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Play-based procedural preparation and support intervention for cranial radiation

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Abstract

Purpose—The primary objective of this study was to examine the relationship between play-based procedural preparation and support intervention and use of sedation in children with central nervous system (CNS) tumors during radiation therapy. The secondary objective was to analyze the cost-effectiveness of the intervention compared to costs associated with daily sedation.

Methods—A retrospective chart review was conducted, and 116 children aged 5–12 years met criteria for inclusion. Outcome measures included the total number of radiation treatments received, the number of treatments received with and without sedation, and the type and duration of interventions, which consisted of developmentally appropriate play, education, preparation, and distraction provided by a certified child life specialist.

Results—The results of univariate analyses showed that age, tumor location, and total number and duration of interventions were significantly associated with sedation use during radiation therapy. Multivariate analyses showed that, after adjustment for age, tumor location, and craniospinal radiation, a significant relationship was found between the total number and duration of the interventions and sedation use. The implementation of a play-based procedural preparation and support intervention provided by a certified child life specialist significantly reduced health-care costs by decreasing the necessity of daily sedation.

Conclusions—Support interventions provided by child life specialists significantly decreased both sedation use and the cost associated with daily sedation during cranial radiation therapy in

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Informed consent The study was approved by the hospital's institutional review board as exempt research with wavier of consent and assent.

children with CNS tumors. This study supports the value of the child life professional as a play-based developmental specialist and a crucial component of cost-effective healthcare.

Keywords

Child life; Radiation therapy; Procedural support; Play; Sedation; Cost-effectiveness

Introduction

Central nervous system (CNS) tumors are the most commonly diagnosed solid tumor in childhood, accounting for nearly 20 % of all pediatric cancers, with 2500 new cases treated in the USA each year [1, 2]. Radiation therapy is an effective treatment modality for many CNS tumors; however, this treatment may produce significant physical and psychosocial stress for both the child and parent [3–6]. Radiation therapy is particularly stressful for children, who must maintain precise body positioning to ensure delivery of radiation to the tumor and avoid unintended exposure to the developing brain [7]. To ensure precise positioning, sedation may be required. However, daily sedation in children may be associated with risks for respiratory depression, aspiration, central line infections [8, 9], learning disabilities, decreased attentiveness, and decreased cognitive functioning [10, 11].

Many pediatric health-care institutions use intervention programs delivered by certified child life specialists (CCLS) to provide developmentally targeted psychosocial support and thereby promote successful coping in children and families facing a variety of stressful illnesses and procedures [12–14]. The CCLS uses a theoretical foundation in child development, therapeutic play, stress and coping, and play-based procedural preparation and support interventions to reduce stress and anxiety for children undergoing diagnostic or therapeutic procedures. Child life specialists are therefore uniquely positioned within the interdisciplinary team to individualize psychosocial treatment plans that incorporate the child’s development, coping abilities, and strengths into the health-care plan.

Play-based procedural support and preparation refers to a specific child life intervention that aims to promote the child’s coping with new and unfamiliar medical experiences, such as invasive procedures or treatments. These interventions include using familiar play materials and unfamiliar medical materials to merge the child’s primary means of learning and communication—play—with the child’s developing understandings of current illness and treatment. By increasing familiarity with the equipment and steps involved in the procedure through play, the child can better anticipate and prepare for the sequence of treatment events.

Specifically in the context of radiation therapy, procedural preparation—including demonstration and education during simulation—may reduce the stress of the radiation experience for the child and parent. Intuitively, successful preparation interventions alleviating the need for sedation should reduce health-care costs; however, prior studies have not explored the potential economic benefit of a CCLS preparation intervention. Therefore, the primary aim of this study was to assess the relationship between play-based procedural preparation and support interventions and the ability of young children with CNS tumors to undergo cranial radiation without sedation. Secondly, we assessed the effect of this play-based intervention on health-care costs.

Methods

Setting

This retrospective study assessed the effect of a play-based procedural preparation and support intervention provided by a CCLS within an outpatient radiation oncology clinic in a free-standing children's oncology hospital. The radiation oncology clinic provides radiation therapy from birth to young adulthood for children with a variety of solid tumor, leukemia, and CNS tumor diagnoses. Treatment plans are individualized based on tumor type, location, and specifications outlined by clinical trials or non-protocol treatment plans developed with the primary oncologist, radiation oncologist, and interdisciplinary staff. The hospital employs one full-time CCLS within the radiation oncology clinic to provide play-based procedural preparation and support interventions. The child life program has provided services for this clinic for 6 years, with the CCLS functioning as a member of the interdisciplinary health-care team.

