



Effectiveness of Game-Based Learning on Anxiety and Postoperative Self-Efficacy among Children Undergoing Surgery

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Abstract

Background Play is an integral part of a child's life that could be effectively implemented for hospitalized children as well. It plays an important role in alleviating the psychological burden and enhancing self-efficacy of children undergoing surgery. Children benefit from play or games because they enjoy learning through them. The present study aims to assess the effectiveness of game-based learning on anxiety and postoperative self-efficacy among children undergoing surgery.

Materials and Methods Using nonprobability purposive sampling technique, 80 school-age children undergoing surgery were selected. Children in the interventional group received game-based learning, whereas those in the control group received routine care. A numeric 0 to 10 state anxiety scale and a self-efficacy scale were used for assessing anxiety and postoperative self-efficacy of children. The obtained data was analyzed using descriptive and inferential statistics.

Results Mann–Whitney U test showed significant difference ($p < 0.05$) between the mean pre- and posttests scores of anxiety in intervention group. Comparison of posttests anxiety scores between the groups also showed a statistical significance ($p < 0.05$). When compared self-efficacy scores within intervention and control groups, Wilcoxon signed-rank test value was significant ($p < 0.05$). Whereas between groups comparison the Mann–Whitney U test value was significant ($p < 0.05$) at 24 and 48 hours after surgery.

Conclusion The study concluded that game-based learning is effective in maintaining adequate postoperative self-efficacy and reducing the anxiety among the children undergoing surgery.

Keywords

- ▶ anxiety
- ▶ children
- ▶ game-based learning
- ▶ postoperative self-efficacy

Introduction

Illness, hospitalization, and surgery might be stressful for a child. Coping strategy of hospitalized children may depend on age, developmental stage, body image, fear, reason for

hospitalization, and previous hospitalization. They may have a sense of tension, apprehension, nervousness, and fear toward the upcoming surgical procedure and at the time they worry of separation from parents and home

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environment. Lack of control, surprising routines, surgical instruments, clinical approaches and additionally the anticipation of a surgical procedure also could lead to stress and anxiety. This may have an effect on the self-efficacy of children.¹

The literature has recognized that there is a negative impact of surgery on children.² Surgery tends to evoke negative behaviors and feelings in children, such as avoidance, guilt, sadness, and distrust, which have been related to preoperative fears and anxiety.³⁻⁵ Several preoperative types of interventions (i.e., pharmacological, behavioral/psychological) have been used to reduce the negative responses of children and their family, to increase the cooperation and compliance during the medical process, to promote self-efficacy and sense of control, and to improve the postoperative recovery and the emotional adjustments after discharge.⁶ Research has also shown that interventional preparation programs that provide educational information positively tend to affect children.⁷

For the last few decades, preoperative interventions have been increasingly used for children undergoing surgery. Preoperative education programs like multimodal preoperative preparation programs involving video, pamphlets, theater tours, medical play, and interactive sessions are found effective in preparing children for surgery.⁸ Along with education programs play and games have also shown effective in preoperative preparation of children.⁹⁻¹¹ It is also seen that preoperative education will have an effect on postoperative activities. Game-based learning has shown to be effective in preparing children for surgery^{5,12-15} and postoperative outcomes.¹⁶⁻¹⁹ It is also seen that to reduce preoperative anxiety, educational interventions are used for children. The educational materials were used to reduce children's preoperative worries,² for psychological preparation,²⁰ as a therapeutic play¹⁹ and were proved effective.

Preparing children for surgery aims at bringing up positive postoperative outcomes. Alleviating anxiety as well as to bring up self-efficacy among children is the responsibility of the health-care professionals working in pediatric surgery units. School-age children are in a concrete operational stage of cognitive development, where mastery of skills, experiences, and self-esteem are very important issues for them. Although these children may engage in some degree of imaginary thinking, they are capable of concrete, logical reasoning and are in the process of gaining an increased understanding of cause and effect. They are able to cooperate in a better way with treatment because they can think before they act. School-age children have an increased awareness of internal body parts and body function. However, when a surgery is planned for them, children worry about bodily injury, pain, changes in appearance, school absenteeism, getting neglected by their peers, disability, and death postoperatively. These factors make them more anxious. But since they are able to think logically, adequate teaching and guidance regarding what to expect postoperatively and the aspects of postoperative care will help to relieve their anxiety and enhance postoperative self-efficacy. It's a known fact that children enjoy learning through play and

games. Thus, incorporating play for hospitalized children is very essential.

