easier. As with repeated reassurance, false suggestion showed no benefit for reducing children’s pain or distress. Suggestion showed no benefit in and of itself, indicating that there was no observed placebo effect induced by a simple statement that some sort of pain management was being used in the absence of a real intervention. There was also no benefit for suggestion used as a means of enhancing the efficacy of another intervention (ie, distraction or vapocoolant). Use of false suggestion as a placebo or to overstate the efficacy of an intervention may be perceived by the person being immunized as deceitful and may lead to distrust of immunizers and health care professionals more broadly, potentially leading to noncompliance with medical care.

Thus, use of false or simplistic suggestion may be problematic for individuals of any age being immunized across the lifespan.

Other than the breathing intervention (cough), the only other psychological intervention studied in adolescents was music distraction. In contrast to the clear benefits of music distraction for children below 12 years old, no support was found for use of music distraction with adolescents above 12 years old. This is consistent with a recent systematic review and meta-analysis that found no evidence supporting use of distraction to reduce pain and distress in adolescents across all types of needle procedures.5 Three of the 4 distraction interventions studied, in samples of predominantly adolescents, included music.59-61 However, evidence for music distraction in adolescents based on a single trial in the current review, and the ability to detect differences between treatment and control groups may have been impeded by the very low levels of self-reported pain following the injection in both groups (ie, average pain <1/10) in this study, potentially introducing floor effects.31 Developmental differences are noted in coping strategies, preferences, and self-efficacy across childhood and adolescence.52 In particular, adolescents seem to have different preferences in how they want to cope depending on the stressor, and they increasingly draw on cognitive strategies.52 Although 70% to 80% of the adolescents in the music distraction trial identified using music to cope with emotional stress, only about half indicated they typically use music to cope with pain.31 It may be that the requirement for adolescents to use music during the vaccine injection detracted from use of a more preferred (and effective) coping strategy (eg, positive self-talk). More research is needed to understand whether individual...
This is concerning, as high risk of bias has been associated with exaggerated treatment effects. While blinding of children, parents, and immunizers to study group can sometimes be difficult given the nature of psychological interventions (ie, it is difficult to hide the presence of a television or headphones), efforts can be made to blind individuals to study hypotheses, and researcher-ratings of the child’s distress can readily be achieved. Several trials also noted contamination of treatment effects in control groups. Although this may be unavoidable due to the natural engagement of parents or other adults’ in specific behaviors (ie, distraction), it does support the value of assessing the natural occurrence of the intervention in control groups. Future trials need to improve the quality of evidence by considering necessary design considerations a priori. A more detailed discussion of limitations of the available evidence and discussions for future research in all areas of pain management for vaccine injections is also available.

Despite the unavoidable limitations posed by the available evidence in this area, the current systematic review and meta-analysis was very rigorous in its approach. A thorough database search for all relevant studies was undertaken, with consistent a priori decisions for identifying relevant clinical questions and critically important outcomes as derived by a multidisciplinary national panel of experts in vaccination pain management (HELPinKids&Adults team). The application of high quality established methods for pooling data and evaluating the quality of evidence ensures confidence in the review’s findings (GRADE10; Cochrane11). Furthermore, a unique strength arises from the inclusion of this review within a series of similar reviews examining psychological interventions for vaccine injections across the lifespan,8 reviews examining physical, procedural, and pharmacological approaches to vaccine pain management, as well as a review on the management of high levels of needle fear.12 The compilation of these reviews in clinical practice guidelines ensures the utility, feasibility, and practicality of a multipronged approach to vaccine pain management and long-term sequelae, and encourages uptake of these findings in clinical practice (also McMurtry CM, Taddio A, Noel M, et al., unpublished data, 2015).69

In summary, a number of psychological interventions show benefit for reducing pain and pain-related outcomes during vaccine injections in children. Effective interventions largely seem to include some degree of distraction, with music distraction being the most consistently beneficial across assessed outcomes for children. In general, effective psychological interventions require minimal training to be implemented by children, parents, and/or immunizers, and can draw from varied available resources, ensuring their clinical utility and appropriateness for children of different ages and at a global level.

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