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Pediatric Nurses' Beliefs and Pain Management Practices: An Intervention Pilot

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Abstract

We evaluated feasibility of the Internet-based Relieve Children's Pain (RCP) protocol to improve nurses' management of children's pain. RCP is an interactive, content-focused, and Kolb's Experiential Learning Theory-based intervention. Using a one-group, pre/posttest design, we evaluated feasibility of RCP and pre/post difference in scores for nurses' beliefs, and simulated and actual pain management practices. Twenty-four RNs completed an Internet-based Pain Beliefs and Practices Questionnaire (PBPQ, $\alpha=.83$) before and after they completed the RCP and an Acceptability Scale afterward. Mean total PBPQ scores significantly improved from pre-to-posttest as did simulated practice scores. After RCP in actual hospital practice, nurses administered significantly more ibuprofen and ketorolac and children's pain intensity significantly decreased. Findings showed strong evidence for the feasibility of RCP and study procedures and significant improvement in nurses' beliefs and pain management practices. The 2-hour RCP program is promising and warrants replication with an attention control group and a larger sample.

Keywords

Children; pain; nursing; pain management; intervention

In 2006, 2.3 million American children were hospitalized; 1.2 million experienced surgery (DeFrances, Lucas, Buie, & Golosinskiy, 2008). Researchers indicate that 51% to 72% of hospitalized children reported moderate to severe pain (Beyer, 2000; Tesler, Wilkie, Holzemer, & Savedra, 1994; Van Hulle Vincent & Denyes, 2004). Unrelieved pain can result in increased pain sensitivity later in life (Mitchell & Boss, 2002; Taddio, Katz, Ilersich, & Koren, 1997; Weisman, Bernstein, & Schechter, 1998). Pediatric nurses' misconceptions about the legitimacy of self-reported pain intensity measurement and opioid pharmacokinetics and dynamics contribute to the inadequate pain relief for hospitalized children. Pediatric nurses relied on children's behaviors and/or physiologic responses, rather than self-report, to judge pain intensity and to choose doses of morphine in case study vignettes (Van Hulle Vincent & Denyes; Van Hulle Vincent & Gaddy, 2009; Van Hulle Vincent, Wilkie, & Szalacha, 2010). Nurses also demonstrated faulty beliefs about analgesic use for children (Ellis et al., 2007; Manworren, 2000; Rieman & Gordon, 2007; Van Hulle Vincent, 2005; Van Hulle Vincent & Denyes; Van Hulle Vincent & Gaddy). Furthermore,

pediatric nurses administered significantly fewer analgesics than that available by physician order and less than recommended by national standards (Helgadóttir & Wilson, 2004; Van Hulle Vincent & Denyes). Intervention is critically needed to advance nurses' beliefs and pain management practices in order to improve children's pain relief.

Beliefs and Pain Management Practices

Self-report is the most important indicator of the existence and intensity of pain for children 4 years of age and older (American Academy of Pediatrics & American Pain Society [AAP & APS], 2001; von Baeyer et al., 2009), and observation of behavior should be used to complement the self-report or when self-report is not possible (AAP & APS). Physiological measures (such as vital signs) usually reflect "stress reactions during acute pain and are only tenuously correlated with the self-report of pain" (AAP & APS, p. 794). In studies of children's pain, researchers showed that children's behavior, especially young children's behavior, does not correlate well with their self-report of pain intensity (Beyer, McGrath, & Berde, 1990; Goodenough, Champion, Laubreaux, Tabah, & Kampel, 1998; Tesler, Holzemer, & Savedra, 1998; Willis, Merkel, Voepel-Lewis, & Malviya, 2003). Taken together, the evidence demonstrates that children's self-reports must be the primary measure of their pain intensity when they are able to provide a self-report.

Unfortunately, pediatric nurses, who must rely on infant and young patients' behavior, continue to rely on behavior more than the child's self-report to judge pain intensities in children older than 4 years of age who are clearly able to report their pain levels. In vignettes, nurses agreed more often with 10-year-old grimacing patients' than 10-year-old smiling patients' self-report and undermedicated the smiling patients to a greater extent and more often than they did for the grimacing patients (Van Hulle Vincent, 2007; Van Hulle Vincent & Denyes, 2004; Van Hulle Vincent et al., 2010). Nurses wanted to see overt and objective evidence of pain (behavior, vital sign change) before agreeing with the child's reported pain intensity level or administering an increased dose of morphine to a smiling child who reported severe pain on a standardized pain scale (Van Hulle Vincent & Gaddy, 2009). These findings indicate that pediatric nurses are not recognizing the legitimacy of pain intensity measured with self-report scales despite vast evidence indicating that self-report is the gold standard for children able to self-report their pain.

