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Adolescent Pediatric Pain Tool (APPT) for Multidimensional Measurement of Pain in Children and Adolescents

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Abstract

Very few multidimensional tools are available for measurement of pain in children and adolescents. We critically reviewed the scientific literature to examine the psychometrics and utility of the Adolescent Pediatric Pain Tool (APPT), a multidimensional self-report tool that evaluates the intensity, location, and quality (including affective, evaluative, sensory, and

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temporal) dimensions of pain. The APPT is available in English and Spanish for children and adolescents, and was modeled after the McGill Pain Questionnaire in adults. We found good evidence for construct validity, reliability, and sensitivity of the APPT for the measurement of pediatric pain. The APPT was used to measure pain in children with different conditions, such as cancer, sickle cell disease, orthopedic, traumatic injuries, and allergy testing. Although the APPT was designed to assess the multiple dimensions of pain, the majority of the reports included results only for the intensity ratings. Unlike the numerical and pediatric faces rating scales, which are widely used in clinical practice and research, the APPT is not limited to the single dimension of pain intensity. It measures multiple dimensions, and may be able to discriminate between nociceptive and neuropathic pain. The APPT is one of a few multidimensional pain measures that can help to advance the science of pediatric pain and its management. When the APPT is used in practice or research, the multiple dimensions of pain may be characterized and compared in different painful conditions. It may guide the use of multimodal interventions in children and adolescents with a variety of pain conditions.

Keywords

Adolescent Pediatric Pain Tool; pain; children; cancer pain; sickle cell pain; postoperative pain

Introduction

Measurement of children's and adolescents' pain as a multidimensional phenomenon has been advanced by the Adolescent Pediatric Pain Tool (APPT) (Savedra, Holzemer, Tesler, & Wilkie, 1993). Twenty-eight studies have been reported in which the APPT was used to contribute knowledge about the sensory (location, intensity, quality, and temporal pattern), affective, and evaluative dimensions of pain in children and adolescents. For children and adolescents, the APPT is especially rare as tool for measuring pain quality (nature of the pain that indicates, for example, if it is nociceptive or neuropathic pain), the temporal pattern of pain (how pain changes over time), and the evaluative dimension of pain (the cognitive appraisal of the pain). Surprisingly, however, there is no critical review of the APPT research. The purpose of this article is to provide a critical review the scientific literature in which researchers used the APPT as the pain measure for children and adolescents with a variety of pain conditions.

The Adolescent Pediatric Pain Tool (APPT) is a one-page double-sided paper-and-pencil instrument for self-report of pain by children and adolescents aged 8-17 years of age (Savedra, Tesler, Holzemer, & Brokaw, 1995). The APPT provides five subscale scores: 1) the number of pain sites (alternatively, the number of pain segments) as a measure of pain location from marks on a body outline (Savedra, Tesler, Holzemer, Wilkie, & Ward, 1989); 2) a pain intensity score measured by a 10-centimeter line known as the Word Graphic Rating Scale (WGRS) and anchored by words no pain, little, medium, large, worst possible pain (Tesler et al., 1991); 3) the number of pain quality descriptors, which yields percent scores for the sensory, affective, evaluative subscales (Savedra et al., 1993); 4) the number of temporal descriptors, which yields a percent temporal subscale (Savedra et al., 1995); and

(5) the percent of total pain quality and temporal descriptors as a total subscale (Wilkie et al., 1990). The APPT is available in English (Figure 1) and Spanish languages (Figure 2).

The APPT measures similar elements as the multidimensional measure used in adults – McGill Pain Questionnaire (MPQ) (Melzack, 1975), which also measures the pain location, intensity, quality, and temporal pattern of the sensory dimension and the affective and evaluative dimensions (Ahles, Blanchard, & Ruckdeschel, 1983; McGuire, Yarbrow, & Ferrell, 1995; Melzack & Wall, 1965; Ngamkham et al., 2012; Wilkie & Monreal, 1999). Of the 67 APPT descriptors, 28 also appear in the MPQ pain quality or pattern lists. Standardized instructions are printed on the tool and a user manual is available from the investigators (Savedra et al., 1993).

The APPT evolved from pioneering research that described children's and adolescents' pain experiences and coping with pain (Savedra, Gibbons, Tesler, Ward, & Wegner, 1982; Savedra, Tesler, Ward, Wegner, & Gibbons, 1981; Savedra, Tesler, Ward, & Wegner, 1988; Tesler, Ward, Savedra, Wegner, & Gibbons, 1983; Tesler, Wegner, Savedra, Gibbons, & Ward, 1981). In these studies, the investigators gained insights about the sensory, affective, and evaluative dimensions of pain. These preliminary studies provided sufficient foundation for funding from the National Institutes of Health and the American Cancer Society to develop a pain measurement tool for research and practice that would represent the multiple dimensions of pediatric pain and would be similar to the MPQ (Melzack, 1975). In a series of seven studies, the investigators developed and tested the APPT and its components.