Participants

A total of 164 children aged 5–12 years were identified as having a CNS tumor and referred for cranial radiation therapy from October 15, 2009 to December 31, 2013. Patients aged 5–12 years were chosen, as this is the developmental age range most often referred for child life services in the radiation oncology clinic. Those with pre-existing developmental delays or posterior fossa syndrome were excluded from analysis, leaving a total of 129 eligible patient records for review. Of the 129 identified children, 116 received child life services that included play-based procedural preparation and support interventions, with the intervention documented in the electronic medical record or in an internal productivity statistics database maintained by the child life program director.

Measures

Child life electronic documentation and statistics and clinical documentation from radiation oncology and anesthesia were available for all study participants. To facilitate collection of these data, a data abstraction instrument was designed to systematically categorize demographic data, sedation patterns, and child life interventions.

Demographic data included each child's sex, age, tumor location (infratentorial, supratentorial), position during radiation treatment (prone, supine), total radiation treatment dose, average minutes of daily radiation treatment, number of days over which radiation was administered, and need for sedation during radiation treatment (all, partial, none). Partial sedation was defined as the child receiving at least one radiation treatment with sedation and at least four treatments without sedation. Play-based procedural preparation and support intervention data included the number of child life sessions and the average duration of each session. Three investigators separately reviewed each child's medical record to ensure inter-rater reliability.

Intervention

The objectives of the play-based procedural preparation and support intervention provided by the CCLS included anxiety reduction through developmentally appropriate education, assessment and application of the child's individual coping strategies. The ultimate goal of the intervention was to assist the child in becoming comfortable with the radiation treatment process, thus eliminating or decreasing the number of radiation treatments under sedation. The play-based procedural preparation and support intervention was defined as age-appropriate play, education, preparation, and/or distraction that helped to provide children with a sense of mastery over their environment. These elements of intervention can be assembled and provided to meet the individual child's developmental level, learning style, and coping preferences. The play-based procedural preparation portion of the intervention specifically used play to introduce the child to sensory stimulation anticipated during the medical treatment or procedure; the procedural support component involved active listening, emotional support, and diversionary play provided during the actual radiation simulation procedure to promote coping and normalcy within the treatment environment. The play-based procedural preparation and support intervention was designed and delivered to the 116 children in this study. First, the child was referred to the CCLS for assessment after the patient's initial consult with the radiation oncology team. During the assessment, the CCLS would gather information on the child's current understanding of radiation treatment, previous medical experiences, coping style, temperament, attention span, ability to separate from caregivers, and level of comfort in the hospital setting and with medical staff.

Second, the CCLS used this information to develop a care plan based upon the child's development, learning style, and assessment of the child's ability to undergo treatment without sedation. The CCLS's care plan for intervention included preparation, planning for rehearsal and practice sessions (if needed), and support during radiation therapy. In order to prepare patients for the experience of radiation therapy, the CCLS would use teaching materials such as a picture preparation book, a video, a teaching doll, or even hands on exploration of medical items in one of the treatment spaces [15]. During the initial preparation session, the sequence of events was explained, and sensory information, including what the child would see, feel, and hear during treatment, was provided by the CCLS using developmentally appropriate language. This session also allowed patients to ask questions and for the CCLS to clarify any misconceptions. At this point, the child and family worked with the CCLS to develop an individualized coping plan and determine if a child would need rehearsal or practice sessions at the initiation of radiation therapy. Some children were assessed to require no sedation for their treatment, while others were assessed to require sedation for all treatment sessions, while others were assessed as likely to benefit from practice sessions with the potential for partial sedation. Practice sessions offered children an opportunity to simulate therapy with body position and cranial immobilization device, treatment environment and holding still for the treatment duration. This gave the child a chance to practice coping strategies and gain confidence with the requirements of radiation therapy in a nonthreatening environment. The practice sessions were considered effective if the child demonstrated the ability to maintain the treatment position as a result of the practice session. Once the patient demonstrated success during the practice session, an attempt was made to deliver radiation therapy without sedation. If three radiation treatments were completed successfully without sedation, then sedation orders were removed from the child's radiation treatment schedule for the remaining weeks of therapy. Children received an individualized treatment coping plan developed with the CCLS for any radiation therapy treatment not requiring sedation. The treatment coping plans included options such as listening to a personalized music playlist or audio book during treatment, hearing guided imagery or relaxation scripts, being updated on treatment timing during a session, and altering the treatment environment if needed, such as lowering lights or placing holes in the treatment mask (see Table 1).

