Supportive Care in Cancer (2018) 26:1815–1824
https://doi.org/10.1007/s00520-017-4009-9

ORIGINAL ARTICLE

Parent perspectives and preferences for strategies regarding nonsedated MRI scans in a pediatric oncology population

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Received: 15 June 2017 / Accepted: 5 December 2017 / Published online: 19 December 2017

Abstract

Purpose Children with cancer frequently require MRI scans for clinical purposes. Sedation with general anesthesia (GA) is often used to promote compliance, reduce motion, and alleviate anxiety. The use of GA for MRI scans is costly in terms of time, personnel, and medications. In addition, prominent risks are associated with anesthesia exposure in patients with complex medical conditions. Successful behavioral interventions have been implemented in clinical research settings to promote scan success and compliance. To our knowledge, parent/caregiver acceptability of behavioral interventions to promote nonsedated MRI has not been systematically investigated in a medically complex population. As a first step toward developing a protocol-based intervention to promote nonsedated scanning, we conducted a survey to explore parental perspectives regarding acceptability of nonsedated scanning and to gain information regarding preference for specific behavioral interventions to facilitate nonsedated MRI exams.

Methods Parents or guardians of 101 patients diagnosed with childhood cancer participated in a semi-structured survey via telephone. The sample was stratified by age group (8–12 years; 13–18 years), gender, and diagnosis (solid tumor (ST), brain tumor (BT), and acute lymphoblastic leukemia (ALL)).

Results The majority of parents indicated that nonsedated MRI scans would be acceptable. Reduced anesthesia exposure was the most frequently identified benefit, followed by decreased irritability post-MRI scan, and shorter appointment time. Challenges included fear of movement and noise during scans and change in routine, with parents of younger children and those with a history of sedated exams identifying more challenges. Behavioral intervention preference differed by patient age and gender; however, education was ranked as most preferred overall.

Conclusion Parents of children treated for cancer consider behavior interventions to promote nonsedated scanning as acceptable. Patient characteristics should be considered when tailoring behavioral interventions. Results can inform future studies of behavioral interventions to promote nonsedated MRI scans. Future research should also investigate the risks associated with failed exams, both in terms of patient medical care and cost effectiveness.

Keywords Pediatric cancer · Sedation · Caregiver · Strategies · MRI · Adolescents/child

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00520-017-4009-9) contains supplementary material, which is available to authorized users.

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MRI scans are frequently employed in pediatric oncology for diagnosis and staging, as well as to monitor response to treatment [1]. Obtaining high-quality scans can be challenging in children for several reasons [2]. Children are required to remain still during scans, as movement may cause artifacts that can decrease the utility of a scan. The scanning procedure may be anxiety provoking, given the loud noises generated by the magnet. The scanner bore is narrow, which can lead to claustrophobia in many patients [3–6]. These factors can lead to

interrupted scans, which are costly in terms of patient and hospital resources.

Sedation with general anesthesia (GA) may be used to promote compliance with MRI scanning, particularly in cases where high-quality images are an integral component to diagnosis, treatment planning, and surveillance. Although frequently necessary in complex medical populations, incorporating GA is not without challenges. The sedation process requires additional preparation time for the clinic and close monitoring during the recovery period. Patients must refrain from eating or drinking prior to sedation and may experience post-procedural nausea/vomiting, fatigue, and irritability [7]. GA may be associated with more serious side effects, such as cardiopulmonary and respiratory complications; although generally infrequent, the risk is greater in patients with complex medical conditions [1, 5, 6]. Furthermore, recent studies have raised concerns regarding the impact of repeated exposure to GA on cognitive development in young children [8] and children with complex medical conditions [9, 10] . Alternative interventions are needed to promote procedural compliance and the collection of high-quality MRI scans without GA. Such programs have the potential to improve the patient experience, reduce associated procedural costs, increase efficiency, and limit the patient exposure to the potential risks related to sedation and GA, including immediate risks and long-term implications on cognitive function.