1. *A body outline diagram (BOD)* as a measure of pain location was tested in 175 hospitalized children and adolescents aged 8-17 years (Savedra et al., 1989).
2. *A pain intensity measure* (Tesler et al., 1991) was tested in three studies with a total of 1,223 children and adolescents, aged 8-17 years, and from 17 schools or three hospitals
3. The *pain descriptors* that represent the sensory pain quality and the affective and evaluative pain dimensions (Wilkie et al., 1990) was tested in the same three studies as the intensity measure.
4. The *temporal pain pattern descriptors* was tested in two studies with 209 children and adolescents, aged 8-17 years, either attending six outpatient clinics or hospitalized at one of three hospitals, and experiencing acute or chronic pain (Savedra et al., 1995).

The findings from this body of formative research was the basis for and supported a 5-day, repeated measures study of the APPT tool that revealed the APPT to be a valid measure of postoperative pain that was sensitive to the changes in pain scores that were expected with recovery (Savedra et al., 1993).

Now two decades after this seminal 1993 publication, several systematic reviews of pediatric pain tools have been published recently (Huguet, Stinson, & McGrath, 2010; Stinson, Kavanagh, Yamada, Gill, & Stevens, 2006). The reviews, however, were limited to instruments that measured single dimensions, mostly intensity, very little on the other dimensions such as pain location or body maps (von Baeyer, Lin, Seidman, Tsao, & Zeltzer,

2011), and none on pain quality or the affective or evaluative dimensions of pain in children and adolescents. The strength of multidimensional pain instruments such as the APPT for measurement of acute, recurrent, chronic, and cancer pain experienced by children and adolescents is not well known. Nor have the limitations of the APPT been discussed to facilitate instrument refinement. We, therefore, present a critical review of the scientific literature to examine the psychometric properties of the APPT and the utility of the APPT in children and adolescents with different pain conditions. We also discuss implications for future research directions for the APPT.

Psychometric Properties of the APPT

Studies conducted in a variety of pain conditions and settings serving children and adolescents provide evidence for the psychometric properties (e.g., validity, reliability, and sensitivity) of the APPT. Numerical indicators of the psychometric properties for the APPT's individual components (location, intensity, quality, and temporal pattern) appear in Table 1.

- In *school settings* with children and adolescents from multicultural groups (43% white), investigators documented the validity and reliability of the pain intensity (Tesler et al., 1991) and pain quality descriptors (Savedra, Tesler, Holzemer, Wilkie, & Ward, 1990; Wilkie et al., 1990). The APPT's measures of pain intensity and pain quality also demonstrated no bias by the age, gender, or race of the participant (Savedra et al., 1993; Tesler, Savedra, Ward, Holzemer, & Wilkie, 1988).
- In an *inpatient setting*, children and adolescents with medical or surgical pain, the APPT intensity ratings were weakly to moderately correlated ($r=.22$, $p<.05$ to $r=.48$, $p<.001$) with analgesic doses, an indication of construct validity (Tesler, Wilkie, Holzemer, & Savedra, 1994). Also, investigators showed construct validity, alternate forms reliability, and inter-rater reliability of the pain location measures (Savedra et al., 1989).
- In *outpatient clinics* and *inpatient settings*, researchers documented validity of the *temporal* descriptors of pain in children and adolescents ($n = 209$, 42% white) (Savedra et al., 1995).
- In an *inpatient setting* with repeated measures over five postoperative days, the entire APPT (with location, intensity, and quality measures) was valid and reliable as a measure of surgical pain (Savedra et al., 1993). As well, the APPT was sensitive to recovery after surgery (Savedra et al., 1993).

In summary, the APPT, either its individual components or the entire multidimensional tool, has adequate 1) content, construct, and criterion validity; 2) test-retest reliability, alternate forms reliability, inter-rater reliability for counting the number of pain sites or pain segments, and internal consistency reliability; and 3) sensitivity to reduction in pain over five days postoperatively, as is expected with postoperative recovery (Jacob & Mueller, 2008; Savedra et al., 1993; Savedra et al., 1995; Savedra et al., 1989, 1990; Tesler et al., 1988; Tesler et al., 1991; Tesler et al., 1994; Wilkie et al., 1990). The psychometrics of the

APPT indicate that it is appropriate for children and adolescents 8-17 years of age, boys and girls, and those from diverse cultural groups (42% to 67% white).

Utility of the APPT in Different Pain Conditions

In the past two decades, the APPT has been used in a variety of pain conditions including postoperative, cancer, sickle cell disease, orthopedic, traumatic injury, and allergy testing. The evidence about pain generated in these studies provides important information about pediatric pain and the utility of the APPT.

Postoperative pain

In one descriptive study of hospitalized children ($n = 65$; 52% female; aged 8 to 17 years) in the San Francisco Bay area, investigators used daily repeated measures of the APPT (without the temporal component) from postoperative day one through postoperative day five (Savendra et al., 1993). Consistent with the predicted nature of the pain postoperatively, the pain intensity and the sensory, affective, and evaluative pain scores decreased over time. For example, average pain intensity was moderate on day 1 (5.8, $SD = 2.1$ cm) and 2 (4.8, $SD = 2.6$). Day 1 pain rating was statistically different from day 3 (3, $SD = 2.2$), day 4 (3.0, $SD = 2.2$), and day 5 (3.5, $SD = 2.4$). Also at a statistically significant level, the mean number of pain quality descriptors decreased from day 1 (8.7, $SD = 7.8$) to day 5 (6.1, $SD = 7.5$) ($p < .05$). The mean number of pain sites (3, $SD = 2.8$ on day 1) did not decrease significantly over the five days (4, $SD = 4.1$ on day 5), but at least one site was located in the area of the child's incision for 98% of the children on day 1 and 74% marked their incision each time they marked the tool. These findings document an average postoperative pain magnitude that is moderate, complex in quality and located in several sites, which is consistent with the site of tissue injury (Savendra et al., 1993).