The researchers in their day-to-day practice have seen that despite routine preoperative preparation, nothing much is done for the children to alleviate their anxiety and bring up self-efficacy. The routine preoperative preparation of children includes only verbal instructions given by doctors and nurses. There is a need for developing a game-based preoperative preparation customized to the needs of school aged children.

Many board games are used to educate children. Snake and ladder game is one among them. This game can be successfully played by schoolers. It gives a fun-filled learning experience for children. Literature shows that snake and ladder game is effective in creating awareness regarding a healthy diet,²¹ clean and healthy behavior to prevent diarrhea,²² personal hygiene,²³ oral hygiene,²⁴ street food safety,²⁵ bullying²⁶ among school children. At the same time, it is shown that providing additional information and knowledge would enhance self-efficacy among children.^{27,28}

Thus, to prepare the school-age children for surgery and to educate them regarding the postoperative care, the researcher developed a snake and ladder game on the general postoperative care aspects that could be used for children getting admitted to the hospital for surgery. Literature shows that when the school-age children were informed regarding what to expect postoperatively, their anxiety level decreases. The snake and ladder game focused to educate children regarding postoperative care aspects including immediate postoperative care in the ward, importance of taking medications, postoperative ambulation, exercise, diet, wound care, emotional care, and mental health in postoperative period, personal hygiene, sleep, self-care activities, prevention of complications, elimination, and follow-up. It was an individualized program where the child plays the snake and ladder with the investigator during which any queries or doubts could be clarified by the researcher. Communicating with researchers could minimize child's the anxiety. Parents were also allowed to be with the child. Overall, the game was offered based on the needs and developmental concerns. The parental involvement increases their confidence and bonding and minimizes child's and parental anxiety as well. And the researcher attempts to study the effectiveness of game-based learning on anxiety and postoperative self-efficacy among children undergoing surgery.

Materials and Methods

The present study used an experimental approach and quasi experimental nonequivalent control group design. Ethical approval was obtained from the Institutional Ethics Committee (Protocol No: YEC 2/ 460). The study population comprised children aged between 8 and 14 years undergoing elective surgery. Following the informed consent process from the parents and taking an assent from children, non-probability purposive sampling technique was used to select 80 children who were assigned to intervention ($n = 40$) and control ($n = 40$) groups, respectively (Sample size was

calculated using G* software. With 5% level of significance, power: 80%, effect size: 0.64% the total sample taken for study was 80). Children admitted at least 24 hours prior to surgery, anticipated to have hospital stay of at least 48 hours after surgery, receiving routine postoperative care, having a parent with child during admission, and able to read and understand Kannada/English language were selected as study samples. Children with physical or psychological conditions that are not appropriate to participate in game-based learning such as blindness, deafness, mental retardation, or psychiatric conditions, who were critically ill needing special care, having a history of previous surgery, receiving special treatment after surgery, and having postoperative complications and stay in postoperative ward for more than 12 hours after surgery were excluded from the study.

The study was conducted in a 1,050-bedded multi-specialty tertiary care hospital that conducts around 800 to 1,000 pediatric surgeries every year, out of which around 200 pediatric surgeries are done on children of 8 to 14 years of age. The pediatric surgery ward of the hospital is 20 bedded and there is a separate ENT and ophthalmology surgery ward. The operation theater is attached to these wards.

The intervention in the study was game-based learning that was administered to children in the intervention group along with the routine care, where the children learnt regarding postoperative care using a snake and ladder game along with the investigator. Through this play, the researcher taught the children regarding postoperative care. The intervention was given once by the researcher and it took about 1 hour to complete the game. The children in the control group received routine postoperative care provided by the hospital staff.