Behavioral interventions are commonly used in clinical research to promote compliance with MRI scanning, including positive reinforcement [2, 11, 12], nonsedated sleep [13, 14], progressive behavioral training [12], practice with the MR scanner [3, 4, 6, 15–18], use of audio/visual systems [1, 19, 20], and educational pamphlets and preparation [21–23]. The use of behavioral interventions, including scanner acclimation/practice, reinforcement for participation, and the provision of movies or music during scans, has resulted in increased rates of successful acquisition in typically developing children [24] and children with complex medical disorders [3, 22, 24]. Scanner practice [3] along with preparation, rehearsal, and support [22] have been shown to be beneficial to children with obsessive compulsive disorder and sickle cell disease, respectively, with decreases in distress and anxiety and increases in MRI scan completions. Successful implementation of such interventions as has been reported in infants with the implementation of flexible scheduling and swaddling, and in children as young as 4 years [13, 14]. Nonsedated sleep during MRI scans have resulted in a 97% completion rate in children 3 months to 4 years [13]. Additionally, 76–100% of individuals aged 8–18 years have been reported to have successfully completed nonsedated MRI scans [25]. Failure rates of nonsedated scans have been reported to drop to as low as 50% in patients 6 years old and to 0% in patients 15 years and older [12].

Demographic and clinical characteristics have been associated with successful acquisition of MRI scans, specifically, greater success is associated with older age at scan and female gender [19] [4], parent ratings of greater attention spans, and more positive temperament [26]. Compared to healthy children, children with complex medical conditions, including sickle cell disease and epilepsy, have lower success rates [22, 27, 28]. Finally, children with behavioral or psychiatric comorbidities may be especially challenging to scan [22, 27, 28].

To our knowledge, there have been no studies that systematically attempt to implement and evaluate behavioral interventions to promote nonsedated MRI scans in children with cancer, a population that requires frequent diagnostic imaging studies for clinical purposes. As such, the factors that may impact design and implementation of interventions are unclear. We conducted a parent survey of the preferences and perspectives of specific behavioral interventions for reducing the use of sedation for MRI studies in a clinical pediatric oncology setting to obtain such information, as a first step toward the design of research protocols investigating the efficacy of behavioral interventions in this setting. We chose to focus on parent perspectives, given their role as major stakeholders in treatment of childhood cancer.

Methods

Study overview

This study was approved as an exempt protocol by the Institutional Review Board. Requirements for written informed consent were waived. Verbal consent was sought from all parents prior to administering the surveys to parents by phone. We recruited the parents of children treated for brain tumors (BT), solid tumors (ST), or acute lymphoblastic leukemia (ALL) at our institution. All participants were parents of children that were 8 years or older and who had completed at least one MRI scan, regardless of sedation state, between May 2014 and April 2015. Parents were required to speak English, as the surveys were administered in English. Recruitment was stratified by age group (8 to 12 vs. 13 to 18 years), gender, and diagnosis to ensure a balanced representation with regard to diagnostic-specific scan characteristics (e.g., sequence, duration, anatomical focus). Survey data were collected between May and June 2015.

Survey instrument

A semi-structured survey was administered via telephone to the parents who met the eligibility criteria as described above. The content categories of the interview included (1) assessment of strategy preference and interest in nonsedated MRI studies, (2) benefits vs. concerns regarding nonsedated MRI studies, (3) review of specific behavior interventions offered

in preparation for nonsedated MRI studies, and (4) ranking of preferences for behavior interventions (Table 1; Online Resource 1). Additionally, parents were encouraged to add their own thoughts regarding concerns for nonsedated MRI and propose other interventions. Survey content was derived from extensive literature review of previously investigated interventions [1–4, 6, 11–23]. Multiple disciplines (e.g., psychology, anesthesiology, neuro-oncology, and diagnostic imaging) were consulted when modifying survey content.

The survey included a standardized introduction that emphasized the risk/benefit ratios of sedated vs. nonsedated imaging studies. To avoid framing bias, the question about interest in nonsedated MRI was asked at the beginning and end of the survey. All questions were initially asked as opened-ended, and were followed by specific prompts. The prompts concerning perceived benefits and challenges were generated based on literature review and anecdotal information from patients, families, and clinicians [1, 5, 7, 13, 17, 19]. Potential behavioral interventions that could encourage nonsedated MRI scans were selected based on a review of literature of behavioral interventions that have been used to promote successful scans in the clinical research setting [1–4, 6, 11–22].