Cancer Pain

In a longitudinal descriptive study, Van Cleve and colleagues (2004) used the APPT to collect pain data during interviews from English- and Spanish-speaking children ($n = 95$, ages 4 to 17 years) who were receiving treatments during the seven phases of leukemia treatments in three southern California hospitals. Children reported significant changes in pain intensity before and after pain management, with percent change in pain intensity ratings that ranged from 16.4% to 29.3%, p -values ranged from .000 to .009 for all seven interviews (Van Cleve et al., 2004).

Bossert and colleagues (1996) interviewed a small sample of parents and children with leukemia ($n = 13$) and solid tumors ($n = 7$) from California about the nature of both disease- and treatment-related pain. They reported that children identified 22 sites on the body outline diagram and 22 words to describe the quality of pain (Bossert et al, 1996). The most frequent sites were the abdomen ($n = 11$), joints ($n = 11$), back pain ($n = 9$) and legs ($n = 9$), which is similar to areas marked in other studies (Table 2).

In a descriptive study with repeated measures, Jacob and colleagues (2007) examined the pain experiences of hospitalized children with cancer in Texas ($n = 49$; 8 to 17 years; mean age 12.5. $SD = 2.8$; 23 males; 26 females). They found that the frequently marked areas for

location of pain in the APPT were the abdomen, back, and chest were most frequently reported sites of pain on day of study enrollment (Table 2).

The Spanish version of the APPT was also used by Spanish speaking children with cancer. Van Cleve and colleagues (2001) used standard translation, back-translation procedures to develop the Spanish APPT. They conducted a series of four pilot studies in California using the same Q sort procedures that were used during the development of the English version. Three of the four pilot studies were conducted in healthy Spanish-speaking children (8 to 17 years) from the Dominican Republic ($n = 5$), Southern California ($n = 7$), and Central California ($n = 5$). They found the majority of the translated Spanish words were identified by the children as words they understood and would use to describe pain. The fourth study included Spanish speaking children with cancer ($n = 5$), who were part of a clinical study that focused on pain in children and adolescents with leukemia. Findings showed that the sensory, affective, evaluative, and temporal scores were correlated significantly with the number of pain sites selected (Van Cleve et al., 2001).

Prior to an oncology clinic appointment, Jacob and colleagues (2008) also used the APPT-Spanish version to measure pain in 44 Spanish-speaking children (8 to 12 years) with cancer from Texas who were asked to describe the pain they experienced during the previous week. The investigators found correlations between the number of body areas marked on the body outline diagram (BOD; Table 2) and the severity of pain (Table 1).

The APPT words selected most frequently to describe cancer pain in hospitalized children with cancer ($n = 49$; 8 to 17 years; mean age 12.5, $SD = 2.8$; 23 males; 26 females), were evaluative and temporal qualities (Jacob et al., 2007). Children with more severe pain selected a larger number of words (15.4, $SD = 2.5$) to describe pain quality. Not selected were words indicating neuropathic pain, such as “hot,” “burning,” “numbness,” or “tingling.” Children with lymphoma (20.5, $SD = 2.1$) and those presenting with respiratory symptoms selected a large number of words (22.0, $SD = 1.0$) to describe pain quality (Jacob et al., 2007).

“Annoying” (“*molesto*”), “aching” (“*doloroso*”), and “awful” (“*desagradable*”) were the most frequently selected descriptors in Spanish-speaking children with cancer (Jacob, McCarthy et al., 2008). Van Cleve and colleagues (2001) also reported that the most frequently selected quality descriptors of pain in Spanish-speaking children ($n = 48$) with leukemia were “annoying” (“*molesto*”) and “uncomfortable” (“*incómodo*”). Selected less frequently were words reflecting sensory quality (mean number 4.8, $SD = 4.7$) were most frequently selected. Words reflecting affective (2.1, $SD = 2.1$), evaluative (2.7, $SD = 1.8$), and temporal (2.5, $SD = 1.7$) qualities (Van Cleve et al., 2001).

Sickle Cell Disease (SCD) Pain

Several investigators used the APPT in studies of children and adolescents with sickle cell disease (Crandall & Savedra, 2005; Dampier, Ely, Brodecki, & O’Neal, 2002; Franck, Treadwell, Jacob, & Vichinsky, 2002; Jacob, Hockenberry, & Mueller, 2008; Jacob et al., 2003; Jacob & Mueller, 2008). In Pennsylvania, Dampier and colleagues (2002) adapted the features of the APPT in a diary that was completed twice daily by 37 children and

adolescents (mean age 10.9, SD = 3.6 years). The mean pain intensity in the evening before analgesics were taken was 6.03 with a decrease in mean score to 3.75 after medications ($t = 128.64$ and 61.40 , $p = .0001$). The mean pain intensity after taking pain medicine during the day showed a similar decrease, with mean pain intensity before medications of 5.85, which decreased to 3.98 after medications ($p = .0001$).

