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The number of injected same-day preschool vaccines relates to preadolescent needle fear and HPV uptake

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ABSTRACT

Purpose: Fear of needles develops at approximately five years of age, and decreases compliance with healthcare. We sought to examine the relationship of preschool vaccine history, parent and preadolescent needle fear, and subsequent compliance with optional vaccines.
Methods: As part of a private practice randomized controlled trial, parents and 10–12 year olds rated needle anxiety on a 100 mm visual analog scale. This follow-up cohort study compared their needle anxiety to previous vaccination records, including number of vaccinations between ages four and six years (total and same-day maximum), and subsequent initiation of the HPV vaccine through age 13.
Results: Of the 120 preadolescents enrolled between 4.28.09 and 1.19.2010, 117 received preschool vaccinations between ages four and six years. The likelihood of being in the upper quartile of fear (VAS $\geq$ 83) five years later increased with each additional same-day injection (OR = 3.108, p = 0.0100 95%CI = 1.311, 7.367), but was not related to total lifetime or total four-to-six year injections. Only 12.5% (15) of parents reported anxiety about their preadolescents' vaccines (VAS > 50). Parent and child anxiety was weakly correlated (r = 0.15). Eight children in the upper fear quartile began their HPV series (26.67%) compared to 14 in the lower quartile (48.28% VAS < 32) (OR 2.57, p = 0.0889, 95%CI 0.864–7.621); there was no difference in HPV uptake between upper and lower quartile of parent anxiety.
Conclusions: The more same-day preschool injections between 4 and 6 years of age, the more likely a child was to fear needles five years later. Preadolescent needle fear was a stronger predictor than parent vaccine anxiety of subsequent HPV vaccine uptake.

1. Introduction

Fear of needles impacts parents' willingness to have children vaccinated [1–3] and affects adults' subsequent healthcare experiences [4–6]. According to hospitalized children, needle punctures are their greatest source of pain next to their disease [7]. The effects of untreated needle pain are remembered even by preverbal children [8,9], and may amplify with age: up to 15% of geriatric patients refuse flu shots due to injection fear [10], and 28% of HIV patients delayed being tested [11]. Young adults delay or may not seek medical treatment [12], and almost 40% of adults refused blood sampling due to reported fear of needle pain [13].

Despite these associations between fear of needles and health behaviors, prospective research into the cause, incidence and impact of needle fear is scant. When the incidence of needle phobia in the general population was described in 1995, 10% of adults and 25% of children reported a moderate to severe fear of needles [14]. In 2012, Taddio et al. reported a 2.5-fold increase: 23% of adults and 63% of children [3]. The cause of this increase has not been explained. Retrospective publications have hypothesized that experiences between ages four and six years result in an acquired fear of needles [15]. The blood donation literature supports that needle-associated vasovagal responses [16] are primarily predicted by acquired needle fear and lead to decreased blood donation [17–19], and recent work suggests vaccines play a role in the development of fear [5,6].

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In a previous study we collected parent anxiety and child fear of impending vaccinations at a 10–12 year routine pediatric visit [20]. For the current study, we compared these responses with previous vaccination history and subsequent vaccination records through age 13 to evaluate the impact of fear on the subsequent decision to initiate the HPV series. Our aim was to determine if more vaccinations at one time and younger initiation of the childhood vaccines would be associated with greater fear of needles at age 10–12 years. In addition, we hypothesized that greater needle fear would be associated with reduced initiation of HPV vaccination.

2. Methods

This cohort study included preadolescents enrolled at a private pediatric office in Atlanta Georgia in the United States between 4.28.09 and 1.19.2010 as part of a randomized controlled clinical trial NCT00910611 supported by the NIH/SBIR Grant 4R44HD056647-02. The current study evaluated the cohort's immunization records through 10.31.13; both studies were approved by the IRB of Georgia State University. For the initial recruitment, all children ages 10–12 years of age presenting to their pediatrician to receive scheduled required intramuscular (IM) vaccinations were eligible for inclusion. Patients were excluded if there was no caregiver available to give informed consent, there were clear cognitive impairments affecting children's ability to understand or communicate the measures used in the study, or parents or children were unable to speak English.

After written informed consent and assent were obtained from the parent and child respectively, the accompanying caregiver provided information about their relation to child, sex, age, race, and maternal level of education, and child's date of birth, sex, race, relevant medical and vaccine history. Prior to randomization, children and parents heard a script explaining how 100 mm Visual Analog Scales (VAS) were used. Parents indicated their child's historical anxiety with vaccination on a 100 mm linear VAS between 0 = "usually not at all upset" to 100 = "usually extremely upset," and their own anxiety about the child's vaccinations that day. Children indicated with a vertical mark on a separate VAS how fearful they were about their shots on that day, between *not at all anxious* and *most anxiety possible*. While "fear" is the technical academic term used to describe justified anxiety with impending pain, we chose to use the less loaded words "anxiety" and "nervousness" in the data collection instrument. Parents and children were blinded to the others' response.