Demographic and clinical variables

After meeting the eligibility criteria, the participants were stratified by age, sex, and diagnosis, before proceeding with the data collection and the interviews. The following information was extracted from patients' medical records for the purpose of the study: demographic characteristics (age, sex); diagnosis (BT, ST, ALL); number of sedated and nonsedated MRI scans; and the total duration (hours, minutes) for each sedated MRI scan. After meeting eligibility criteria, attending brain tumor physicians requested to review our list of potential BT patients for the survey. Attending physicians recommended that patients with medically complex situations, poor prognoses, active disease, and conditions/disabilities that required sedation be excluded from our survey (Fig. 1).

Survey training, administration, and data collection

Interviews were administered by three clinical research assistants (CRA) and one graduate student. Practice administration was completed within the group and the most experienced CRA supervised the initial interviews performed by the less-experienced CRAs. Regular investigator meetings were held to discuss progress and to problem solve any issues. Phone interviews were performed from May to June of 2015 and the average interview duration was 16.4 min. A list of eligible patients was stratified by diagnosis and was split between CRAs. Families were called sequentially with the goal of calling 33 parents in each diagnosis group until accrual was met. Data collection and entry was completed by the lead CRA. Parent responses were captured via survey paper, with closed-

Table 1 Summary of parent survey content

Section	Question	Outcome
Interest and perspectives	Interest[a]	Likert scale (1 = not interested, 5 = very interested)
	Discussed with medical team	Yes or no
	Perceived feasibility	Yes, no, unsure
Perceived benefits concerns of MRI without sedation[b]	Benefits	Reduced exposure; decreased appointment time; no NPO requirement; decreased irritability
	Concerns[b]	Change in routine, scanner space; scanner noise; movement; child's age
Behavioral Interventions to promote MRI without sedation	Education[b] Acclimation Distraction during scan Reinforcement during scan Rewards after scan	Helpful = yes or no; timing = before or during visit; modality = independent (website/brochure) or interactive (phone call); focus = parent or child
Ranking	Preference for intervention	Likert scale (1 = most useful, 4 = least useful)
	Timing	Before visit; during visit; both
	Focus	Parent; child; both
	Modality	Independent; interactive; both