Dampier and colleagues (2002) found that the mean number of sites of sickle pain per day was greatest in the group of patients with episodes of sickle pain and other pain (mean, 3.23 sites), followed by sickle pain alone (mean, 2.39 sites). The most frequently indicated locations of sickle cell pain were in the extremities (14.3%) and hips (6.8%). In another study (Jacob et al., 2003), the most frequent pain sites in 27 children with SCD who were hospitalized for acute sickle cell pain episodes, were the chest, abdomen and lower back areas. On average there were 8.0 (SD = 0.3) sites. In that study, the number of pain sites decreased slightly on subsequent days of the hospitalization. Jacob and colleagues (2008) examined the analgesic response to patient controlled analgesia (PCA) morphine in children with SCD in Texas, the location (on the body outline diagram markings) and the spatial distribution of pain were important parameters that indicated effectiveness. The extensiveness of the markings on the body outline diagram was reported to be more informative (with a 50% decrease in the number of body areas) than the pain intensity ratings (showing 5% decrease) in pain during the average five-day hospitalization stay (Jacob et al., 2003). However, when hydromorphone was used during the hospitalization (Jacob, Hockenberry et al., 2008), the number of body areas marked did not change significantly.

In a study by Dampier and colleagues (2002) the temporal quality of pain was described as steady and the evaluative quality of pain was described as uncomfortable in more than half of the sickle pain days. In another study (Jacob et al., 2003), the mean number of pain quality descriptors chosen on the first day of the hospitalization was 14 (SD not reported) inclusive of 6 sensory, 2 affective, 3 evaluative and 3 temporal words. Patients used a variety of nociceptive pain descriptors (e.g., throbbing, pressure, hurting) to describe their pain, and not neuropathic pain descriptors (e.g., burning, shooting).

In California inpatient and outpatient settings where the APPT was used (Franck et al., 2002), females reported more painful descriptors, significantly higher pain intensity, and more painful areas on the BOD than males. Also, older patients reported more painful body areas and used more evaluative and temporal qualitative pain descriptors than younger patients with sickle cell disease (Franck et al., 2002). Pain intensity ratings, the number of quality descriptors, and the mean number of painful body areas marked on the APPT were not significantly different in the hospital setting when compared to the clinic setting (Franck et al., 2002). As well, patients selected sensory pain descriptors, and few quality descriptors with affective, evaluative, or temporal dimensions (Franck et al., 2002). In adolescents with SCD who were receiving hydromorphone (Dampier et al., 2002), the most frequently selected words were also sensory quality words; the number of pain descriptors decreased during hospitalization.

Crandall and Savedra (2005) reported their experience using the APPT in an 11-year-old patient with SCD in California. The patient often had a change in health care providers and was experiencing inadequate pain management. Both patient and care providers were expressing frustration in communicating with this patient about pain. To facilitate description of the pain experience, the team used the APPT. The patient found the APPT to be useful in communicating about the extensiveness and quality of pain and selected 41 descriptors, including 20 sensory, 6 affective, 6 evaluative, and 9 temporal words. The health care providers consequently understood and recognized the multidimensionality of her pain (sensory, affective, evaluative, and temporal). The APPT word list conveyed that her pain made her concerned about dying, contributed to her lack of sleep, and caused her not to socialize with her peers, which changed the health care provider's approach and provided direction to the management of the child's pain. The patient's subsequent admission for a pain crisis resulted in improved communication with the team and the patient reported that she was less consumed by her pain (Crandall & Savedra, 2005).

Orthopedic Pain

Young and colleagues (1994) used the APPT to examine orthopedic pain in Michigan. They measured prospectively the intensity of pain experienced and its progression with time among 23 patients (mean age 14, range 11-20 years; 12 males). Patients completed the APPT as a measure of pain before and three times (10 days, 60 days, and 120 days) after a surgical procedure for correction of bone and soft tissue deformities in the extremities (Ilizarov Technique). Findings supported the APPT construct validity, with pain intensity ratings of 0 cm on the day prior to the procedure, highest in the immediate postoperative period, and then a progressive decrease over time. The mean change was +2.81 cm ($p < .001$), -0.62 ($p = .14$), and -1.09 ($p = .071$), respectively between the 4 different measurement intervals. Although the authors made reference to the number of words, they did not report the actual words that the children selected. Therefore, it was not possible to make a conclusion about the quality of the pain (sensory, evaluation, or affective), temporal characteristics or whether the nature of the pain was nociceptive or neuropathic.

In Colorado, Kotzer and colleagues (1998) examined the effectiveness of two types of preoperative education program (routine versus standardized) in children undergoing spinal fusion; the APPT was used to assess pain. They reported no statistically significant differences in the intensity, location, or quality of pain between the two groups of patients over the first four postoperative days. Pain intensity ratings reported on postoperative days 1 to 4 appear in Table 4.

