

An Innovative Painted Immobilization Mask for Pediatric Patients Undergoing Radiation therapy



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INTRODUCTION

Radiation therapy (RT) is a commonly used treatment modality for paediatric patients¹. It involves the use of very high ionizing radiation delivered daily over a period of time and thus, the use of immobilization devices such as mask, is often necessary to ensure treatment reproducibility and accuracy. Although the delivery of RT is non-invasive, it strikes fear and anxiety in many paediatric patients due to the large RT treatment machine (Fig 1) and having to be alone in the treatment room with an immobilization device clamped onto them for the whole duration of their treatment. These factors substantially reduce their compliance to remain still during treatment. As a result, most paediatric patients will require the administration of General Anaesthesia (GA) (Fig 2). Concerns have been raised regarding the safety and long-term consequences of daily GA such as sleep disruption, malnutrition and psychological stress associated with high doses of Ga usage repetitively^{2,3}.



Fig 1 A Radiation Therapy Treatment Machine



Fig 2 A pediatric patient with an immobilization mask undergoing GA assisted RT.

PROJECT AIM

This project aims to create an innovative painted radiotherapy immobilization masks for paediatric patients undergoing radiation therapy to allay patients fear and anxiety in order to minimise the reliance of daily GA. This project also aims to study the radiation safety and efficacy of the painted mask under high radiation exposure. To our knowledge, this study is first of its kind in Singapore.

METHODOLOGY

A multidisciplinary team was formed consisting of Doctors, Radiation Therapists, Physicists and 2 RT students. Approval was obtained from SingHealth Centralized Institute Review Board (CIRB Ref: 2020/2788). The painted immobilization mask project consisted of 3 parts. (PDSA 1-3)



PDSA 1 – Investigate the radiation safety of paints used and the influence of different paint colors and layers.

60 cutoff samples (Fig 3) were created and painted with one to three layers of paint to investigate the radiation absorption of the different paint layers and colors used on the immobilization mask.

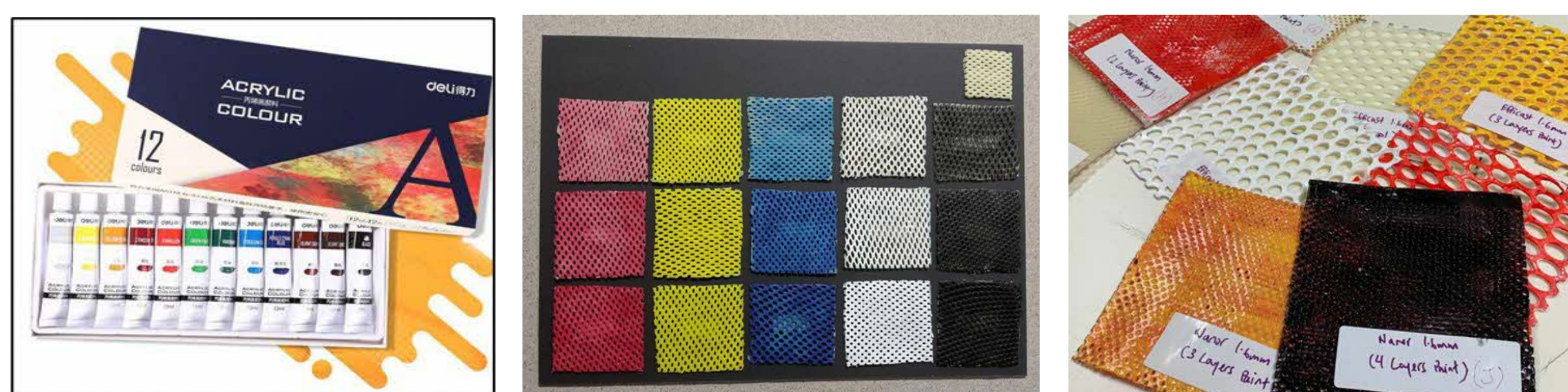


Fig 3. Types of paint used and a color chart of different layer thickness of paint



PDSA 2 – The design of a series of cartoon templates

The design of a painted mask (Fig 4). Templates of various cartoon designs were constructed using clear PVC sheets to facilitate the painting process.