NPO nothing by mouth

[a] Interest question was asked at the beginning and end of the survey

[b] Open-ended followed by prompts

[c] Questions asked from the parent and child perspective

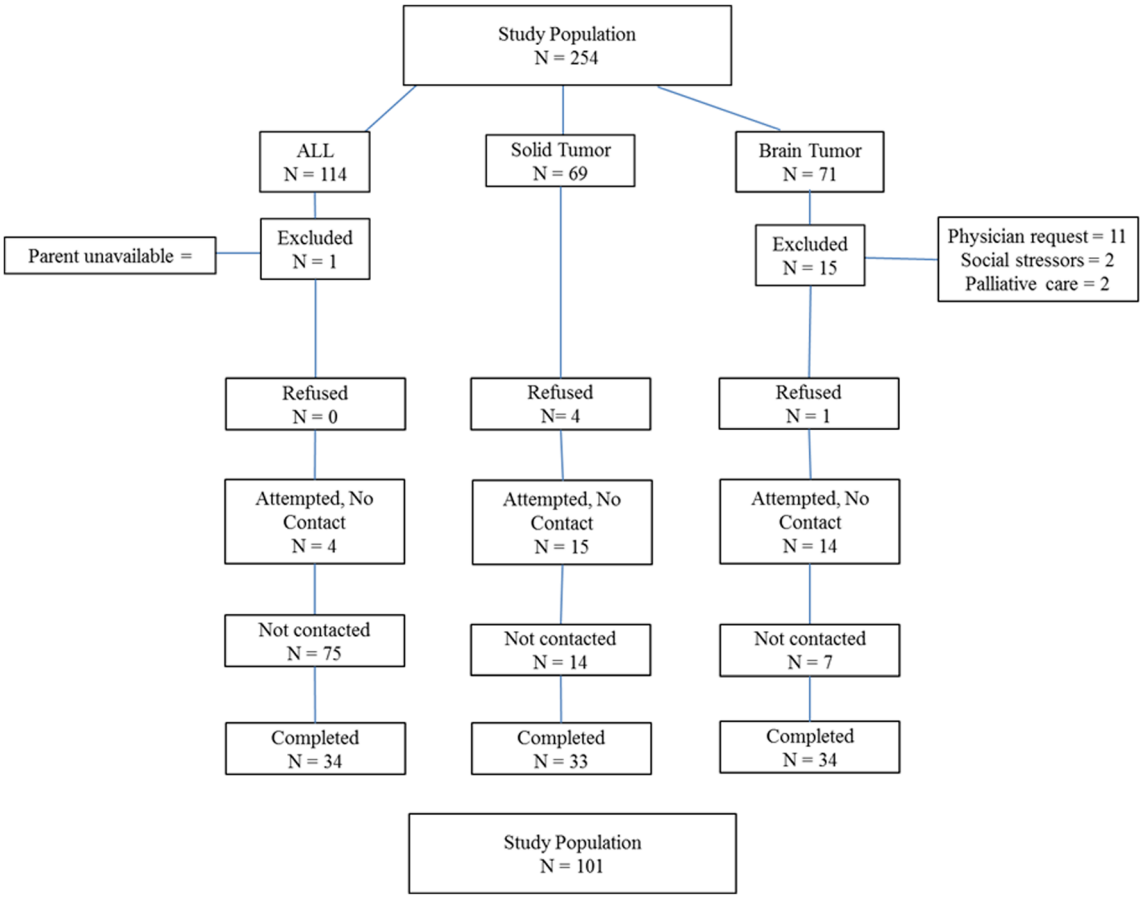

Fig. 1 Survey participation flowchart. Details pertaining to initial study inclusion criteria, reasons for exclusions after recruitment, administration of the survey, and the total number of patient surveys completed are displayed. Patients were not contacted due to target accrual goal being met

ended question responses being marked on the survey (i.e., see S1), while open-ended questions were captured verbatim. Twenty-five percent of surveys and medical record extractions were verified for accuracy of data collection by cross-referencing data entered to source documentation.

Statistical analysis

Descriptive statistics were used to characterize the sample with respect to demographic and clinical factors of interest. Frequency comparisons were used to examine the impact of dichotomous or categorical variables on survey responses. Finally, qualitative data were summarized thematically by reviewing parent suggestions after the completion of the survey. Themes were categorized via discussions during lab meetings. Common suggestions are summarized in the section "Qualitative findings: parental suggestions." Analyses were completed using SPSS (version 22). Results of all statistical comparisons are reported with two-sided p values. Results were considered significant at $p < 0.05$.

Results

Participants

Of 254 families of patients who had MRI scans during the study time frame and were screened for eligibility to participate in the study, 101 met the eligibility criteria and were surveyed for this study. Figure 1 depicts the breakdown of eligible patients by diagnosis and provides details of patients who met initial study inclusion criteria, reasons for exclusion after recruitment, details on the administration of the survey, and the total number of patient surveys completed by group. Patients were between 8 and 18 years (mean (M) = 13.1 ± standard deviation = 3.4) at the time of the study and underwent 1–19 MRI scans (5.7 ± 3.9), of which 1–12 were sedated MRI scans (1.9 ± 2.6; Table 2). Fifty-two percent of participants were male. There were no significant differences in age of patients or proportion of males and females (% male: BT = 47, ST = 52, ALL = 56) within each group. Patients with the diagnosis of BT had more total number of MRI scans (M = 7.0; $p = 0.01$) and sedated scans (M = 2.8; $p = 0.05$) compared to patients with diagnoses of ST and ALL patients,

