The Impact of a Play-Based Procedural Preparation and Support Intervention for Children Undergoing Cranial Radiation for Treatment of a Central Nervous System Tumor

St. Jude Children's Research Hospital

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Final Report

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Research Question: Does a child life play-based procedural preparation and support intervention have an economic impact on the cost of radiation therapy delivery in children with a central nervous system tumor.

Time Frame: January 1, 2014 – July 15, 2014

The St. Jude Children's Research Hospital child life program has a long history of providing play-based procedural preparation and support interventions to patients undergoing cranial radiation for treatment of central nervous system (CNS) tumors. Such procedural preparation and interventions may decrease the need for sedation during cranial radiation, eliminating the risk of sedation related side effects and health care cost.

Study Objectives

1. Assess the relationship between a child life play-based procedural preparation and support intervention and the ability of young children (5-12 years) with CNS tumors to undergo cranial radiation without anesthesia.

2. Assess the economic impact of a child life play-based procedural preparation and support intervention and the child's ability to undergo consecutive days of cranial radiation without anesthesia compared to those requiring anesthesia.

Study Questions

1. Does the implementation of a play-based procedural preparation and support intervention by child life specialists decrease the use of sedation and anesthesia among children (5-12 years) with CNS tumors receiving cranial radiation?

2. Does the implementation of a play-based procedural preparation and support intervention by child life specialists have an economic impact on healthcare costs among children (5-12 years) with CNS tumors receiving cranial radiation?

In January 2014, a retrospective review of two correlated data sources was completed and included the electronic medical record and narrative -based child life electronic documentation from the dates of October 15, 2009 to December 31, 2013.

One hundred sixty-four (164) patients, age 5-12 years were identified as having been diagnosed with a CNS tumor and referred for cranial radiation therapy. Those with pre-existing developmental delays, neurocognitive conditions, or posterior fossa syndrome were excluded from analysis, leaving a total of 129 eligible patient records for examination. After potential participants were identified, Institutional Review Board review was submitted and approved. Of the 129 identified patients, 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, as well as clinical documentation from radiation oncology and anesthesia, were available for all participants. In order to facilitate this collection, a data abstraction instrument named the Outcome Measures Form was designed to systematically categorize demographic data, sedation patterns and child life interventions among the study participants (Appendix A). The Outcome Measures Form was completed for each individual patient record, and then was coded and entered systematically into a comprehensive database.

Demographic data included the child's gender, age, tumor location (infratentorial, supratentorial), position during radiation treatment (supine, prone) total radiation treatment dose, average minutes of daily radiation treatment, the number of days over which radiation was administered, and the need for sedation during radiation treatment (all, partial, none). Play-based procedural support and intervention data during radiation treatment

included the number of child life sessions and the average duration of each session. Three investigators separately reviewed each participant's medical record in order to ensure inter-rater reliability.

Economic data was provided by the institutional financial services. The total cost of treatment was estimated by averaging the cost of the total number of treatments with sedation and the total without sedation. The average cost of one treatment with sedation was $5,233.63 and $1,811.31 without sedation. These average costs are based on staff salaries, supplies and services. The total cost of child life intervention was estimated by the total time spent in all child life interventions. The cost of a 45 minute child life intervention session was $18.95 based on supplies and salary.

Statistical Analyses

Patient characteristics were summarized by descriptive statistics. Univariate Generalized Estimating Equations (GEE) regression models were applied to examine the consideration of the following covariates: age at time of treatment, gender, tumor location (infratentorial, supratentorial), patient position during treatment (supine, prone), number of intervention sessions, and the total duration of all intervention sessions (minutes). The criterion of $p<0.1$ was used to select variables from the univariate model to include in a multivariable model. The multivariate model included main effects only (i.e. no interaction terms). Given the high correlation between the number of intervention sessions and the duration of all sessions; they were evaluated separately in multivariate models. The Wilcoxon rank-sum test was used to compare the combined total cost of treatment and intervention between sedation groups. Data were analyzed separately for the total population and for patients that received intervention only. A two-sided significance level of $p<0.05$ was used for all statistical tests. Statistical analyses were conducted using SAS Version 9.3.

Results

One hundred sixteen (116) patients that received child life intervention were included in the analysis. Table 1 details the characteristics for the total population. The mean age at the time of radiation was 8.1 years (range 5 to 12.8 years), 57% male, 63% of the patient tumors were infratentorial and 64% were in the supine position during treatment. Patients that received the child life intervention averaged 4.5 sessions, with all sessions averaging a total duration of 210.4 minutes.