Statistical analyses

Patient demographics were summarized by descriptive statistics. Multinomial logistic regression was used to examine the relationship between a play-based procedural preparation and support intervention and the use of sedation during radiation therapy, with and without adjustment for covariates. The total number and the duration of all intervention sessions were used as measures for the effect of the intervention and were evaluated separately in all analyses. Covariates were selected by using the criterion of $P<0.1$ for inclusion in the adjusted model. The following demographic and clinical parameters were considered as potential covariates: age at the time of treatment, sex, tumor location (infratentorial, supratentorial), patient position during treatment (prone, supine, prone/ supine), and craniospinal radiation (Table 2). The Wilcoxon rank-sum test was used to compare the combined total cost of treatment and intervention between sedation groups. A two-sided significance level of $P<0.05$ was used for all statistical tests. Statistical analyses were performed by using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Effect of child life intervention on sedation

A total of 116 patients received the child life intervention and were included in the analysis. The multinomial logistic regression models examined the association between demographic and clinical characteristics and sedation (Table 3). Age and tumor location were significantly associated with sedation use. A 1-year increase in age was associated with significantly higher odds of receiving cranial radiation without sedation over full sedation (OR 3.24; 95 % CI 2.12–4.95; $P<0.001$) and significantly higher odds of receiving cranial radiation with partial sedation over full sedation (OR 2.00; 95 % CI 1.28–3.12; $P = 0.002$). Compared to patients with supratentorial tumors, patients with infratentorial tumors were less likely to receive cranial radiation without sedation over full sedation (OR 0.19; 95 % CI 0.07–0.48; $P<0.001$). There was a trend toward significance for the association between craniospinal radiation and sedation use; compared to patients that did not receive craniospinal radiation, patients that received craniospinal radiation were less likely to receive cranial radiation without sedation over full sedation (OR 0.41; 95 % CI 0.17–1.003; $P=0.051$). The results from multinomial logistic regression models examining the association between intervention measures and sedation use are shown in Table 4. The total number and duration of all intervention sessions were significantly associated with the use of sedation, with and without adjustment for covariates. After adjustment for age, tumor location, and receipt of craniospinal radiation, each additional intervention session was associated with a 23 % increase in the odds of receiving cranial radiation with partial sedation over full sedation (OR 1.23; 95 % CI 1.001–1.507; $P=0.048$). After adjustment for age, tumor location, and receipt of craniospinal radiation, each additional minute of the child life intervention session was associated with a 0.4 % increase in the odds of receiving cranial radiation with partial sedation over full sedation (OR 1.004; 95 % CI 1.000–1.008; *P*=0.036).

Economic effect of a child life intervention on sedation use

Economic data were provided by the institution's financial services division. The total cost of treatment was estimated by averaging the cost of the total number of treatments with and without sedation: the average cost of one treatment was $5233.63 with sedation and $1811.31 without sedation. The total cost of child life intervention was estimated by the total time spent in all child life interventions: the cost of a 45-min child life intervention session was $18.95. These average costs are based on staff salaries, supplies, and services. The total treatment cost, total child life intervention cost, and the combined total cost of treatment and intervention are shown in Table 5, with all costs increasing with the use of sedation during cranial radiation. The cost of child life intervention was highest for patients receiving partial sedation, and lowest for those receiving full sedation. Undergoing more sessions or longer sessions was associated with a greater likelihood that the child would receive partial sedation over full sedation. Thus, child life intervention could significantly reduce the health-care cost by reducing the need for sedation from full to partial, with a potential mean cost difference of $77,814 (95% CI $69,022–$86,604; *P*<0.001).

Discussion

These findings support previous literature confirming that play-based procedural preparation significantly decreases the need for sedation in pediatric populations [16–18]. Similar to other psychological preparation programs for young children, our program confirms that early introduction into the radiation unit helps the child incorporate coping strategies for immobilization during radiation therapy [13], which thereby decreases the need for sedation during radiation therapy.