Pediatric nurses have demonstrated faulty beliefs about analgesic use with children and have reported unsupported beliefs about opioid pharmacokinetics and dynamics including drug dosing, effects (peak and duration), and titration; respiratory depression; sedation; and addiction (Ellis et al., 2007; Manworren, 2000; Rieman & Gordon, 2007; Van Hulle Vincent, 2005; Van Hulle Vincent & Denyes, 2004; Van Hulle Vincent & Gaddy, 2009). Unless nurses understand the pharmacokinetic and pharmacodynamic effects of opioids, it is unlikely that hospitalized children will receive optimal pain relief.

Researchers found that pediatric nurses consistently administered amounts of analgesics that were substantially less than those recommended by national standards (Helgadóttir & Wilson, 2004; Van Hulle Vincent & Denyes, 2004) and less than amounts available by physician order (Simons & Moseley, 2008; Twycross, 2007; Van Hulle Vincent & Denyes). Research of children's pain intensity levels over a similar period has also shown that children's pain has not been adequately relieved (Beyer, 2000; Ellis et al., 2002; Huth, Broome, Mussatto, & Morgan, 2003; Johnston, Bournaki, Gagnon, Pepler, & Bourgault, 2005; Kotzer, 2000; Pölkki, Pietilä, & Vehviläinen-Julkunen, 2003; Van Hulle Vincent & Denyes) with substantial numbers of children reporting moderate to severe pain. These findings demonstrate that although the International Association for the Study of Pain (Finley, Franck, Grunau, & von Baeyer, 2005) advocates for the effective use of analgesic

medication for children to prevent and treat their pain, nurses have not consistently administered analgesics in sufficient doses or at frequent enough intervals to relieve hospitalized children's pain.

There has been limited examination of the effects of educational interventions on pediatric nurses' beliefs and pain management practices; few research teams examined analgesic administration as an outcome. Investigative teams (Ellis et al., 2007; Johnston et al., 2007; Le May et al., 2009) reported nurse outcomes of improved perception of pain assessment and management (Ellis et al., 2007), improved knowledge (Johnston et al.; Le May et al.), increased frequency of pain assessment documentation (Le May et al.), and increased use of nonpharmacological interventions (Johnston et al.). Of the teams who measured analgesic administration, Johnston et al. and Le May et al. reported no significant change in nurses' analgesic administration. Children's pain levels were not measured in any study.

We used Ajzen and Fishbein's (1980) theory of reasoned action to provide direction for this study. Main concepts of this theory are many, but those used to guide this pilot study included: beliefs, intention, and behavior. According to Ajzen and Fishbein, behavioral change is ultimately the result of change in beliefs and that one's behavior is predicted by one's intention to perform the behavior. In order to influence behavior, one must be exposed to information that will produce a change in one's beliefs. Therefore, in this study we provided nurses with evidence-based information that we expected would change their beliefs about the legitimacy of self-report and analgesic use and subsequently their pain management practices. We conceptualized nurses' intentions as their simulated pain management practices in case study vignettes.

Purpose

The purpose of the study was to evaluate the feasibility of the Internet-based intervention Relieving Children's Pain (RCP) and study procedures. The RCP is an innovative, interactive, content-focused, and Kolb's experiential learning theory-based intervention to improve hospitalized children's pain management. As indicators of protocol feasibility, we measured: (a) the length of time required for nurses to complete the RCP; (b) its acceptability to them; (c) the percent of nurses who participated and completed the study; (d) the number of medical records obtained that included documentation of prescribed and administered analgesics; and (e) pre/post change in aggregate scores for the nurses' beliefs (legitimacy of self-report, effects of unrelieved pain, use of analgesics, opioid kinetics), pain management practices (simulated [pain assessment and opioid administration in case study vignettes], actual [available analgesics administered]), and children's pain intensity levels. We expected the nurses to complete RCP and the pretest/posttests in 2 to 2.5 hours, 75% of the nurses rate it acceptable, 75% participate, 90% complete the study; 100% of the medical records obtained. We also expected that the change in nurses' beliefs and practices scores show a trend for beliefs and pain management practices that support pain relief for hospitalized children.