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Fig 4. An immobilization mask before and after painting

RESULTS

A) Effect of painting on radiation dose absorption

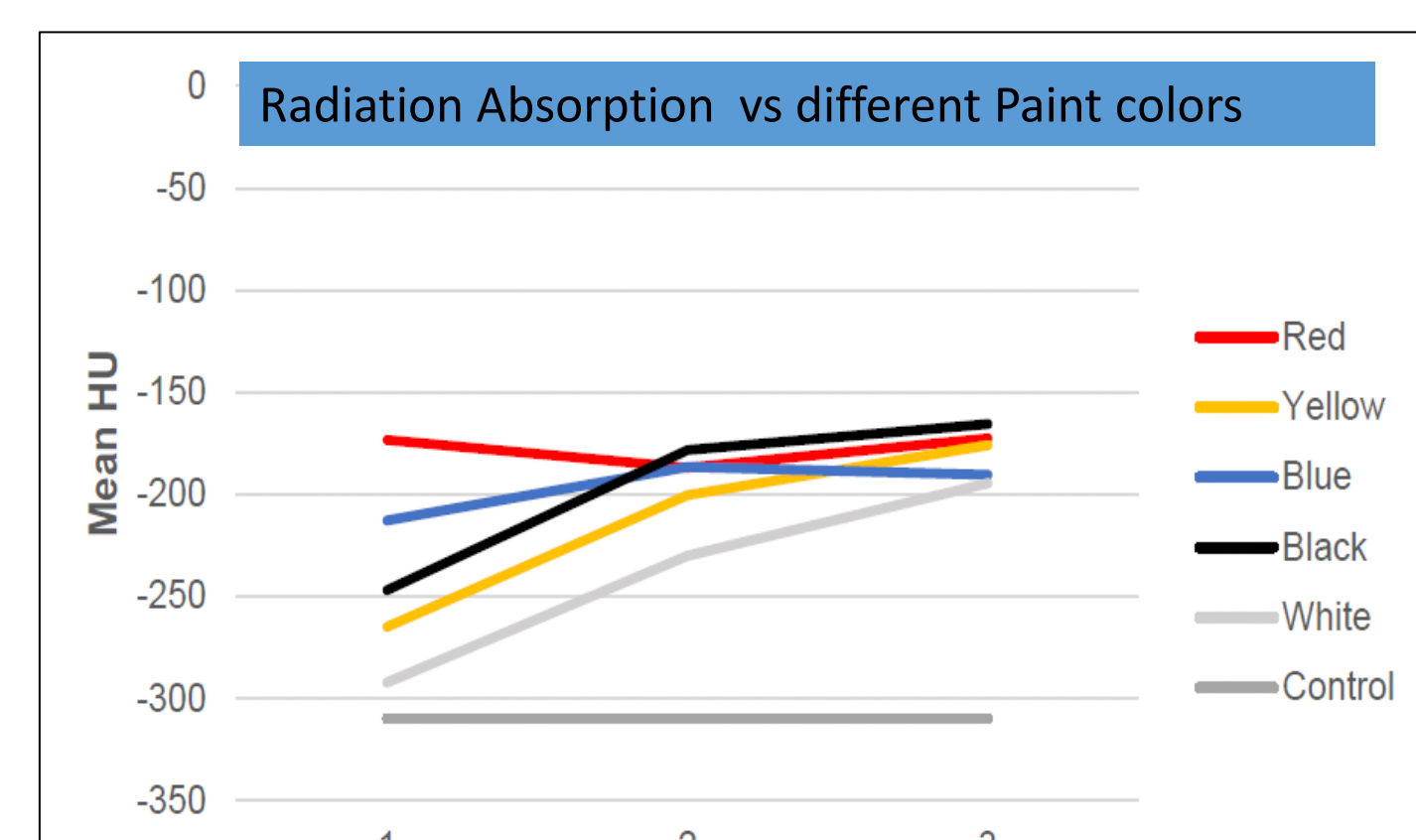
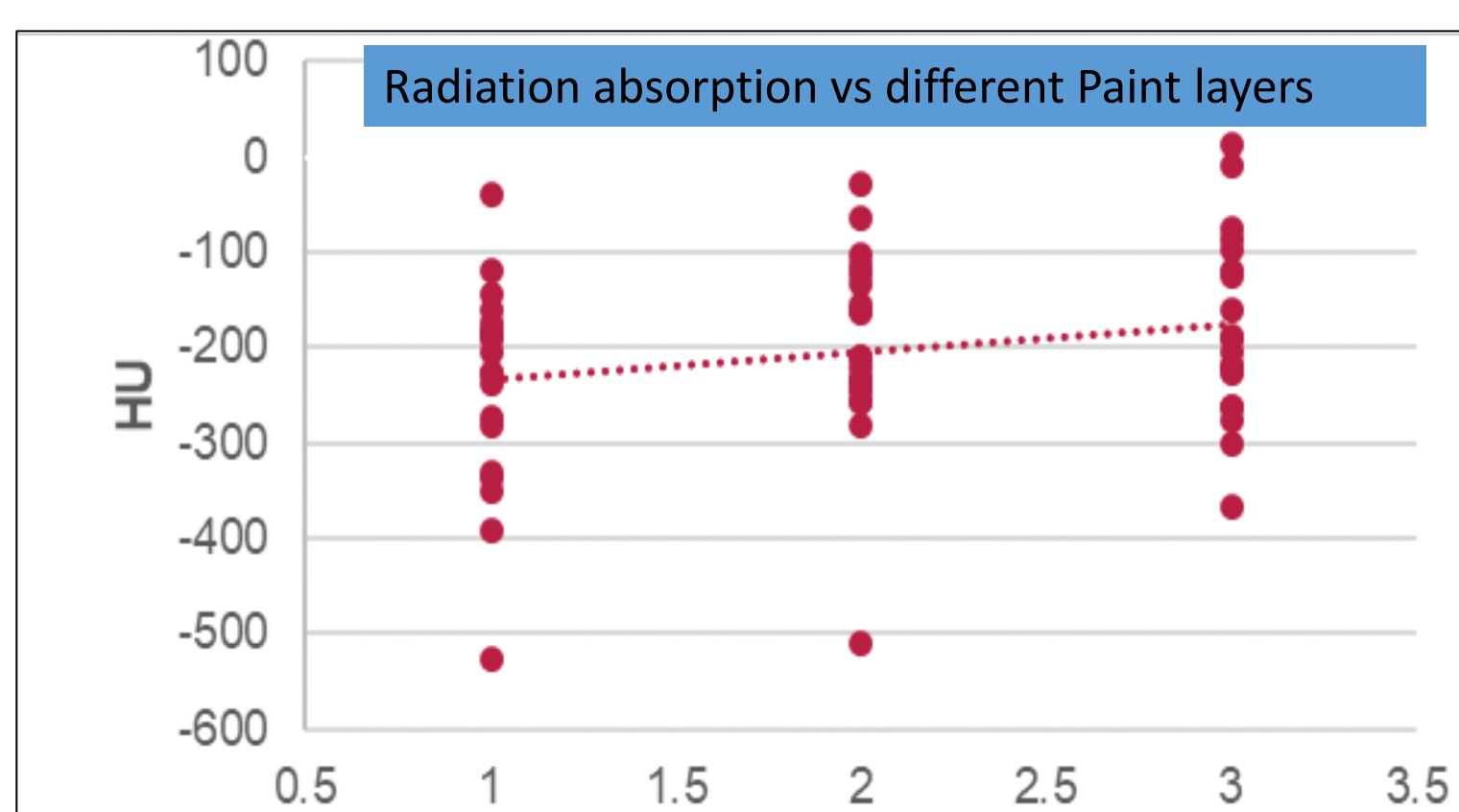
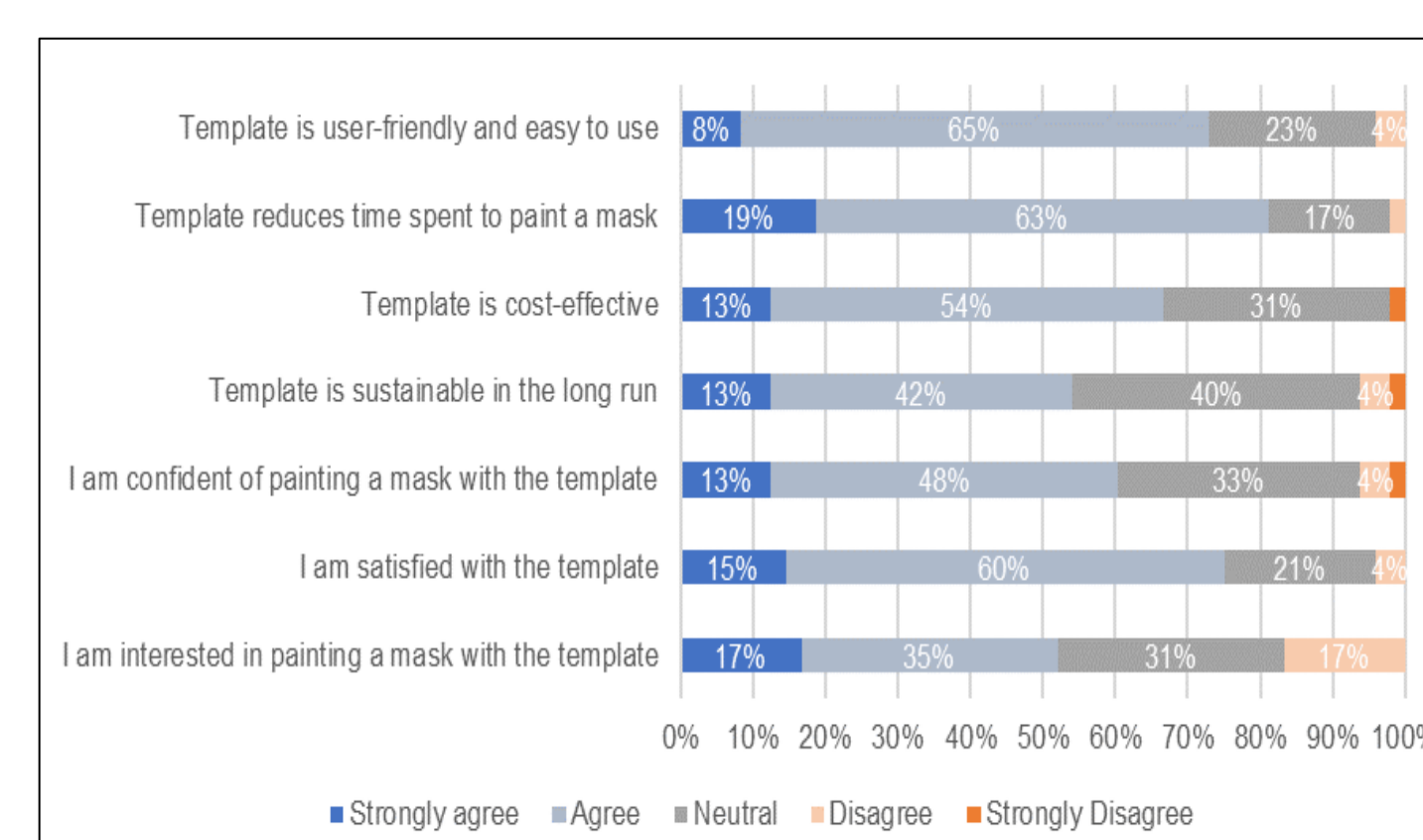