The researcher collected data using demographic proforma, numeric 1 to 10 state anxiety scale and self-efficacy scale. The demographic proforma consisted of nine items. The numeric 0 to 10 state anxiety scale, which is a standardized scale, was used to assess the level of anxiety among children. The anxiety is graded based on the scores, 0: not at all, 1 to 2: little, 3 to 5: medium, 6 to 8: a lot, 9 to 10: worst imaginable. Anxiety was assessed on admission, 24 and 48 hours after surgery by the investigator.

The self-efficacy scale developed by the investigator, which is a 25-item checklist, was used to assess postoperative self-efficacy among children. Maximum possible score was 50. The self-efficacy is graded based on the scores, ≤ 16 : inadequate self-efficacy, 17 to 33: moderately adequate self-efficacy, 34 to 50: adequate self-efficacy. Self-efficacy was assessed 24 and 48 hours after surgery by the investigator.

The tools were validated by seven subject experts and their suggestions were incorporated. The reliability of self-efficacy scale was tested by establishing the equivalence using rater interrater method and the calculated reliability was $r=0.9$. The reliability of anxiety scale was tested by establishing the internal consistency by Cronbach's α and the calculated reliability $r=0.8$.

Statistical Analysis

Statistical analysis was performed using SPSS V.22.0 (Statistical Package for the Social Sciences). Descriptive statistics were used for representing the demographic variables, the anxiety, and self-efficacy scores. Mann-Whitney U test was used to compare the anxiety scores within and between the groups. One way analysis of variance (ANOVA) was used for the post hoc analysis of pair wise comparison of anxiety scores within the groups. Wilcoxon signed-rank test was used to compare the self-efficacy scores within the groups, whereas between groups comparison was done by Mann-Whitney U test. Chi-squared test was computed to find the association between anxiety and postoperative self-efficacy with selected demographic variables ($p < 0.05$ is considered as significant).

Results

The majority (31.25%) of children in the control group belonged to 13 to 14 years, whereas in the intervention group, majority (25%) belonged to 11 to 12 years. In both groups, majority were males. The majority of the study participants belonged to Muslim religion. Majority (95% in the control group and 87.5% in the intervention group) of the study participants were accompanied by the mother. The majority of children in both the intervention (72.5%) and control (72.5%) groups come from a nuclear family. The majority of parents in the control group (75%) are between the ages of 25 and 35 and majority (62.5%) in intervention group belonged to 36 to 45 years of age. The majority of the study participants belonged to first order of birth. The majority of children both in control (40%) and intervention (62.5%) groups underwent abdominal surgery.

The study findings also revealed that there is a significant association between the age of the child and anxiety both in control ($\chi^2=25.41$; $p=0.03$) and intervention group ($\chi^2=29.3$; $p=0.00$), class of studying and anxiety in intervention group ($\chi^2=29.35$; $p=0.00$), religion and anxiety in intervention group ($\chi^2=45.3$; $p=0.0$), and between the parental age and anxiety in intervention group ($\chi^2=30.6$; $p=0.01$).

The study has also shown that there is a significant association between the age of the child and self-efficacy in control group ($\chi^2=54.6$; $p=0.02$), parent accompanying and self-efficacy in control group ($\chi^2=29.4$; $p=0.04$), birth order of the child and self-efficacy in intervention group ($\chi^2=86.3$; $p=0.02$), and type of surgery and self-efficacy in intervention group ($\chi^2=60.3$; $p=0.03$).

Discussion

Children enjoy learning through play. Therefore, play is widely used to prepare for hospitalization, surgery, and to educate them during their hospital stay. At the same time, it is studied that preoperative information provided to parents also influences the children undergoing surgery.⁸ Many hospitals have play rooms attached to pediatric wards and

Table 1 Comparison of anxiety scores within the groups at different time interval, $n = 40 + 40$

Study groups	Time	Mean \pm SD	Median (IQR)	Mann-Whitney U test value	p-Value
Control	On admission	5.75 \pm 1.94	5.5 (4-7)	711.5	0.15
	At 24 hours of surgery	4.82 \pm 1.81	5.0 (4-6)		
	At 48 hours of surgery	5.3 \pm 2.82	5.0 (2-8)		
Intervention	On admission	5.37 \pm 1.35	5.0 (5-6)	469.8	0.02 ^a
	At 24 hours of surgery	2.67 \pm 1.49	2.0 (2-3)		
	At 48 hours of surgery	1.35 \pm 1.70	1.0 (0-2)		

Abbreviations: IQR, interquartile range; SD, standard deviation.