Methods

We used a quasi-experimental one-group pretest-posttest design (Polit & Beck, 2008) to evaluate feasibility and acceptability of the RCP intervention and study procedures. We measured feasibility of the intervention by examining one unit's pediatric nurses' beliefs and pain management practices prior to the intervention and immediately after the intervention. The analytic unit of this feasibility study is the pediatric unit, which served as its own control. This approach is consistent with the theory of reasoned action (Ajzen & Fishbein, 1980) and reflective of a dynamic practice environment where a single nurse does not

provide all the pain management for a single hospitalized child. Instead, a number of different nurses provide care 24 hours per day for the several days that a child is hospitalized. Conducting an aggregate level analysis is an innovative approach to addressing a dynamic practice environment.

Sample

The only eligibility criterion was to be a nurse working on the one selected patient-care unit. We recruited a convenience sample of 30 registered nurses, 75% of the 40 nurses working on the selected patient-care unit at a children's hospital in the Midwest; 24 of these 30 nurses completed RCP (80% of recruited, 60% of nurses on unit). Three of the recruited nurses accessed the website, consented to participate, and completed the pretest but did not complete the rest of RCP; two of these nurses were unable to complete because the content portion of the program was not compatible with a Macintosh computer. Participants cared for at least 1 to 5 children in pain per week with most (79.2%) caring for six or more children per week. Participants' mean age was 31.2 ($SD = 8.9$) years and their mean years of pediatric experience was 7.4 ($SD = 9.5$). Twenty-three of the 24 participants reported that they were female, white, and non-Hispanic/Latina. Most were prepared with a Baccalaureate in Nursing degree (66.7%) with other participants reporting education preparation of Masters of Nursing (16.7%), Associate Degree (8.3%), Diploma (4.2%), or other (4.2%).

Intervention

We used Kolb's experiential learning theory (Kolb, 1983) (ELT) to guide the development and deployment of the RCP intervention. Kolb's theory is "experiential" to emphasize the central role that experience plays in the learning process. Kolb contends that his ELT is consistent with what is known about how people learn, grow, and develop and thus is both a holistic and multilinear model of adult development. Kolb describes learning as requiring both grasping (perceiving) the experience and transforming (processing) the experience; either alone is not sufficient. The two modes for grasping experience include concrete experience (CE) and abstract conceptualization (AC), whereas the two modes for transforming experience are reflective observation (RO) and active experimentation (AE). Some individuals' perceive new information through experiencing the concrete and tangible qualities of the world; they rely on their senses and immerse themselves in concrete reality (CE). Other individuals perceive new information through symbolic representation or abstract conceptualization; they think and analyze rather than rely on their senses (AC). Similarly for processing information, some individuals carefully watch others who are involved in an experience and reflect on what happened (RO), whereas others jump right in and take action (AE). Therefore, for any effective educational intervention, content must be presented in all four modes to maximize successful learning for each individual.

Based on Kolb's theory, the RCP, delivered via a password-protected Internet site, included all four modes: beginning with a concrete experience (CE), allowing reflection on the experience from multiple perspectives (RO), content presented in the abstract conceptualization (AC), and ending with active experimentation (AE) to generalize or transform the content to practice behaviors in other situations. Table 1 provides examples of the Kolb learning modes with content (legitimacy of self-report, use of analgesics, deleterious effects of unrelieved pain) for the RCP intervention.

In the RCP intervention, the media files (e.g., photographs, videotapes, audio clips) include a variety of people representing rich diversity. The graphics are colorful and help to illustrate concepts. The participant is allowed flexibility in navigating the content within and between the learning modules after completion of the pretest and prior to beginning the posttest. Therefore, interactivity is maximized but the program design protects the integrity

of the pretest and posttest measures of study outcomes related to beliefs and simulated practice.

Measures

We used three measures of study variables: the Computer Program Acceptability Scale, Pain Beliefs and Practices Questionnaire (PBPQ), and medical record abstraction. Each instrument is described in the following sections.

Computer Program Acceptability Scale—This acceptability survey is a 13-item self-reported tool focused on the use of the computer program (e.g., technical difficulty, visual problems, instructions, comprehensive information). Each item is scored 0 as “not acceptable” or 1 as “acceptable.” The acceptability score for each individual is calculated by the sum of the 13 items, with possible scores ranging from 0 to 13. Validity of the Computer Program Acceptability Scale has been assessed in adults with pain or cancer pain using an interactive computerized pain assessment program or a similar multimedia educational program (Wilkie et al., 2001; Wilkie et al., 2003). Four-week test-retest reliability revealed Spearman's $\rho(16) = .77, p < .001$ (Wilkie, personal communication). We modified two of the items to represent children's pain management.