Decreasing sedation use has a long-term effect on the well-being of the child and family by protecting the patient from potential physiological and cognitive deficits [2, 10, 11, 13, 19]. In addition, decreasing sedation use may have financial benefits for the institution. Unlike previous studies, our findings also emphasize the cost-effectiveness of reduced sedation through interventions facilitated by a CCLS [20, 21], thus saving thousands of dollars in health-care costs. We have found that the child life intervention was associated with significant reduction in health-care costs, and findings provide supporting evidence for the implementation of child life programs within radiation and diagnostic imaging units. In summary, play-based programming implemented by a CCLS supports the child's psychosocial development and mastery over the health-care environment while also being related to reduced treatment cost.

Although our results support the use of child life interventions for children with CNS tumors undergoing radiation therapy, there are noted limitations. First, due to logistic restraints, our study was retrospective and lacked a randomized control group: a prospective methodology would have allowed for a real-time estimation of costs and would allow for other important patient-reported outcomes including coping, stress, and anxiety associated with treatment. Secondly, the retrospective data reflects a time in which the radiation oncology child life program was in its early stage of program development. Over time, the program has grown in scope and time spent with each child, thus, our reported results may underestimate the program's current value to the institution. Finally, although age was included as a factor for analysis, age may not always account for individual differences related to development; this further highlights the importance of individually targeted and developmentally focused psychosocial intervention provided by a child life specialist.

Play is the most universal tool used by CCLSs to support coping in children during the illness experience. By gradually introducing unfamiliar or anxiety-producing procedures and equipment through play, children attain a greater understanding of and control over their environment [22]. This study provides evidence to emphasize the importance of a child life program within pediatric settings as a service that supports patients' coping during anxiety producing procedures with the potential to reduce health-care costs. Furthermore, these programs, specifically in radiation therapy settings, may contribute to a reduction in health-care costs, therefore augmenting childhood coping while also promoting cost-effective and high-quality care for children with CNS tumors and their families.

Conclusion

The treatment experience for children with CNS tumors can be daunting. To assist with the stress and anxiety of radiation therapy, sedation is often used; however, sedation may increase the child's clinical risks, as well as being time-consuming and costly. This retrospective study describes the efficacy of child life interventions and the decrease of sedation use within an outpatient radiation oncology clinic treating children with CNS tumors. By retrospectively reviewing the medical records and child life documentation, we assessed play-based procedural preparation and support interventions and the associated use of sedation in children (aged 5 to 12 years) receiving radiation therapy for a CNS tumor. The implications of this study are two-fold: individual treatment-related coping plans and play-based procedural preparation and support interventions developed by child life specialists are associated with reduced need for sedation during treatment, even for young children; and child life specialists are a cost-effective means for decreasing health-care costs. Additional prospective research is needed to validate the association between a child life program and clinical and financial outcomes, as well as the most effective play-based procedural preparation and support interventions for children with oncological diseases undergoing medical procedures and treatment.

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Table 1

Play-based procedural preparation and support intervention

Before radiation therapy	
Assessment	
•	Consultation with radiation oncology medical team
•	Referral to CCLS
•	CCLS meets with patient and family for rapport building, play, and expressive activities
•	CCLS gathers information (patient's understanding of treatment, previous hospital experiences, ability to separate from caregiver, attention span, temperament, learning style, and level of comfort with medical staff)
Developmentally appropriate preparation	
•	Teaching materials shown (video, picture preparation book, teaching doll)
•	Sequence of events explained
•	Sensory information explained
•	CCLS clarifies any misconceptions
•	Individualized coping plan developed with patient and family
Rehearsal and practice sessions	
•	Increased opportunities to explore immobilization device
•	Increased opportunities to acclimate to treatment position
•	Increased opportunities to experience treatment environment
During radiation therapy	
Support	
•	Personalized music playlist or choice of audio book
•	Guided imagery and relaxation scripts
•	Updating patient on treatment progress
•	Altered treatment environment (i.e., lowered lights, adjusted temperature, nose holes in mask, and weights on feet)