^a $p < 0.05$ = significant.

they have proven effective in reducing preoperative anxiety among children.²⁹

Present study showed that game-based learning is effective in reducing preoperative anxiety and enhancing postoperative self-efficacy of children ($p < 0.05$). It is evident from the literature review that children prepared for surgery were less anxious³⁰ and preoperative anxiety was less in children who were prepared psychologically.³¹ At the same time, hospital tours, play therapy, information videos, surgical brochures,⁵ preoperative cognitive behavioral program,³² preoperative education programs,³³ viewing animated cartoons and phone interviews,² and therapeutic play intervention³⁴ were also proved effective in reducing preoperative anxiety of children. Moreover, even if it was not studied here, the reduction in anxiety has positive impact on postoperative recovery and it was seen that children who were prepared for surgery had a speedy recovery and fewer emotional problems than those who were not prepared.³⁵ Preoperative education programs contribute to decrease the anxiety as well as self-efficacy.³⁶ Yet another study confirmed that board games also can be effectively used to prepare children undergoing surgery in terms of reducing children's preoperative worries, regardless of their gender, age, previous surgical experiences, temperament, and coping dispositions.²

In the present study, researchers used snake and ladder board game to teach the children regarding postoperative care. Board game like snake and ladder is interactive and interesting, liked by most of the school-age children. Literature has shown that snake and ladder game was effective in teaching children.²¹⁻²⁶

In the present study, the anxiety scores compared within groups by Mann-Whitney U test value was significant ($p < 0.05$) in the intervention group (**Table 1**). Within groups pair wise comparison, post hoc tests by one-way ANOVA test value were significant ($p < 0.05$) at admission to 48 and 24 hours to 48 hours of surgery (**Table 2**). Between groups comparison by Mann-Whitney U test also was significant ($p < 0.05$) at admission to 24 hours, admission to 48 and 24 hours to 48 hours of surgery (**Table 3**). These findings are supported by a study where a mobile app was proved effective ($p = 0.003$) in reducing preoperative anxiety of children³⁷ and a multimedia information in the form of a peer modelling video was also effective ($p < 0.001$) on preoperative anxiety.³⁸ Thus, it is proved that the game-based learning has a positive impact on anxiety of children undergoing surgery.

Table 4 shows the arbitrary grading of postoperative self-efficacy scores. The present study has shown that when compared self-efficacy scores within groups, Wilcoxon signed-rank test value was significant ($p < 0.05$) in both the groups (**Table 5**). Whereas between groups comparison the Mann-Whitney U test value shows a statistical significance ($p < 0.05$) at 24 and 48 hours after surgery (**Table 6**). These findings are supported by a study where the use of gaming in children showed positive changes in exercise self-efficacy ($p < 0.05$).³⁹ Thus it can be said that game-based learning enhances the postoperative self-efficacy among children.

The main challenge faced by the investigator is the unavailability of the sample. The present study took place

Table 2 Pair wise comparison of change scores of anxiety within the groups (post hoc tests by one way ANOVA), $n = 40 + 40$

Study groups	Change between	Paired differences		
		Change in mean \pm SD	Change%	ANOVA test p-value
Control	Admission and 24 hours after surgery	0.93 \pm 0.13	9.3	0.17
	Admission and 48 hours after surgery	0.45 \pm -0.88	4.5	0.54
	24 hours after surgery and 48 hours after surgery	-0.48 \pm -1.01	-4.8	1.0
Intervention	Admission and 24 hours after surgery	2.7 \pm -0.14	27	0.14
	Admission and 48 hours after surgery	4.02 \pm -0.35	40.2	0.02 ^a
	24 hours after surgery and 48 hours after surgery	1.32 \pm -0.21	13.2	0.01 ^a

Abbreviations: ANOVA, analysis of variance; SD, standard deviation.