Traumatic Injury

Crandall and colleagues (2002) examined traumatic injury in 13 adolescents in California (mean age 14.2, SD = 2.4 years; 7 males; 6 females; 7 Caucasians) who experienced serious injuries, involving fractures and surgery (54%) that were most frequently associated with automobile accidents (85%), or sport and work accidents. The adolescents were asked to describe what they recalled from the scene of the accident, emergency department, and hospital settings, and other events they perceived to be important. When pain was described, adolescents were asked what caused their pain, their actions and interactions to manage pain,

and the consequences of pain, and they completed the APPT. The majority (64%) reported pain as severe on the APPT word graphic rating scale. The mean number of segment areas marked on the body outline diagram was 10.1 (SD = 8.8) (Table 3). The number of words used to describe the quality of pain is presented in Table 5. Although reference to the number of words and the dimensions of the words was made, the actual words selected were not reported. Therefore, it was not possible to make a conclusion about the nociceptive or neuropathic nature of the pain.

Allergy Testing

In a pre/post test design conducted in Arizona, Jeffs (2007) used the APPT in a pilot study of pain associated with allergy testing and effects of distraction during allergy testing. Adolescents (n = 32) were randomly assigned to three intervention groups: 1) self-selected distraction (n = 10); 2) investigator selected distraction (n = 12); and 3) usual care (n = 10). Findings indicated there were no differences in pain ratings among the groups (Table 5). For the patients (27/32), who had repeat allergy testing and provided additional measurements, there were higher mean pain ratings during repeat allergy testing compared to the initial testing. After controlling for anxiety, pain ratings were still higher, although not significant ($p = .26$) during the repeat allergy testing for the participants, regardless of the assigned intervention groups (Table 4). The words selected to describe the pain associated with the initial allergy testing were predominantly sensory dimension descriptors (itching, like a pin, like a sting, scratching, like a scratch, pin-like, burning, sharp, stinging) and one evaluative descriptor (annoying). Participants selected similar words during the repeat allergy testing, when they selected additional words (i.e., hurting from the sensory dimension; uncomfortable and bad) from the evaluative dimension.

Discussion

We examined the psychometric properties and the utility of the APPT in different pain conditions. We found that the APPT has excellent evidence for validity, reliability, and sensitivity from six studies with a total sample of 1,732 children and adolescents recruited from settings that included 17 schools, 6 outpatient clinics, and 3 inpatient hospitals. The samples were multiethnic (42% to 67% white) and balanced for gender. After its initial testing, the APPT was widely used in the post-surgical (1 study, n = 65), sickle cell disease (6 studies, n = 139), and cancer (6 studies, n = 261) populations, and sometimes in traumatic brain injury (1 study, n=13), orthopedic (2 studies, n = 116), and minor procedures (allergy testing) (1 study, n = 32). In total, 2,375 children and adolescents used the APPT in 23 studies published from 1989 to 2008 and predominately conducted in California with at least one study in five other states (Pennsylvania, Arizona, Michigan, Colorado, Texas). For the most part, investigators reported the APPT data for the intensity, location, and quality of pain during acute illness and hospitalizations. Except for its test of the temporal descriptors (Savedra et al., 1995), the APPT has not been used in other pain conditions, such as other chronic and recurrent pain in children.

The APPT pain intensity ratings were generally mild during minor procedures (allergy testing), severe in patients with traumatic injury, and varied from mild to severe pain in SCD

patients and in both English and Spanish speaking populations of children and adolescents with cancer. Pain intensity ratings in orthopedic patients were highest immediately after procedures and progressively decreased over time as would be expected with recovery.

Although the APPT was designed to assess the multiple dimensions of pain, we found that the majority of the reports provided results for the intensity ratings, and less frequently for the location, quality, and temporal pattern of the sensory dimension and the affective and evaluative dimensions. In the postoperative, cancer, orthopedic, traumatic brain injury, SCD and allergy testing procedures, we found that the APPT pain intensity ratings were sensitive to changes over time. We did not find reports with APPT findings from children and adolescents with painful conditions that are known to be complex (e.g., advanced cancer; conditions requiring critical or intensive care), recurrent (e.g., recurrent abdominal pain), or chronic (e.g., migraine, juvenile rheumatoid arthritis). Studies are needed to determine whether APPT pain intensity ratings are sensitive to changes in pain over time in these types of pain conditions. Furthermore, research in these types of pain conditions may uncover the need for APPT instructions to be revised to better represent types of pain that are recurrent, chronic or persistent.

The APPT demonstrated variable extensiveness in the spatial distribution of the pain in both cancer and sickle cell disease populations. In the majority of the studies, the reported BOD findings were limited to only the most frequently marked areas. The most frequently reported areas were the back, chest and abdomen in cancer patients and the chest, back and extremities in patients with SCD. One interesting finding is that the number of body areas and spatial distribution of the pain changed dramatically even when the pain intensity ratings did not change (Jacob et al., 2003). Since we did not find studies in which the APPT measured more complex, recurrent, chronic and persistent states, it is unknown whether the BOD findings would be as informative in these populations. Future studies in these populations are needed to determine the sensitivity of the APPT body outline diagram to detect changes in pain over time.