Impact of Child Life Intervention and Sedation

The multivariate model for predictors of sedation use among patients who received the child life intervention included age at the time of treatment, tumor location, and total number of intervention sessions and the total duration of all intervention sessions. To determine the impact of the number of sessions and the impact of minutes, the multivariate models included each covariate separately. In the number of sessions model, age at the time of treatment and the total number of child life intervention sessions were positively associated with the use of sedation after adjustment for all covariates (Table 2). A one-year increase in age was associated with significantly higher odds of receiving cranial radiation without sedation over full sedation (OR: 3.001; 95% CI: 1.967-4.577; $p<0.0001$) and significantly higher odds of receiving cranial radiation with partial sedation over full sedation (OR: 2.015; 95% CI: 1.267-3.204; $p=0.0031$) after adjustment for tumor location and number of intervention sessions. Each additional intervention session was associated with a 23.3% increase in the odds of receiving cranial radiation with partial sedation over full sedation after adjustment for age and tumor location (OR: 1.233; 95% CI: 1.007-1.511; $p=0.0430$).

The total duration in minutes of the child life session was included in a separate multivariate model. Age at the time of treatment and the total duration in minutes were positively associated with sedation use after adjustment

for all covariates in the model. A one-year increase in age was associated with significantly higher odds of receiving cranial radiation without sedation over full sedation (OR: 2.953; 95% CI: 1.935-4.508; p<0.0001) and significantly higher odds of receiving cranial radiation with partial sedation over full sedation (OR: 1.927; 95% CI: 1.213-3.061; p=0.0055) after adjustment for tumor location and duration of intervention sessions. Each additional minute for the duration of all intervention sessions was associated with a 0.4% increase in the odds of receiving cranial radiation with partial sedation over full sedation after adjustment for age and tumor location (OR: 1.004; 95% CI: 1.000-1.008; p=0.0318).

Economic Impact of a Child Life Intervention on Sedation Use

The total treatment cost, total child life intervention cost, and the combined total cost of treatment and intervention are shown for the total population and for patients that received intervention only in Tables 3 and 4.

The total treatment cost, child life intervention cost and combined treatment and intervention cost increased with the utilization of sedation during treatment. The child life intervention was highest for patients that received partial sedation, followed in cost by no sedation and full sedation.

From previous described results, we found that the child life intervention has a significant impact on sedation use, such that, the more sessions or time spent in sessions the more likely a patient was to receive partial sedation over full sedation. The child life intervention significantly reduced the healthcare cost by reducing the need for sedation from full to partial sedation with a mean cost difference of $77,813 ([14,477], p<0.0001).

Future Plans

Data analyses validate play-based procedural preparation and support are valuable interventions for decreasing the amount and costs of daily sedation use in cranial radiation therapy for children with CNS tumors. This study supports the value of the child life profession as a play-based developmental service, but also as a crucial component of cost effective healthcare.

The research team is currently writing a manuscript based on the data collected. The anticipated submission to *Pediatrics* is estimated for November 1, 2014.

Appendix A.

OUTCOME MEASURES FORM

Section 1: Demographic Information

MRN:_____

*Birthday:*_____

*Date of RT CT SIM:*_____

*Age at time of RT CT SIM:*_____

Gender: male female

*Diagnosis:*_____

Posterior fossa, developmental delay, autism diagnosis? YES NO ***(If yes, end data collection.)***

Section 2: Radiation/Sedation Information

Received prior radiation at St. Jude or another facility: YES NO ***(If yes, end data collection.)***

*Medical indications that necessitate sedation? YES NO Type of indication:*_____ ***(If yes, did patient begin radiation therapy under anesthesia? YES NO. If yes, end data collection.)***

*Treatment Start Date:*_____ *Treatment End date:*_____

*Total dosage (gray) of treatment:*_____

Average duration of individual sessions: _____minutes_____

*Patient position during treatment:*_____

Sedation use: ALL PARTIAL NONE

Total number of treatments WITH sedation: _____

*Dates range of treatments WITH sedation:*_____

Total number of treatments WITHOUT sedation: _____

*Dates range of treatments WITHOUT sedation:*_____

Section 3: Child Life Intervention Information

Date of CL intervention 1:_____Duration of CL intervention 1:_____minutes

Name of child life specialist:_____

Type of intervention (circle all that apply):

Child Life Reports

Medical Rounds/Staff Contacts

Patient/Family Education

- Procedural Preparation
- Medical Play
- Diagnosis Teaching

Procedural Support

- Rehearsal/practice session
- Distraction/diversion

Therapeutic Interventions

- Play
- Emotional Support
- Relationship Building
- Peer Support

Developmental Stimulation

- Limiting sensory stimulation
- Environmental interventions

Parent/Caregiver Interventions

- Parent education/ Reinforcement
- Family Guidance
- Obtaining Feedback

Child's Responses

- Demonstrated understanding
- Identified coping plan
- Remained still
- Completed with assistance
- Completed without assistance
- Reported anxiety
- Denied anxiety
- CLS observed anxiety
- No observed anxiety