^a $p < 0.05$ = significant.

Table 3 Comparison of anxiety scores between the groups at different time interval, $n = 40 + 40$

Change between	Study groups	Change in mean \pm SD	Median	IQR	Mann-Whitney U test value	p-value
Admission and 24 hours of surgery	Intervention	2.7 \pm 1.66	3	1-4	402.5	0.00 ^a
	Control	0.92 \pm 2.0	1	-1-2		
Admission and 48 hours of surgery	Intervention	4.02 \pm 1.80	4	3-5	307	0.00 ^a
	Control	0.45 \pm 3.3	0.0	-2-3		
24 hours of surgery and 48 hours of surgery	Intervention	1.32 \pm 0.99	1	0.2-2	373	0.00 ^a
	Control	-0.47 \pm 2.17	0.0	-2-1		

Abbreviations: IQR, interquartile range; SD, standard deviation.

^a $p < 0.05 =$ significant.

Table 4 Arbitrary grading of postoperative self-efficacy scores, $n = 40 + 40$

Sl.no.	Scores	Arbitrary grading	Control group		Intervention group	
			24 hours, n (%)	48 hours, n (%)	24 hours, n (%)	48 hours, n (%)
1	16	Inadequate self-efficacy	35 (87.5)	25 (62.5)	23 (57.5)	15 (37.5)
2	12-33	Moderately adequate	5 (12.5)	10 (25)	15 (37.5)	13 (32.5)
3	34-50	Adequate self-efficacy	0 (0)	5(12.5)	2 (5)	12 (30)

Table 5 Comparison of self-efficacy scores within group at different time interval, $n = 40 + 40$

Study groups	Time	Mean \pm SD	Median (IQR)	Wilcoxon signed-rank test value	p-Value
Control group	At 24 hours of surgery	9.60 \pm 7.22	-3(-5.7 - (-1))	-5.1	0 0.00 ^a
	At 48 hours of surgery	14.47 \pm 10.89			
Intervention group	At 24 hours of surgery	15.30 \pm 9.18	-3(-14.7-0.0)	-4.5	0.00 ^a
	At 48 hours of surgery	22.07 \pm 13.02			

Abbreviations: IQR, interquartile range; SD, standard deviation.

^a $p < 0.05 =$ significant.

Table 6 Comparison of self-efficacy scores between the group at different time interval, $n = 40 + 40$

Time interval	Study groups	Change in mean \pm SD	Change %	Mean diff.	Median IQR	Mann-Whitney U test value	p-Value
At 24 hours of surgery	Intervention	15.30 \pm 9.18	11.4	5.7	6(5-6)	483.5	0.002 ^a
	Control	9.60 \pm 7.22					
At 48 hours of surgery	Intervention	22.07 \pm 13.02	15.2	7.6	9.5 (4.2-14.7)	499	0.004 ^a
	Control	14.47 \pm 10.89					

Abbreviations: IQR, interquartile range; SD, standard deviation.

^a $p < 0.05 =$ significant.

during coronavirus disease 2019 pandemic. Thus, the inpatient children for surgery were comparatively less. Therefore, the investigator took a long time for the data collection. The present study was limited to the children admitted to a hospital at a single geographic unit, hence generalization is not possible. The sample was chosen using a purposive sampling method, which reduces the subjects' chances of being chosen for the study as a study sample. Study participants were followed up to 48 hours of surgery only.

Conclusion

The literature confronts that there is a need for every pediatric unit in the hospital to implement educational sessions including preoperative preparation programs and use of play will be apt. It is also ideal to involve parents for these programs and parental knowledge also influences children; for the same reason in the present study also the parents were allowed to be with the child during game-

based learning. Health-care professionals should plan and implement variety of individualized and customized programs based on the needs of children to help them cope with the hospitalization.

Note

The authors assure that the manuscript has not been submitted to any other journal for publication NOR it has been presented earlier elsewhere.

The Institutional Ethics Committee has approved this project. (Protocol No: YEC 2/ 460).

Sources of Support

Nil.

Conflicts of Interest

None declared.

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