PBPQ: Beliefs—The PBPQ includes two scores: (a) total beliefs score based on 26 items focused on nurses' beliefs about the legitimacy of self-report, effects of unrelieved pain, and use of analgesics (dosing, respiratory depression, sedation, addiction) and (b) opioid kinetics score based on 16 items focused on nurses' beliefs about the pharmacokinetics of morphine, hydromorphone (Dilaudid), and oxycodone. Sample items appear in Table 2.

For the 26-item total beliefs score, response options are on a Likert-type scale that ranges from 1 (do not agree at all) to 6 (agree very much). The total score is determined by calculating a mean score of all items with higher mean scores indicating pain management beliefs that are supportive of effective pain management. We adapted select items for the PBPQ from Manworren's Pediatric Nurses' Knowledge and Attitudes Survey Regarding Pain (PNKAS) (Manworren, 2001) and from Ward and colleague's Barriers Questionnaire (BQ) (1993), supporting content validity. Based on research findings (Van Hulle Vincent, 2007; Van Hulle Vincent & Gaddy, 2009; Van Hulle Vincent et al., 2010), additional items were added when a specific topic was not sufficiently addressed. Content validity was further supported through a review of items by two expert nurses in pain management research. In our current study, we demonstrated excellent initial evidence of internal consistency of the PBPQ total score with Cronbach Coefficient Alphas of .83 at the pretest ($N = 26$) and .85 at posttest ($N = 24$).

The 16-item opioid kinetics score includes items about the opioid pharmacokinetics (peak effects [8 items] and duration of action [8 items]). Responses are open-ended and allow the participant to record the number of minutes or hours, which is then scored as correct or incorrect. The opioid kinetics score ranges from 0 to 16 with higher scores indicating more correct beliefs. The following peaks and durations were considered correct responses: IV morphine (20 minutes [min], 2-4 hours [hr]), IV hydromorphone (30 min, 2-3 hr), oral oxycodone (60 min, 3-4 hr) (Omoigui, 2004; Taketomo, Hodding, Kraus, Lexi-Comp Inc., & American Pharmacists Association., 2008; Wilkie, 2002). The same opioid peak and duration questions were included four times in the PBPQ; 73.1% of the nurses reported the same value for the morphine peak at all four opportunities at pretest, indicating internal consistency of their responses. Likewise, 71% of the nurses responded with internally consistent values on the four morphine duration items.

PBPQ: Simulated pain management practices—The PBPQ provides 16 items about simulated pain management practice, pain assessment (8 items) and opioid administration (8 items), in case study vignettes. These case study vignettes were refined from the PNKAS (Manworren, 2001). In the initial set of vignettes, one child smiles and the other child grimaces. Both are 10-year-old boys, 1 day post-abdominal surgery, and have normal vital signs; the pain intensity level reported by both children is 8 (0 to 10 scale). Two hours earlier both children received 2 milligrams (mg) of morphine and reported pain levels over the last 2 hours ranging from 6 to 8; they identified 2 as an acceptable pain level. Neither child has had any respiratory depression, sedation nor any other untoward side effect related to the morphine. There is a physician's order for "morphine IV 1-3 mg Q1HR PRN for pain" (dose is within the recommended ranges for the child's weight). After reading the vignettes, nurses respond to two items: (a) asking them to rate the child's pain on a scale of 0 to 10 and (b) asking them to indicate how much morphine to administer, with options of 0, 1, 2, and 3 mg. An answer of 8 is considered correct for the pain rating because the child is reporting a pain rating of 8. And, because the child received 2 mg of morphine 2 hours earlier followed by pain levels of 6 to 8, the appropriate response for morphine administration is to administer 3 mg.

Following the same format as above, additional vignettes were developed to represent 2 children receiving intravenous Dilaudid for pain and 2 receiving oral oxycodone. A final set of vignettes were constructed similar to the morphine vignette set but a night nurse provided information about the child's pain intensity. Nurses' pain ratings of the children's pain and opioid doses selected in vignettes are scored as correct or incorrect providing a range of scores from 0 to 8 for nurses' simulated assessment scores and 0 to 8 for nurses' simulated opioid dose scores. Higher scores indicate better pain management practices. In the PBPQ, 4 of 8 assessment items are identical for both the smiling and for the grimacing child; 76.9% of the nurses reported the same value for pain assessment at all four opportunities for the smiling child and 88.5% for the grimacing child, indications of internal consistency in their responses.