Table 2 Demographic and clinical characteristics

	Overall group		Brain tumor		Solid tumor		ALL		
	M ± SD	Median	M ± SD	Median	M ± SD	Median	M ± SD	Median	p[a]
Current age	13.1 ± 3.4	13.1	12.6 ± 3.3	12.8	13.8 ± 3.3	14.2	12.9 ± 3.5	12.8	0.34
Total scans	5.7 ± 3.9	4.0	7.03 ± 3.9	7.0	4.1 ± 2.9	4.0	5.8 ± 4.4	4.0	0.01[b]
Sedated	1.9 ± 2.6	1.0	2.8 ± 3.1	1.0	1.7 ± 2.8	0.0	1.3 ± 1.7	0.0	0.05[c]

Overall = 101, brain tumor = 34, solid tumor = 33, ALL = 34

M mean, *SD* standard deviation, *ALL* acute lymphoblastic leukemia

[a] Two-sided p value from one-way ANOVA with diagnosis

[b] Post hoc mean comparisons show BT > ST

[c] Post hoc mean comparisons show BT > ALL

respectively. In the overall group, 52.5% of participants had prior experience with sedated MRI scans. Compared to the older age group, there was a significantly greater frequency of patients with prior sedation experience in the younger group (Table 3; % with prior sedation experience: age 8–12:11 = 80.9%, age 13–18:11 = 27.8%, $p = .000$). There were no differences in the frequency of patients with prior sedation experience by gender ($p = .608$) or by diagnosis ($p = .087$).

Parental preferences and perspectives on the acceptability of nonsedated MRI scans

Characteristics of parental preferences of nonsedated MRI scans are described in Table 4. Overall, 71% of parents expressed interest in their child completing MRI scans without sedation at survey end compared to an initial interest expressed by 64% of parents. Parents of older patients (13–18 years old) expressed more interest in their child completing MRI scans without sedation compared to parents of younger patients (8–12 years old) prior to the survey (73 vs. 53%; $p < 0.05$) and afterwards (81 vs. 59%; $p < 0.01$). Furthermore, parents of older patients believed their children are more likely to complete an MRI without sedation compared to parents of younger patients (87 vs. 53%; $p < 0.01$). Moreover, after completion of the survey, more parents of ST patients (88%) expressed interest in their child completing MRI scans without sedation compared to parents of BT (61%) and ALL (64%) patients ($p < 0.01$). Finally, parents of patients with a prior history of sedated MRI scans expressed less initial interest (54 vs. 75%; $p < 0.05$), final interest (60 vs. 83%; $p < 0.05$), and perceived likelihood (53 vs. 92%; $p < 0.01$) of their child completing MRI scans without sedation.

Overall, reduced exposure to sedation or GA was the primary benefit expressed (56%), followed by decreased irritability after MRI scans (42%) and decreased appointment time (41%). The most reported challenge expressed by parents, from both their perspective and the potential perspective of their child, was the possibility of excessive movement during the scan (35 vs. 30%, respectively), followed by small spaces from the child's perspective (29%). Additionally, parents identified their child's reaction to scanner noise as a potential challenge (18%). Parents spontaneously reported additional benefits and challenges to completing nonsedated MRI scans. Of

Table 3 Demographic and clinical characteristics by group based on prior experience with sedated MRI scans

	Prior experience with sedated MRI scans %	No prior experience with sedated MRI scans %	p
Gender			
Male	50.0	50.0	.608
Female	55.1	44.9	
Age group			
8 to 12:11	80.9	19.1	.000
13 to 18:11	27.8	72.2	
Diagnosis			
Acute lymphoblastic leukemia	47.1	52.9	.087
Brain tumor	67.6	32.4	
Solid tumor	42.4	57.6	

Two-sided p value from chi square frequency comparisons by gender, age group, and diagnosis

Table 4 Preferences and perspectives on the acceptability of nonsedated MRI scans