Fig 5 and 6. Relationship between Radiation Absorption (Hounsfield Unit HU) and nos. of paint layers and colors

B) Survey results on the acceptance and feasibility of a painted immobilization mask



Results of Wilcoxon signed-rank test summarising radiation therapists' perception of a painted immobilisation mask (n = 48)

Statement	Non-painted mask		Painted mask		Z	p
	M	SD	M	SD		
Patient willing to put on mask during first attempt in set-up	2.83	0.93	3.60	0.87	-4.11*	<.001
Immobilisation mask would add to patients' fear and anxiety	4.21	0.85	3.56	0.90	-3.71*	<.001
Patients able to lie still during treatment with immobilisation mask	3.00	1.01	3.40	0.92	-2.87*	.004
Patients able to cooperate and comply with immobilisation mask	3.21	0.77	3.58	0.90	-2.54*	.011
Patients likely to require S/GA to complete treatment	3.40	1.05	3.06	0.81	-2.34*	.019

Note: For each statement, the degree of agreement ranges from 1 (Strongly Disagree) to 5 (Strongly Agree).
*Based on negative ranks
†Based on positive ranks

Table 1 & 2. Survey of RTTs perception of the painted immobilization mask

There is statistically no significant difference in radiation absorption (HU) between painted and non-painted masks $t(8) = -.782, p = .457$. There is no significant effect in dose absorption when the mask is painted up to three layers (Fig 5). The choice of different colours (Fig 6) also do not have any effect on radiation dose absorption. Survey results of RTT's perception of the painted immobilization mask (Table 1&2) showed its potential to allay paediatric patients fears and anxiety during radiotherapy, thus increasing cooperation and the potential to minimising the likelihood of the use GA.

CONCLUSION

This painted immobilization mask innovation tackles the issues of anxiety in paediatric patients in a very direct manner. It covers more than just pacifying a child into complying with treatment procedures. The product other than being aesthetically pleasing, also equips the child with the concept of choice, thus the child will feel that he has a say or a part to play in his treatment. In conclusion, the use of a painted immobilization mask is a simple, safe and feasible innovative idea that has great potential to significantly improve a paediatric patient's radiotherapy experience. The painted immobilization mask in familiar cartoon characters would make RT a fun experience for paediatric patients, improving their overall experience and satisfaction.

References:
1. Laprie, A., Hu, Y., Alapetite, C., Carrie, C., Habrand, J.L., Bolle, S., Balosso, J. (2015). Pediatric brain tumors: A review of radiotherapy, state of the art and challenges for the future regarding proton therapy and carbon therapy. *Cancer/Radiotherapy*, 19(8), 775–789. <https://doi.org/10.1016/j.canrad.2015.05.028>
2. Stackhouse, C. (2013). The use of general anesthesia in pediatric radiotherapy. *Radiography*, 19(4), pp.302-305.
3. Verma, V., Beethe, A., LeRiger, M., Kulkarni, R., Zhang, M. and Lin, C. (2016). Anesthesia complications of pediatric radiation therapy. *Practical Radiation Oncology*, 6(3), pp.143-154.