The APPT demonstrated the multidimensionality (sensory, affective, and evaluative) of pain in both cancer and SCD populations. Interestingly, individuals with SCD reported higher pain intensity, number of body areas and number of words during acute pain episodes than post-operative children and adolescents. The most frequently reported pain quality descriptors in cancer, sickle cell disease, orthopedic, traumatic injury, and minor procedures (allergy testing), were predominantly evaluative (annoying, uncomfortable) and sensory (sore, aching, hurting) qualities, and less affective (awful). Generally, the sensory pain quality descriptors that were reported did not suggest neuropathic pain. Most likely, this finding is due to the acute nature of the pain in those populations. It is possible that descriptors reflecting neuropathic pain may be selected in the more complex, chronic, recurrent pain, or persistent pain. However, we did not find the use of the APPT in these populations. Future studies are needed that examine whether the word descriptor list of pain is able to discriminate between nociceptive and neuropathic pain types.

Clinicians and researchers who use the APPT word list may be able to identify the etiology of pain and to better understand the affective, evaluative, and temporal dimensions of pain.

The pain quality word descriptors of the APPT have the potential to distinguish between nociceptive and neuropathic pain that may be useful for selecting appropriate pain management strategies (Wilkie, Huang, Reilly, & Cain, 2001). Neuropathic pain is generally resistant or less responsive to opioid therapy and often requires alternative analgesics (antidepressants, anticonvulsants, local anesthetics) or larger opioid doses to achieve pain relief. Studies with the APPT are needed in pain states that are more complex, recurrent, chronic or persistent to determine whether the word descriptor list may be useful in detecting neuropathic pain in children and adolescents. The number of APPT descriptors that represent neuropathic pain is small and additional research may be needed to identify additional neuropathic descriptors known and used by children and adolescents to adequately capture this type of pain in this special population.

Limitations

The psychometric properties, clinical utility in the different pain conditions, and multidimensionality of the APPT were demonstrated, but there are challenges to its interpretability. Interpretability is defined as the property of the measure to be meaningful and useful to clinicians. For example, an index of severity should signify mild, moderate, or severe. The score or the change score of the measure should distinguish those who had a trivial change from those who had an important amount of change, and its ability to indicate small, medium, or large change (Powell, Kelly, & Williams, 2001). This property has only been demonstrated for the intensity ratings, although there is some evidence in the sickle cell disease literature (Jacob et al., 2003) that the pain location dimension may also be informative. Innovations that advance the potential clinical utility and interpretability, such as the Composite Pain Index (Wilkie et al., In review) and computerize delivery format (Huang et al., 2003; Wilkie et al., 2003) are examples of additional ways to advance the APPT. A composite pain index (CPI) score is calculated by converting the number of pain sites, pain intensity (current, least, and worst), total number of pain quality descriptors, and pain pattern to 100 scale and summing them to provide a single score that represented the multidimensional pain experience (Wilkie et al., In review).

A major limitation in many of the studies is the small sample size in each study, and therefore one must be cautious with interpretation of the findings. The studies were predominantly descriptive, and few were longitudinal (Jacob et al., 2003; Savedra et al., 1993; Van Cleve et al., 2004).

Only one, a small pilot study had random assignment to one of three interventions (Jeffs, 2007). The APPT has never been used in randomized clinical trials or in larger intervention studies. Furthermore, the studies were predominantly reflective of acute pain states, rather than the more complex, recurrent, chronic or persistent pain states.

Conclusions

Numerous research studies have shown the APPT to demonstrate evidence of construct validity in a variety of pain conditions. Unlike the numerical and pediatric faces rating scales, which are widely used in clinical practice and research, the APPT is not limited to the single dimension of pain intensity. It measures the different dimensions of pain,

including the location, intensity, quality, and temporal pattern components of the sensory dimension as well as the affective and evaluative dimensions. Potentially, it may be able to discriminate between nociceptive and neuropathic pain, and may guide the use of multimodal interventions in children and adolescents with a variety of pain conditions.

The APPT is one of a few multidimensional pain measures that can help to advance the science of pediatric pain and its management. When the APPT is used in practice or research, the sensory, affective, and evaluative dimensions of pain may be characterized and compared in different painful conditions. Different therapies directed toward specific pain experience dimensions such as pacing activities for the temporal aspect of the sensory dimension and stroking and calming talk for the affective quality dimension could be combined to optimize pain control. Additional research is needed to further enhance the utility of this multidimensional measure in children and adolescents with recurrent, chronic, and complex pain.

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CODE _____
DATE _____

ADOLESCENT PEDIATRIC PAIN TOOL (APPT)

INSTRUCTIONS:

1. Color in the areas on these drawings to show where you have pain. Make the marks as big or small as the place where the pain is.

2. Place a straight, up and down mark on this line to show how much pain you have.

3. Point to or circle as many of these words that describe your pain.

1 annoying	5 blistering	10 awful	15 off and on
bad	burning	deadly	once in a while
horrible	hot	dying	sneaks up
miserable		killing	sometimes
terrible	6 cramping	11 crying	steady
uncomfortable	crushing	frightening	
2 aching	like a pinch	screaming	If you like,
hurting	pinching	terrifying	you may add
like an ache	pressure		other words:
like a hurt	7 itching	12 dizzy	_____
sore	like a scratch	sickening	_____
3 beating	like a sting	suffocating	_____
hitting	scratching	13 never goes away	
pounding	stinging	uncontrollable	
punching	8 shocking		
throbbing	shooting	14 always	
4 biting	splitting	comes and goes	
cutting	9 numb	comes on all of	
like a pin	stiff	a sudden	
like a sharp knife	swollen	constant	
pin like	tight	continuous	
sharp		forever	
stabbing			

For office use only.