	Overall	Gender		Age Group		Diagnosis			Prior sedated MRI [a]	
	%	Male %	Female %	8–12 %	13–18 %	BT %	ST %	ALL %	Yes %	No %
Initial rank (very interested)	64	67	60	53*	73*	59	73	58	54*	75*
Final rank (very interested)	71	73	68	59*	81*	61*	88*	64*	60*	83*
Endorsed discussion with medical team	53	52	55	45	60	57	55	49	53	54
Likelihood of completion (very likely)	71	71	71	53*	87*	62	76	77	53*	92*
Primary benefit										
Reduced exposure	56	53	60	47	65	50	52	68	53	60
Shorter appointment	41	43	39	43	39	41	36	44	42	40
No NPO requirement	27	25	29	28	26	41	21	18	26	27
Decreased irritability post-MRI	42	41	42	47	37	35	61	29	51	31
Primary challenge (child)										
Routine	15	14	15	28	4	15	18	11	25	4
Small space	29	29	29	40	19	32	24	29	43	13
Noise	18	18	17	28	9	8	21	24	28	6
Movement	35	37	33	36	33	32	33	38	43	25
Primary challenge (parent)										
Routine	11	10	12	13	9	12	15	6	15	6
Small space	9	6	12	11	7	18	0	9	11	6
Noise	10	6	14	15	6	9	12	9	15	4
Movement	30	27	33	40	20	50	15	24	43	15
Child's age	5	8	2	11	0	12	0	3	9	0

Chi-Square comparisons performed on questions 1–4 only

[a] Patients with a previous history of having sedated MRI scans. *NPO* = nothing by mouth

*$p < .05$

such, allowing their child to be aware of their treatment process was noted as an additional benefit, along with no physical strain on the parent during recovery time (i.e., their child is able to walk away and not be pushed in a wheelchair). Additional challenges, such as the length of the scan (11%) and anxiety related to entering the scanner (9%), were also expressed by parents.

Parental strategy preferences

Characteristics of parental strategy preference are described in Table 5. Overall, distraction was rated as the most helpful strategy during MRI scans (94%) followed by reinforcement (89%) and scanner practice (80%). However, 39% of parents ranked education as the most useful strategy. With regard to timing, 69% of parents rated strategy usage would be most helpful before and during MRI scans. Most notably, 74% of parents rated strategy use would be helpful to both themselves and their child. Parents of males expressed less utility in prizes compared to parents of females (62 vs. 92%; $p < 0.01$). Moreover, parents of older patients expressed less utility in prizes compared to parents of younger patients (69 vs. 85%; $p < 0.05$). Parents of older patients expressed less utility of scanner practice compared to parents of younger patients (72 vs. 89%; $p < 0.05$).

Qualitative findings: parental suggestions

Of these strategies, parents were able to spontaneously suggest additions they deemed helpful in promoting successful nonsedated MRI scans. As such, it was suggested that parental education allow the parents to answer their child's questions, focus on the logistics of the procedure, and assist the child with scan preparation. Additionally, child education could consist of information to reduce anxiety, explanations of the purpose of the procedure, and visual information in the form of pictures and videos. Practice could also consist of practice within the MR room, whereas distractions, such as movies or music, should be age-appropriate if used. Finally, reinforcements could also take place during and after the scan, in the form of visual feedback to measure progress and self-selection of prizes if warranted, respectively.

Table 5 Parental preference for strategies focused on promoting nonsedated MRI

	Overall		Gender			Age group			Diagnosis			Prior sedation	
			Male	Female		8 to 12	13 to 18		BT	ST	ALL	Yes	No
	%		%	%		%	%		%	%	%	%	%
Strategy													
Education (parent)	73		65	81		76	70		75	73	71	79	67
Education (child)	85		85	86		92	80		82	85	88	87	83
Scanner practice	80		80	80		89	72	*	82	82	77	83	77
Distraction	94		94	94		94	94		97	88	97	94	94
Reinforcement	89		92	85		89	89		94	88	85	93	85
Prizes	76		62	92	**	85	69	*	79	76	74	83	69
Overall ranking													
Most useful[a,b]	39	Education	39	39		34	43		32	46	44	34	46
Least useful	44	Reinforcement	48	39		43	44		44	46	41	40	48
When[c]	69	Both, during	64	76		68	70		71	82	56	66	73
How[d]	72	Both, interactive	67	78		72	72		91	70	56	77	67
Who[e]	74	Both, child	71	78		70	78		79	67	77	72	77