Immunization history was obtained from the Georgia Registry of Immunization Transactions and Services (GRITS), a state-wide computer database populated by the pediatric offices. Twelve charts were initially missing vaccination data and required additional follow up to verify the records. When state data was missing, researchers verified vaccines and dates with the primary care physician. When the primary care physician was unable to verify whether a patient received a vaccine or the date, parents were contacted directly to confirm.

2.1. Statistical analysis

The sample size was predetermined for the three arm controlled trial of a pain relief device; all recruited subjects were eligible for inclusion in the current cohort. Presumptive predictors of preadolescent fear included parental anxiety, the greatest number of single-day injections between age four and six, age in months at that time, the total number of childhood vaccinations and total between age four to six. Quantitative variables were categorized into quartiles, and adjacent categories combined when similar. Cochran-Mantel-Haenszel Statistics were used to calculate odds ratios and assess for significance of relationships and dose-response. Relationships between child fear and parent anxiety were examined using scatterplots, Pearson's correlation coefficient, histograms and paired mean analyses. Number of injections as a predictor of child fear was modeled using linear and logistic regression. Data were analyzed with SAS 9.4 (Cary, North Carolina).

3. Results

120 children aged 10–12 years were enrolled between April 28, 2009 and January 19, 2010. (Fig. 1) One patient was previously unvaccinated, and two patients were not vaccinated within the four to six year age range; these were excluded from further prospective fear quartile analysis.

There were no demographic differences between preadolescents in the low, middle two, and upper quartiles of fear. (Table 1) Parents were much less likely to be anxious about their child's vaccinations that day than their children. (Fig. 2) The majority of parents (63%) indicated an anxiety about their child's vaccines of 10 mm or less, with 27 parents endorsing 0/100 mm. Only 15/120 parents (12.5%) indicated an anxiety of 50 mm or greater. In addition, parent anxiety was weakly correlated to child fear ($r = 0.15$ $p = 0.0150$) (Fig. 3).

The median endorsement of fear for the children was 56/100. The likelihood of children being in the upper quartile of fear (VAS ≥ 83) was related to the number of previous vaccinations on one day in a dose response manner, (Fig. 4) however the age or injection relationship did not fit a linear model ($r = 0.19724$, $p = 0.0330$). No child receiving one injection was in the upper fear quartile, 2(9.5%) with two, 22(26.8%) with three, and 6(50%) of children who received four vaccinations on the same day ($p = 0.0387$). For every 1 additional same-day injection, the likelihood of being in the highest fear group five years later increased (OR = 3.108, $p = 0.0100$ 95%CI = 1.311, 7.367).

The correlation between parents' VAS assessment of "How does your child usually react to vaccinations?" (not at all to extremely upset) and the child's reported fear of their vaccinations was $r = 0.45$, $p \leq 0.0001$, indicating moderate correlation. 53% of parents underestimated anxiety (mean 32 mm), 13% were within ±5 mm of their child's stated anxiety, and 34% overestimated (mean 25.9 mm). A paired means analysis showed a significant difference in the parents' historical estimation of their child's anxiety and their child's anxiety report ($p = 0.0085$).

The total number of prior vaccinations over a child's lifetime was not related to fear at age 10–12 years ($r = 0.11$) or initiation of HPV vaccination. HPV initiation for children whose parents were in the lower or upper quartile of vaccine anxiety did not differ. However, 26.7% of children in the upper quartile of needle anxiety ($\geq$83 on VAS) began their HPV series compared to 48.3% of those in the least anxious quartile (<32 on VAS) (OR 2.57, $p = 0.0889$, 95%CI 0.864–7.621) (Fig. 5).

4. Discussion

This study found that preadolescent fear related to childhood single-day injection history in a dose-dependent manner, but the infant and total number of childhood vaccinations did not predict fear. Parents of preadolescents underestimated their children's anxiety, and parent and child anxiety correlated poorly: parents skewed toward "not anxious" while the preadolescents skewed to the "most anxiety possible". Preadolescents' needle fear was a stronger predictor of subsequent uptake of the HPV vaccine than parent vaccine anxiety.

Needle fear is associated with decreasing adherence to healthcare, but the genesis of this fear is unclear [21]. Retrospective stud-

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