Medical record abstraction: Actual pain management practices and children's pain—We used medical record abstraction for nurses' actual pain management practice and for children's pain intensity levels. Records of all children admitted to the selected patient-care unit during the study period were examined for 30 days before and 30 days after all nurses completed the intervention. We abstracted the type, dose, route, and frequency of analgesics ordered by physicians and administered by nurses. We created the percentage of available analgesics administered by nurses (hereafter called analgesics administered) by calculating the percentage of the pro re nata (PRN) analgesics ordered by the physician that was administered by the nurse. Analgesics administered ranges from 0% to 100% with higher scores indicating greater opioid analgesic administration. Validity for our measure of nurses' actual pain management practices is inherent in the activity; that is, nurses' record the actual amounts of analgesics that they administer.

Nurses used the 0 to 10 Numeric Rating Scale (NRS), Faces Pain Scale-Revised (FPS-R), or the FLACC scale to measure children's pain intensity. With all measures, the level of pain ranges from 0 (no pain) to 10 (very much or worst pain). Validity and reliability have been demonstrated for these instruments (Hicks, von Baeyer, Spafford, van Korlaar, & Goodenough, 2001; Jensen, Karoly, & Braver, 1986; Manworren & Hynan, 2003; Merkel, Voepel-Lewis, Shayevitz, & Malviya, 1997; von Baeyer et al., 2009).

Procedures

Once the appropriate Institutional Review Boards provided approval, the Primary Investigator (PI) recruited pediatric nurses via individual/group meetings on the hospital unit and mail contact. Nurses interested in participating contacted the PI via email and were provided with a password and login to access the RCP intervention. Before nurses were able to begin RCP, they were required to complete the online consent form which addressed the study purpose and requirements, and the risks, benefits, and rights as a volunteer. Once the nurses consented, they were directed to the webpage with instructions on how to complete the PBPQ pretest, demographic survey, and the Internet-based intervention. Following completion of the intervention, nurses were directed to the webpage with the posttests (PBPQ, Acceptability Survey). Nurses were compensated for their participation with a \$50 check and continuing education credits. After all nurse data were collected, from a list of names provided by the hospital Information Technology Department, we identified all children admitted to the unit during the study period. Children's medical records were reviewed for analgesics ordered and administered for the 30 days before and 30 days after all nurses completed the intervention.

Analysis

Data were exported from the central database to which it had been written as participants completed the online questionnaires. After data cleaning, the preliminary analyses included assessing the psychometric properties of the scaled measures (e.g., beliefs); calculating descriptive statistics to ensure the quality of the data (check distributions, examine outliers) and describing the unit characteristics (e.g., nurses' education, patients' age). We calculated each percentage of analgesics administered and children's pain levels pre- and post-intervention and compared the pre-post means using two-sample t-test. We examined change from pre- to post-RCP of nurses' PBPQ-reported beliefs using paired t-tests. Higher scores indicated a positive difference in pain management practice and better pain relief for hospitalized children. Multiple tests were adjusted using Bonferroni correction. Statistical significance was established at an alpha level of 0.05. All statistical analyses were performed using SAS 9.2 statistical software (SAS Inc., Cary, NC).

Results

Study Procedure Feasibility and Acceptability

Participants completed the RCP intervention and the pre/posttests in about 2 hr ($M = 2.05$ hr, $SD = 0.77$, ranged from 0.71 hr to 3.68 hr). We obtained 100% of the children's medical records with documentation.

Nurses' acceptability scores ($M = 12.79$, $SD = 0.66$) revealed that all participants agreed that the RCP instructions were easy to understand and the program was organized, easy to use, and engaging. All participants reported that after completing the RCP, their knowledge about children's pain management issues increased and that this learning module would be well received by other health care providers. All participants reported that they did not feel rushed and only one participant thought that the program was too hard. All but one participant agreed that they enjoyed using the RCP, felt that the audio-visual materials portrayed real-life situations, and that Internet-based learning was a good way for people to participate in continuing education.

Beliefs: PBPQ

Nurses' PBPQ total mean beliefs scores (legitimacy of self-report, effects of unrelieved pain, and use of analgesics) and opioid kinetics scores (peak and duration of effects) significantly improved from pretest to posttest, with a robust effect as demonstrated by the

large and statistically significant t-values of 10.27 (total beliefs) and 6.01 (opioid kinetics; see Table 3).

Item analysis of PBPQ total scores revealed significant changes from pretest to posttest for items regarding legitimacy of self-report, effects of pain, and use of analgesics. Table 2 displays nurses' PBPQ item mean scores, t-test, and P values pretest to posttest. As can be seen, the changes in most of the nurses' mean scores pretest to posttest were significant with nurses scoring all items at posttest > 4 , indicating agreement with the statement.