Chi-square comparisons performed for strategy type only. Rankings are consistent with overall group preferences unless otherwise noted

*$p \leq .05$; **$p \leq .01$

[a] BT most frequently ranked distraction

[b] Parents of patients with prior sedated MRI experience most frequently ranked distraction

[c] Before/during visit, both

[d] Independent (website/video/brochure), interactive (phone/Skype, in person)

[e] Parent, child

Discussion

This parent survey is the first to evaluate and report parental/caregiver preferences and perspectives of interventions that facilitate nonsedated MRI scans in pediatric oncology patients. Methods for promoting nonsedated scans include reward-based protocols [2], the use of desensitization paradigms [25] or play-based preparation [23], practice in a mock scanner, and parent and/or child education; however, institutions differ in the approaches taken to promote nonsedated scans that may not be published. Nonsedated scans may only be implemented when the child is capable of having a nonsedated scan (by age, developmental status, etc.); in all other circumstances, we have to provide some level of intervention, either behavioral or pharmaceutical. The FDA's 2017 Drug Safety Communication includes guidelines for the administration of general anesthesia by physicians. Physician discretion should be used when considering general anesthesia for pediatric patients. The role of the anesthesiologist is to decide on the choice of the safest intervention when the child is not capable of completing nonsedated scans. Institutions may have specific guidelines in place; their role is to direct the patients with more complex medical conditions toward access to the most qualified providers of sedation and anesthesia, the anesthesiology physicians. Implementation of behavioral interventions promoting nonsedated MRI scans has been reported [1–4, 6, 11–13, 16–23] and studies have demonstrated success at promoting nonsedated MRI scans [13, 14, 25, 29]. However, our study is the first to systematically evaluate parental acceptance and preferences for strategies to promote nonsedated MRI scans in children with cancer. This population is of particular interest given the high exposure to multiple MRI scans for sequential disease evaluation in a busy clinical setting and potential-associated risks of side effects associated with sedation and GA [1, 5–7].

Our survey revealed that parents of pediatric oncology patients are open to the idea of nonsedated MRI scans. Parents recognize that there are both benefits and challenges to completing nonsedated scans, such as the advantage of no recovery time needed post-sedation or GA vs. the potential for increased scan time for nonsedated MRI scans, respectively. The most widely reported benefit in our survey was the reduction in the use of sedation and GA, with many reporting the perceived benefits of having a child attentive during and immediately following a scan. However, some parents reported concerns regarding the integrity and quality of scans as a result of the lack of sedation. Additionally, many parents expressed interest in completing sedated MRI scans if nonsedated scans could not be successfully completed. However, this interest was less expressed in parents of patients with BT and ALL

compared to parents of patients with ST. ST patients are on average older than BT and ALL patients, where younger patients may be required to complete lengthy monitoring scans. Furthermore, due to variability in tumor location, ST patients may be positioned in the scanner in a variety of ways, with their head more likely being free. BT patient scans are typically longer than both ST and ALL patients for diagnostic/staging and surveillance purposes. It was revealed that parents are supportive of age- and gender-specific strategies. Parents suggested that older patients may not be as responsive to incentives and practice, and males may be less receptive to prizes than females. Furthermore, parents of patients with a prior history of sedated MRI scans reported a lower likelihood and less interest in their child completing nonsedated MRI scans.

Overall, our findings provide information that can be used to inform the design of quality improvement procedures or interventions aimed at promoting nonsedated MRI scans. Specifically, behavioral interventions may be most successful for new patients at the beginning of their treatment experience and for those diagnosed with ST, given that their parents were significantly more interested in nonsedated MRI scans compared to parents of patients with a prior history of sedation use and parents of patients with diagnoses of BT and ALL. Furthermore, behavioral strategies were perceived as acceptable by parents of patients as young as 8 years, thus implementation for younger patients could be plausible. It appeared that once pediatric oncology patients had several experiences with sedated MRI scans, the parents may find it more difficult to transition into completing procedures without sedation.