BSA: _____
IS: _____
#S (2-9) _____ / 37 = _____ %
#A (10-12) _____ / 11 = _____ %
#E (1,13) _____ / 8 = _____ %
#T (14,15) _____ / 11 = _____ %
Total _____ / 67 = _____ %

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M.C. Savedra, M.D. Tesler, W.L. Holzemer, & J.A. Ward, University of California, San Francisco, School of Nursing, San Francisco, CA 94143-0606
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Figure 1.

CODIGO _____ Numero de Identificación: _____
Entrevista N° 1 2 3 4 5 6 7

FECHA _____

INSTRUMENTO PEDIATRICO PARA EL DOLOR EN ADOLESCENTES (APPT)

INSTRUCCIONES:

1. Colorea en estos dibujos los lugares donde sientes dolor. Asegúrate de colorear todas las áreas (grandes o pequeñas) donde sientes dolor.

Figure 2.

2. Coloca una raya (de arriba hacia abajo) sobre esta línea para indicar qué tanto dolor sientes.

No siento dolor | Siento poco dolor | Siento mucho dolor | Siento muchísimo dolor | Tengo el peor dolor posible

3. Señala o encierra en un círculo todas las palabras que describan tu dolor.

1 molesto malo horrible miserable terrible incómodo	5 como una ampolla ardiente caliente	10 desagradable mortal agonizante inaguantable	15 va y viene de vez en cuando de repente algunas veces permanente
2 doloroso hiriente dolor agudo como una herida adolorido	6 como un calambre aplastante como un pellizco apretón presión	11 llorar atemorizante me hace gritar aterrador	Si quieres, puedes añadir tus propias palabras: _____ _____ _____
3 agotador severo latente punzante palpitante	7 comezón como un rasguño como una picadura arañazo pique	12 mareo repugnante sofocante	Para uso de la oficina únicamente: BSA: _____ IS: _____
4 como una mordedura como una cortadura como un alfiler como un cuchillo filoso como una aguja agudo como una puñalada	8 espantoso como un disparo como un dolor que me parte	13 nunca desaparece incontrolable	#S (2,9) _____/37= _____ % #A (10-12) _____/11= _____ % #E (1,13) _____/8= _____ % #T (14,15) _____/10= _____ % Total _____/66= _____ %
	9 adormecido entumecido hinchado tieso	14 siempre repentino constante continuo eterno	

Table 1

Evidence of Reliability and Validity of the APPT

Reference	Pain Condition/Setting	Coefficients	Comments
Jacob et al., 2008	Cancer/Hispanic	$r = .45$	Correlation between number of body areas on BOD and severity of pain
		$r = .69$	Correlation between the Spanish-translated WGR of APPT scale (0 to 10 cm) and the Spanish-translated numerical rating scale (0 to 10)
		$\alpha = .81$	Cronbach's alpha showing correlations between the Spanish and English WGR & NGR scales
		$\alpha = .73$	Cronbach's alpha showing correlations among the total number of body areas marked on BOD, pain intensity ratings on WGR, and total number of word descriptors
		$r = .63$	Correlation coefficient between the pain intensity ratings on the WGR and the total number of body areas marked on the BOD
		$r = .52$	Correlation coefficient between the pain intensity ratings on the WGR and the total number of word descriptors
		$r = .59$	Correlations between the total number of body areas marked on BOD and the total number of word descriptors.
Savendra et al., 1993	Medical/Surgical	$\kappa = .71$	Agreement of pair 1-2 coders on site number
		$\kappa = .55$	Agreement of pair 1-3 coders on site number
		$\kappa = .58$	Agreement of pair 2-3 coders on site number
		$\kappa = .35$	Agreement of pair 1-2 coders on location of marks
		$\kappa = .30$	Agreement of pair 1-3 coders on location of marks
		$\kappa = .34$	Agreement of pair 2-3 coders on location of marks
		$\kappa = .45$	Agreement of pair 1-2 coders on surface area covered
		$\kappa = .36$	Agreement of pair 1-3 coders on surface area covered
Tesler et al., 1991	Healthy Children	$r = .66$ to $r = .80$	Correlation of five scales to rate pain intensity of standardized painful stimuli depicted in a pictorial analogue situation
			Construct validity: highest pain on first postoperative day (67.8 mm) and decreased gradually over 5 days (20.8 mm)
	Surgical		Demonstrated sensitivity to changes in pain ratings over time
		$r = .68$ to $r = .97$	Correlations among pairs of scores from five scales supporting convergent validity.
		$r = .91$	Test-retest reliability between the two word-graphic rating scales and one of 4 other scales
Van Cleve et al., 2001	Cancer/Hispanic	$r = .99$	Correlation between number of sensory words and number of sites
		$r = .81$	Correlation between number of affective words and number of sites
		$r = .99$	Correlation between number of evaluative and number of sites
		$r = .86$	Correlation between number of temporal words and number of sites
Wilkie et al., 1990	Healthy Children Medical/Surgical	$e = 0.49$ to $e = 0.59$	Factor loadings from confirmatory factor analysis using LISREL for the sensory word groups
		$e = 0.59$ to $e = 0.85$	Factor loadings from confirmatory factor analysis using LISREL for the affective word groups
		$e = 0.71$	Factor loadings from confirmatory factor analysis using LISREL for the evaluative group
		$r = .35$ to $r = .44$	Correlations among sensory, affective, and evaluative words and pain intensity scores
		$r = .63$ to	Correlations among the sensory, affective, and evaluative word scores