Date of CL intervention 2:_____Duration of CL intervention 2:_____minutes

Name of child life specialist:_____

Type of intervention (circle all that apply):

Child Life Reports

Medical Rounds/Staff Contacts

Patient/Family Education

- Procedural Preparation
- Medical Play
- Diagnosis Teaching

Procedural Support

- Rehearsal/practice session
- Distraction/diversion

Therapeutic Interventions

- Play
- Emotional Support
- Relationship Building
- Peer Support

Developmental Stimulation

- Limiting sensory stimulation
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Parent/Caregiver Interventions

- Parent education/ Reinforcement
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Child's Responses

- Demonstrated understanding
- Identified coping plan
- Remained still
- Completed with assistance
- Completed without assistance
- Reported anxiety
- Denied Anxiety
- CLS observed anxiety
- No observed anxiety

Table 1: Characteristics for the total population

		Sedation Use		
	Overall (N=129)	**None (n=68)**	**Partial (n=16)**	**Full (n=45)**
Age at time of treatment				
Mean (SD)	8.1 (2.3)	9.5 (1.8)	7.7 (2.1)	6.2 (1.3)
Median [range]	8.0 [5.0-13.1]	9.0 [5.3-13.1]	7.5 [5.1-12.1]	5.7 [5.0-12.0]
Gender				
Female	54 (42%)	29 (43%)	5 (31%)	20 (44%)
Male	75 (58%)	39 (57%)	11 (69%)	25 (56%)
Tumor location				
Infratentorial	81 (63%)	32 (47%)	14 (88%)	35 (78%)
Supratentorial	47 (36%)	36 (53%)	2 (13%)	9 (20%)
Infratentorial/Supratentorial	1 (1%)	0 (0%)	0 (0%)	1 (2%)
Patient position during treatment				
Prone	36 (28%)	14 (21%)	5 (31%)	17 (38%)
Supine	78 (60%)	47 (69%)	8 (50%)	23 (51%)
Prone/Supine	15 (12%)	7 (10%)	3 (19%)	5 (11%)
Received child life intervention				
No	13 (10%)	7 (10%)	1 (6%)	5 (11%)
Yes	116 (90%)	61 (90%)	15 (94%)	40 (89%)
Number of child life intervention sessions				
Mean (SD)	4.0 (3.3)	3.7 (3.0)	6.1 (4.1)	3.8 (3.2)
Median [range]	3 [0-14]	3 [0-12]	6 [0-14]	3 [0-11]
Total duration of all child life intervention sessions (minutes)				
Mean (SD)	189.2 (167.9)	194.8 (159.7)	281.6 (219.8)	148.0 (147.8)
Median [range]	140.0 [0-755]	150 [0-675]	247.5 [0-755]	100 [0-567]

Table 2: Multinomial logistic regression modeling sedation use predicted by demographic, clinical, and intervention factors among patients that received intervention

	No sedation vs. Full sedation		Partial sedation vs. Full sedation	
	Odds ratio (95% CI)	**P**	**Odds ratio (95% CI)**	**P**
Univariate models				
Age at time of treatment	3.244 (2.124-4.954)	**<0.0001**	1.997 (1.278-3.118)	**0.0024**
Gender Female vs Male)	0.971 (0.435-2.165)	0.9418	0.611 (0.177-2.115)	0.4370
Tumor location (Infratentorial vs Supratentorial)*	0.186 (0.071-0.485)	**0.0006**	1.421 (0.260-7.768)	0.6849
Patient position during treatment				
Prone vs Prone/Supine	0.413 (0.081-2.093)	0.2853	0.469 (0.060-3.647)	0.4692
Supine vs Prone/Supine	1.286 (0.281-5.891)	0.7462	0.571 (0.080-4.080)	0.5769
Total number of child life intervention sessions	0.989 (0.863-1.134)	0.8741	1.220 (1.020-1.458)	**0.0294**
Total duration of all child life intervention sessions (minutes)	1.002 (0.999-1.005)	0.1111	1.005 (1.001-1.009)	**0.0089**
Multivariate model #1[a]				
Age at time of treatment	3.001 (1.967-4.577)	**<0.0001**	2.015 (1.267-3.204)	**0.0031**
Tumor location (Infratentorial vs Supratentorial)*	0.343 (0.096-1.221)	0.0987	2.773 (0.425-18.101)	0.2865
Total number of child life intervention sessions	0.973 (0.808-1.171)	0.7684	1.233 (1.007-1.511)	**0.0430**
Multivariate model #2[a]				
Age at time of treatment	2.953 (1.935-4.508)	**<0.0001**	1.927 (1.213-3.061)	**0.0055**
Tumor location (Infratentorial vs Supratentorial)*	0.405 (0.112-1.463)	0.1678	2.746 (0.425-17.738)	0.2887
Total duration of all child life intervention sessions (minutes)	1.001 (0.998-1.005)	0.4278	1.004 (1.000-1.008)	**0.0318**