During implementation of behavioral interventions, developmental considerations to inform approaches should be taken. Parent and child education should be provided before and during the procedure and this information is best recited independently, with hospital personnel, and with both the parent and child. Based on the patient's age, the strategy chosen may vary. Whenever possible, scanner practice should be offered to reduce anxiety [24], along with distractions and reinforcement during the procedure, to reduce motion [1, 20].

Strengths

There are several strengths to our current investigation. Parents are the major stakeholders to patient care for their children, and our investigation is the first reported survey focused on parental preferences and perspectives of nonsedated MRI scans and possible strategies that would be beneficial to their children. Furthermore, given our prospective study design, we were able to inquire about potential strategies to promote nonsedated MRI scans prior to their implementation. Our results indicate that nonsedated MRI scans are of interest for parents/caregivers of children with cancer diagnoses and strategy preference is specific to demographic and clinical aspects of the patient. The information obtained in this parental survey will allow for the systematic integration of such strategies into research protocols allowing for comparisons of efficacy, sedation reduction, and image quality.

Limitations

Given that our sample consisted of parents of patients with diagnoses of BT, ST, and ALL, our survey results may not apply to other forms of childhood cancer or to other pediatric populations. Moreover, the youngest patients in our survey were 8 years old and we did not stratify by age group prior to designing the survey project; thus our results may not apply to patients younger than 8 years or be representative of different distributions of cancer patients at other institutions. Furthermore, parental challenges may differ across age groups with patients who have/have not experienced at least one sedated MRI scan and those who have prior sedated/nonsedated MRI scans prior to their cancer diagnosis. Given the fact that our institution is a comprehensive cancer center prior MRI scan experience prior to diagnosis is unknown. It is suggested that parents of patients with other forms of childhood cancer, those with differing sedation experience prior to cancer diagnosis, and those who are younger than 8 years old be surveyed in a similar fashion to obtain preferences and perspectives information. Only major behavioral interventions (i.e., audio/visual feedback, practice, awards) were surveyed during our investigation and our results may not apply to subsets of these behavioral interventions (e.g., specific forms of audio/visual feedback) if they were to be inquired during later investigations. Finally, parent/caregivers were surveyed during this study, we did not inquire the attitudes of patients themselves or attending physicians. The patient perspective is of importance, given the fact that they are required to complete the procedure and self-reported preferences may not align with parent-proxy preferences/perspectives. Moreover, the attending physician preference/perspective is of importance, given their pivotal role regarding the use and recommendation of sedation and GA. Both patient and physician preferences/perspectives should be captured in a similar fashion.

Future recommendations

Overall, our survey revealed that nonsedated MRI scans are of interest for families of children with cancer diagnoses. Currently, our institution does not have research protocols aimed at reducing sedation during MRI scans; however, clinical resources include the provision of parent/child education and child life support. We acknowledge that reconciling the clinical practice and the research standards can represent a challenge and are committed to developing and implementing strategies to better address this. Research protocols demand high accuracy of imaging studies and possibly higher

frequency of imaging studies for data collection. Because we are aware of these specific challenges in the research setting, we are promoting a comprehensive plan of action, as an institution, to address the goal of reducing exposure to anesthesia and providing the safest clinical care. As noted earlier, intervention strategies should be tailored specifically for patient characteristics (age, gender), and interventions may be best used for new patients and patients with diagnosis of ST, among other cancer diagnoses. Furthermore, tailored interventions should be designed and implemented with input from the multidisciplinary team, in order to allow for consideration of the many factors that can impact success with nonsedated scanning. Future research should also investigate the risks associated with failed exams, in terms of patient medical care and cost effectiveness. These results have the potential to inform quality improvement procedures and research protocols interested in promoting nonsedated MRI scans in pediatric cancer populations.

Acknowledgements This work was supported by the National Cancer Institute (St. Jude Cancer Center Support (CORE) under grant [P30 CA21765] and the American Lebanese Syrian Associated Charities (ALSAC). Research was conducted at St. Jude Children's Research Hospital in Memphis, Tennessee.

Compliance with ethical standards

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

Informed consent This study was approved by the hospital's Institutional Review Board. Informed consent was obtained by all individual participants in this study

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