Item analysis of nurses' PBPQ opioid kinetics scores showed that percentages of correct pretest scores for morphine, hydromorphone, and oxycodone were low: morphine (peak 19% to 23%, duration 12%), hydromorphone (peak 31% to 35%, duration 4% to 8%), and oxycodone (peak 27%, duration 12% to 15%). Posttest scores overall improved but percentages correct remained low for hydromorphone and oxycodone (29% to 58%) but somewhat stronger for morphine (42% to 71%). The ranges of nurses' posttest scores varied: for morphine peak effect—15 to 120 min and duration of action—1 to 5 hr, for hydromorphone peak—15 to 90 min peak and 1 to 5 hr for duration, and for oxycodone peak—30 to 120 min and 2 to 6 hr for duration.

Simulated pain management practices: PBPQ

Nurses' PBPQ simulated pain management practice mean scores for both pain assessment and administration of opioids in vignettes significantly improved pretest to posttest with t-values of 4.12 (assessment) and 4.80 (opioid administration; see Table 3). Nearly 100%, all but one nurse for 1 of 8 vignettes, rated both the smiling and grimacing child's pain in agreement with the child as compared to pretest (smiling 58%; grimacing 73-77%). Similar but not as robust improvement was seen for opioid dosing for both the smiling and grimacing children with 88% to 96% of nurses selecting the appropriate opioid doses for morphine (cases with and without night nurse report) and hydromorphone as compared to pretest (smile 38% to 42%, grimace 69%). However for oxycodone, there was little improvement, 7% to 11% of nurses responded correctly at pretest and only 12% at posttest.

Actual pain management practices and children's pain levels

We identified all children admitted to the unit during the study period and obtained all of their medical records to collect data needed for calculation of analgesics administered and children's pain levels for the 30-day pre- and 30-day post-intervention observation period. Findings (See Table 3) showed a significant decrease in children's pain levels (5.22 to 4.77, $p < .001$) and notable improvement in nurses' available analgesic administration. The majority of analgesics prescribed and administered were acetaminophen, ibuprofen, ketorolac, and morphine. Nurses administered significantly more doses of ketorolac (49.5% to 54.2%, $p < .05$) and ibuprofen (39.5% to 52.7%, $p < .05$) after the intervention than before. Likewise, nurses administered more (although not significantly more) morphine after the intervention (27.1% to 31.4%, $p = 0.28$). Nurses, however, administered similar amounts of acetaminophen pre-to-posttest (34.7% to 35.7%, $p = 0.60$). Nurses on the neurosurgical unit where pilot data were collected reported that they were reluctant to administer morphine because of its "neuro effects;" this likely influenced the lack of significance.

Discussion

The purpose of the study was to evaluate the feasibility of the Internet-based intervention, Relieve Children's Pain (RCP), and study procedures. We discovered four important findings. First, we showed strong evidence for the feasibility of the RCP intervention and

study procedures. We were able to recruit and retain 60% of the nurses on the unit who completed the RCP in the expected 2 hours. Second, the nurses made positive comments about the content and format of the Internet-based, interactive education intervention. Third, we showed that the theory-driven, Internet-based, and content-focused RCP intervention significantly improved nurses' (a) beliefs (legitimacy of self-report, effects of unrelieved pain, use of analgesics, opioid kinetics), (b) simulated pain management practice (pain assessment and opioid administration in case study vignettes), and (c) actual practice (analgesics administered). Fourth, we discovered that children's pain was significantly decreased after the intervention. Nurses' significant improvements in their total beliefs, opioid kinetics, and both their simulated and actual pain management practice support the potential efficacy of the RCP intervention.

The improvement in nurses' beliefs about the legitimacy of children's self-report of pain and in particular their change in beliefs about not relying on behavior and vital signs to verify children's reports of pain is a major accomplishment and reverses the findings in previous research (Van Hulle Vincent, 2007; Van Hulle Vincent & Denyes, 2004; Van Hulle Vincent et al., 2010). Furthermore, our earlier finding indicated that when nurses' pain assessments are in agreement with the child's pain rating, it was a significant predictor of nurses administering an appropriate dosage of morphine in vignettes (Van Hulle Vincent et al., 2010). Because nurses' simulated and actual pain management practices improved after the RCP, we conclude that the result was, at least in part, as function of their more accurate beliefs about the legitimacy of children's self-report. These findings support the relationships between beliefs and behavior and between intention and behavior as proposed by Ajzen & Fishbein's (1980) theory of reasoned action.