[a]The criterion of p<0.1 was used to select variables from the univariate analysis to include in the multivariate analysis.
*The patient with an infraterntorial and supratentorial tumor was excluded as there is only one patient in this group.

Table 3: Cost of treatment and intervention by sedation use for the total population

	No sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	68	0.0	0.0	0.0	0.0	0.0
Total treatments without sedation	68	30.2	3.0	30.0	19.0	38.0
Total treatment cost[a]	68	$54,738.85	$5,490.82	$54,339.30	$34,414.89	$68,829.78
Total child life intervention cost[b]	68	$82.02	$67.26	$63.17	$0.00	$284.25
Total treatment and Intervention cost[c]	68	$54,820.88	$5,483.51	$54,534.06	$34,520.17	$68,922.42
	Partial sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	16	7.4	6.9	5.5	1.0	27.0
Total treatments without sedation	16	22.9	6.6	24.5	4.0	30.0
Total treatment cost[a]	16	$80,358.84	$24,596.21	$73,162.06	$52,327.69	$148553.25
Total child life intervention cost[b]	16	$118.57	$92.56	$104.23	$0.00	$317.94
Total treatment and Intervention cost[c]	16	$80,477.41	$24,630.76	$73,267.34	$52,344.53	$148,660.63
	Full sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	45	30.4	1.6	30.0	26.0	35.0
Total treatments without sedation	45	0.0	0.1	0.0	0.0	1.0
Total treatment cost[a]	45	$159,026.30	$8,271.12	$157,008.90	$136,074.38	$184,988.36
Total child life intervention cost[b]	45	$62.34	$62.25	$42.11	$0.00	$238.77
Total treatment and Intervention cost[c]	45	$159,088.64	$8,274.15	$157,162.61	$13,6074.38	$185,179.97

[a]Estimated by: (# of treatments with sedation x $5,233.63) + (# of treatments without sedation x $1,811.31)
[b]Estimated by: (total minutes spent in all child life intervention sessions/45 minutes) X $18.95
[c]Estimated by: total treatment cost + total child life intervention cost

Table 4: Cost of treatment and intervention by sedation use for patients that received intervention

	No sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	61	0.0	0.0	0.0	0.0	0.0
Total treatments without sedation	61	30.1	3.2	30.0	19.0	38.0
Total treatment cost[a]	61	$54,606.54	$5,754.88	$54,339.30	$34,414.89	$68,829.78
Total child life intervention cost[b]	61	$91.44	$64.63	$73.69	$12.63	$284.25
Total treatment and Intervention cost[c]	61	$54,697.98	$5,749.15	$54,533.01	$34,520.17	$68,922.42
	Partial sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	15	7.7	7.0	6.0	1.0	27.0
Total treatments without sedation	15	22.6	6.7	24.0	4.0	30.0
Total treatment cost[a]	15	$81,409.01	$25,085.45	$74,873.22	$52,327.69	$148,553.25
Total child life intervention cost[b]	15	$126.47	$90.05	$107.38	$16.84	$317.94
Total treatment and Intervention cost[c]	15	$81,535.49	$25,116.06	$74,906.91	$52,344.53	$148,660.63
	Full sedation					
Cost Variables	**N**	**Mean**	**SD**	**Median**	**Min**	**Max**
Total treatments with sedation	40	30.4	1.4	30.0	27.0	35.0
Total treatments without sedation	40	0.0	0.2	0.0	0.0	1.0
Total treatment cost[a]	40	$159,278.48	$7,637.70	$157,008.90	$141,308.01	$184,988.36
Total child life intervention cost[b]	40	$70.14	$61.74	$44.22	$6.32	$238.77
Total treatment and Intervention cost[c]	40	$159,348.61	$7,638.99	$157,181.56	$141,358.54	$185,179.97

[a]Estimated by: (# of treatments with sedation x $5,233.63) + (# of treatments without sedation x $1,811.31)
[b]Estimated by: (total minutes spent in all child life intervention sessions/45 minutes) X $18.95
[c]Estimated by: total treatment cost + total child life intervention cost