Table 2

Patient characteristic by sedation use

		Sedation use		
	All (*N*=116)	**None (*n*=61)**	**Partial (*n*=15)**	**Full (*n*=40)**
Age at time of treatment (year)				
Mean (SD)	8.1 (2.2)	9.4 (1.8)	7.7 (2.2)	6.3 (1.4)
Sex				
Female	50 (43%)	27 (44%)	5 (33%)	18 (45%)
Male	66 (57%)	34 (56%)	10 (67%)	22 (55%)
Tumor location				
Infratentorial	73 (63%)	28 (46%)	13 (87%)	32 (80%)
Supratentorial	42 (36%)	33 (54%)	2 (13%)	7 (17.5%)
Infratentorial/supratentorial	1 (1%)	0 (0%)	0 (0%)	1 (2.5%)
Patient position during treatment				
Prone	32 (27.6%)	11 (18%)	5 (33.3%)	16 (40%)
Supine	74 (63.8%)	45 (74%)	8 (53.3%)	21 (52.5%)
Prone/supine	10 (8.6%)	5 (8%)	2 (13.3%)	3 (7.5%)
Received craniospinal radiation				
No	83 (72%)	49 (80%)	9 (60%)	25 (62.5%)
Yes	33 (28%)	12 (20%)	6 (40%)	15 (37.5%)
Total number of intervention sessions				
Mean (SD)	4.5 (3.1)	4.1 (2.9)	6.5 (3.9)	4.2 (3.1)
Duration of all intervention sessions (min)				
Mean (SD)	210.4 (164.0)	217.1 (153.5)	300.3 (213.8)	166.6 (146.6)

SD standard deviation

Table 3

Multinomial logistic regression modeling of sedation use as predicted by demographic and clinical characteristics

	No. sedation		Partial sedation	
Demographic/clinical characteristics	**OR (95 % CI)**	***P***	**OR (95 % CI)**	***P***
Age at time of treatment (year)	3.24* (2.12–4.95)	<0.001	2.00* (1.28–3.12)	0.002
Sex				
Male	Reference		Reference	
Female	0.97 (0.43–2.16)	0.942	0.61 (0.18–2.11)	0.437
Tumor location[a]				
Supratentorial	Reference		Reference	
Infratentorial	0.19* (0.07–0.48)	<0.001	1.42 (0.26–7.77)	0.685
Patient position during treatment				
Prone/supine	Reference		Reference	
Prone	0.41 (0.08–2.09)	0.285	0.47 (0.06–3.65)	0.469
Supine	1.29 (0.28–5.89)	0.746	0.57 (0.08–4.08)	0.577
Received craniospinal radiation				
No	Reference		Reference	
Yes	0.41 (0.17–1.003)	0.051	1.11 (0.33–3.75)	0.865

The reference category is full sedation

OR odds ratio, *CI* confidence interval

[a] One patient with an infratentorial and supratentorial tumor was excluded

* Statistically significant value

Table 4

Multinomial logistic regression modeling of sedation use as predicted by intervention measures

	No. sedation				Partial sedation			
	Unadjusted		Adjusted[a]		Unadjusted		Adjusted[a]	
Intervention measures	**OR (95 % CI)**	***P***	**OR (95 % CI)**	***P***	**OR (95 % CI)**	***P***	**OR (95 % CI)**	***P***
Total no. of intervention sessions	0.99 (0.86–1.13)	0.874	0.97 (0.81–1.18)	0.789	1.22* (1.02–1.46)	0.029	1.23* (1.001–1.507)	0.048
Duration of all intervention sessions (min)	1.002 (0.999–1.005)	0.111	1.002 (0.998–1.005)	0.347	1.005* (1.001–1.009)	0.009	1.004* (1.000–1.008)	0.036

The reference category is full sedation

OR odds ratio, *CI* confidence interval

[a] Adjusted for age at time of treatment, tumor location, and receipt of craniospinal radiation

[*] Statistically significant value

Table 5

Cost of treatment and intervention by sedation use

Cost variables	No. sedation (*n*=61)		Partial sedation (*n*=15)		Full sedation (*n*=40)	
	Mean	SD	Mean	SD	Mean	SD
No. of treatments with sedation	NA	NA	7.7	7.0	30.4	1.4
No. of treatments without sedation	30.1	3.2	22.6	6.7	0	0.2
Total duration of all child life intervention sessions (min)	217.1	153.5	300.3	213.8	166.6	146.6
Total treatment cost[a]	$54,607	$5755	$81,409	$25,085	$159,278	$7638
Total child life intervention cost[b]	$91	$65	$126	$90	$70	$62
Total treatment and intervention cost[c]	$54,698	$5749	$81,535	$25,116	$159,349	$7639

All cost variables have been rounded to the nearest dollar

NA not applicable, *SD* standard deviation

[a](No. of treatments with sedation×$5233.63)+(no. of treatments without sedation×$1811.31)

[b](Total min spent in all child life interventions/45 min)×$18.95

[c]Total treatment cost+total child life intervention cost