Overall, nurses' scores on most of analgesic use items at pretest were generally high, thus allowing for little change in scores after the intervention, with a few exceptions. The percentage change score for the incidence of respiratory depression was dramatic and although not as great, percentage score changes for incidence/danger of addiction and sedation were also large, suggesting that the RCP content provided nurses with sufficient evidence to correct unsupported beliefs as found in prior research (Ellis et al., 2007; Manworren, 2000; Rieman & Gordon, 2007; Van Hulle Vincent, 2005; Van Hulle Vincent & Denyes, 2004; Van Hulle Vincent & Gaddy, 2009). Nurses' more accurate beliefs about the incidence of respiratory depression, sedation, and addiction, in combination with their significantly improved knowledge of the deleterious effects of unrelieved pain, likely contributed to nurses' improved simulated opioid administration, and improved their actual pain management practices and children's pain relief.

Item analysis allowed us to identify PBPQ items that did not perform as expected. For example, the item "Children less than 8 years cannot reliably report pain intensity" had a negative t-value. In the intervention, we presented evidence about the legitimacy of self-report for children as young as 3-years of age. We believe that in this item, the use of a double negative and the discrepancy in the child's age may have been confusing for the nurses. Furthermore, recent evidence indicates that use of self-report scales are indicated for children 4-years and older (von Baeyer, 2009). Thus we will modify this item for future use. Another item that did not perform as expected was simulated oxycodone administration. We believe that the minimal improvement seen from pretest to posttest was due to the fact that oxycodone alone (versus combination with acetaminophen) was rarely ordered on the unit where the pilot was conducted and thus, nurses had minimal or no experience with administration. This in-depth analysis at the item level provides insights for strengthening the RCP intervention.

Nurses' scores on the opioid kinetics items were low in the pretest period and unfortunately remained low after the intervention. We believe that these findings indicate the need for the intervention to be stronger and perhaps the need for a booster especially for nurses with incorrect scores at the immediate posttest period. Furthermore, we believe that the open-ended response option along with the correct/incorrect scoring contributed to low scores.

In regard to measurement of nurses' actual pain management practices, we demonstrated our ability to collect these vital data reflecting real practice over the two 30-day time periods. After the intervention, nurses did administer significantly more ketorolac and ibuprofen but not significantly more morphine. Nurses' fairly consistent administration of amounts of acetaminophen pre- to post-intervention is mostly likely due to nurses administering ketorolac and ibuprofen in place of acetaminophen rather than administering acetaminophen in addition to these nonsteroidal analgesics.

Additional research is needed to test the efficacy and the effectiveness of the RCP intervention. This pilot study must be replicated with an attention control group and with a larger number of nurses, over a longer period of time.

This pilot study provides preliminary evidence that our RCP could reverse nurses' faulty beliefs and overcome the pediatric nurses' ineffective pain assessment and management practices when they care for hospitalized children and thus, improve children's pain relief. The significant improvement in this small sample of 24 nurses with the 2-hour RCP program is promising and warrants replication in a larger sample with an attention control group.

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Table 1**Kolb Learning Modes in the RCP**

Kolb Learning Modes	Examples of Content		
	Legitimacy of Self-report	Use of Opioids	Effects of Unrelieved Pain
Concrete Experience (CE)	Photo: boy playing videogame Vignette text depicts: 13 year old (yo) boy, post abdominal surgery, vital signs, pain level report, available analgesics	Photo: boy in the playroom Vignette text depicts: 13 yo boy, femur fracture, vital signs, pain level report, available analgesics	Photo: boy playing videogame, father at bedside Vignette text depicts: 13 yo boy, post-abdominal surgery, vital signs, pain level report, available analgesics
Reflective Observation (RO)	Series of questions about photo & text in CE (e.g., How would you rate Billy's pain? Upon what information did you base your assessment of Billy's pain?)	Series of questions about photo & text in CE (e.g., How would you rate Matt's pain? What interventions would you implement to relieve Matt's pain?)	Series of questions about photo & text in CE (e.g., What do you think are the possible causes of the pain that Billy is experiencing?)
Abstract Conceptualization (AC)	Best evidence about the legitimacy of self-report to guide pain management practices provided	Best evidence about effective administration of opioid analgesics provided	Best evidence about deleterious effects of unrelieved pain & pain physiology provided
Active Experimentation (AE)	1. Video: nurses during shift report; nurse caring for Tyler reports that although he reported a pain level of 8 (0-10 scale) she did not administer give because he fell asleep 2.Series of questions (e.g., How would you respond to Tyler?) 3.Feedback about choice with rationale provided	1. Photo & Vignette (Same as CE) 2.Series of questions (e.g., How much analgesic did Matt receive compared to what was prescribed?) 3.Feedback about choice with rationale provided	1.Photo: little girl sitting quietly in bed Vignette text depicts: Sammy, a 10 yo after a skin graft, lying motionless & calm, reporting pain level of 7; available analgesics listed 2.Series of questions (e.g., What are the potential consequences of this level of pain?) 3.Feedback about choice with rationale provided