Reference	Pain Condition/Setting	Coefficients	Comments
Young, et al., 1994	Orthopedic	$r = .66$	
		$r = .63$	Correlation between least pain on APPT & HSC
		$r = .75$	Correlation between most pain on APPT & HSC
		$r = .72$	Correlation between current Pain on APPT & HSC
		$r = .68$	Correlation between number of words on APPT and pain on HSC
		$r = .80$	Correlation between pain intensity on the APPT and HSC
		$r = .82$	Correlation between pain Intensity on APPT & number of words on APPT

Note: APPT: Adolescent Pediatric Pain Scale; WGR: Word Graphic Rating Scale of the APPT; BOD: Body Outline Diagram; HSC: Hospital for Sick Children Scale; r : Pearson's or Spearman's correlation coefficients; α : Cronbach's alpha; κ : Cohen's Kappa coefficient; e : Eigen values

Table 2

Percentage of the Sample Reporting Pain Location by Cancer and Sickle Cell Disease

	Cancer		Sickle Cell Disease	
	Van Cleve, et al, 2004	Jacob et al, 2007	Franck, et al, 2002	Jacob, et al, 2003
Extremities	23.4%	--	--	50% to 75%
Head and neck	20.6%	--	--	--
Abdomen	15.6%	18.4%	53.8%	50% to 66.7%
Back	15.3%	12.2%	46.2%	50% to 66.7%
Chest	--	14.3%	30.8%	66.7% to 83%

Table 3

Mean (SD) Number of Segments Marked on Body Outline Diagram of the APPT

	Mean	SD
Number of Areas by Pain Severity in Cancer		
Mild pain	2.8	0.8
Moderate pain	4.6	2.2
Severe pain	7.0	11.4
Number of Areas by Age Group in Cancer		
Children	3.4 to 7.5	3.9
Adolescents	2.1 to 3.8	2.6
Number of Areas by Cancer Diagnosis		
Lymphoma	19.5	15.5
Leukemia	2.5 to 3.7	2.0
Sarcomas	3.5	2.1
Solid tumors	3.9	NR
Number of Areas by Setting in Sickle Cell Disease		
Clinic	5.8	4.6
Day Hospital	10.2	8.8
Inpatient	7.8	7.8

Note: NR not reported

Table 4

Mean (SD) Pain Intensity Reported for Different Pain Conditions

Sickle Cell Disease (Franck, et al, 2002)	M		SD	
	M	SD	M	SD
	5.92	2.62 (a)		
	6.99	1.56 (b)		
	6.88	2.05 (c)		

Cancer (Van Cleve, et al, 2004)	Before Treatment		After Treatment	
	M	SD	M	SD
	5.6	2.2	3.2	1.8
	4.6	2.5	2.5	2.4
	4.2	2.8	1.7	1.2
	3.8	2.6	2.2	2.1
	4.3	3.0	2.0	1.7
	4.7	3.0	2.0	1.7
	4.4	2.5	1.4	1.6

Orthopedic surgery (Kotzer, et al, 1998)	Day 1		Day 2		Day 3		Day 4	
	M	SD	M	SD	M	SD	M	SD
Routine Pre-op Education	1.3	0.3	1.1	0.3	1.1	0.4	1.1	0.4
Standardized Pre-op Education	1.5	0.3	2.5	0.3	1.3	0.3	1.3	0.3

Allergy Testing (Jeffs, 2007)	Initial Testing		Repeat Testing	
	M	SD	M	SD
Self-selected distraction (n=10)	1.3	1.0	3.7	2.2
Investigator selected distraction (n=12)	1.2	0.6	3.9	2.0
Usual care (n=10)	1.2	0.9	4.6	2.6
Overall	1.3	0.8	4.1	2.3

Note: M = mean; (a) Clinic; (b) Day Hospital; (c) inpatient; NR not reported; **authors reported in 0 to 100 mm but reported here as 0 to 10 cm (to facilitate comparison with the 0 to 10 scales, the common metric used in clinical practice).

Table 5
Mean (SD) Number of Pain Quality Descriptors Associated with Different Pain Conditions

	Cancer		Traumatic Brain Injury		Allergy Testing		Sickle Cell Disease	
	Jacob, et al, 2007		Crandall, et al, 2007		Jeffs, 2007		Franck, et al, 2002	Jacob, et al, 2003
	M	SD	M	SD	M	SD	M	SD
Total Number	9.2	11.5	19.8	7.1	NR		10.0 to 7.5	NR
Sensory	3.9	5.3	10.9	4.3	4.8	4.7	3.7 to 7.5	NR
Evaluative	1.8	2.1	3.0	1.3	2.7	1.8	1.7 to 2.1	NR
Affective	1.4	2.4	2.4	1.7	2.1	2.1	1.8 to 2.5	NR
Temporal	2.1	2.7	3.9	1.7	2.5	0.0	1.8 to 2.6	NR

Note: NR = not reported