Table 2

PBPQ Items Scores by Pretest and Posttest ($N = 24$)

Item	Pretest		Posttest		Paired t-test	
	M	SD	M	SD	t	p*
Legitimacy of Self-report						
Observable vital sign changes not relied on to verify report	4.12	1.48	5.33	0.92	4.28	0.008
Child may sleep in spite of severe pain	4.50	1.17	5.63	0.58	5.12	<.001
Child older than 8 years can reliably report pain intensity	4.96	1.25	4.92	1.21	-0.25	1.000
Observable behavioral changes not relied on to verify report	3.62	1.47	4.83	1.52	3.50	0.049
Most accurate judge of child's pain intensity is the child	5.00	1.10	5.92	0.28	4.53	0.005
Most accurate judge of child's pain intensity is not the nurse	5.12	0.91	5.54	0.78	2.10	1.000
Use of Analgesics						
Respiratory depression rarely occurs	2.69	1.38	4.96	1.68	4.45	0.005
Addiction, physical dependence, tolerance not similar	4.77	1.50	5.50	1.02	2.23	0.931
Not real danger of addiction	4.42	1.55	5.67	0.76	3.68	0.031
Likelihood of opioid addiction is < 1%	4.69	1.44	5.63	0.92	2.93	0.195
Not a real danger of deep sedation	3.92	1.32	4.96	1.16	4.03	0.013
Not a real danger physical dependence	4.54	1.48	4.96	1.33	1.12	1.000
Not a real danger of tolerance	4.12	1.40	4.46	1.53	0.97	1.000
Increased dosages of morphine provide increased relief	3.81	1.13	4.21	1.72	1.40	1.000
After initial dose, adjust doses to child's response	4.69	1.26	5.46	0.72	2.94	0.190
Give analgesics around the clock on a fixed schedule	5.27	0.78	5.79	0.41	3.68	0.031
Do not only give analgesics when child asks	5.15	0.73	5.46	0.88	1.43	1.000
Do not only give analgesics when nurse determines	5.19	1.10	5.54	0.88	2.32	0.772
Opioids plus nonopioids more effective pain relief	5.12	0.95	5.75	0.53	4.04	0.013
Nonpharmacological methods alone not effective to relieve moderate/severe pain	4.08	1.41	4.92	1.67	3.04	0.153
Multiple points on pain pathway for pain relief strategies	5.35	0.56	5.88	0.34	4.15	0.010
Effects of Unrelieved Pain						
Harmful physiological & psychological effects	5.46	0.51	5.96	0.20	4.80	<.001

Item	Pretest		Posttest		Paired t-test	
	M	SD	M	SD	t	P [*]
Immune system changes can lead to death	3.64	1.35	5.58	0.65	8.16	<.001
Cardiopulmonary changes (hypoxemia & pneumonia)	4.64	1.15	5.88	0.34	5.43	<.001
Gastric stasis & paralytic ileus	4.04	1.34	5.88	0.45	6.73	<.001
Changes in CNS, increased sensitivity to pain	4.42	1.21	5.88	0.34	5.99	<.001

Note. M = mean

^{*} Adjusted p value with Bonferroni correction.

Table 3
Pre- and Post-Intervention PBPQ Scores, Children's Pain Intensity, and Analgesics Administered

Variable	Pretest		Posttest		Paired t-test	
	Mean	SD	Mean	SD	t value	p value
PBPQ (N = 24)						
Total beliefs score	4.52	0.52	5.40	0.46	10.27	<.0001
Opioid kinetics score	2.67	1.93	7.83	3.95	6.01	<.0001
Assessment score	5.13	3.43	7.96	0.20	4.12	<.0001
Opioid dose score	4.00	3.09	6.42	2.06	4.80	<.0001
Children's Pain Intensity Score	5.22	2.22	4.77	2.01	3.98	<.001
Analgesics Administered (%)						
Acetaminophen	34.70	25.54	35.70	25.57	0.53	0.5967
Ibuprofen	39.50	20.45	52.70	27.89	2.29	0.0251
Ketorolac	49.50	29.94	54.20	29.51	2.25	0.0305
Morphine	27.10	21.00	31.40	23.06	0.55	0.2826