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Letter from the Editors

As we present to you the annual issue of the McGill Journal of Medicine for the year 2023-2024, we are delighted to explore the profound theme of "*Healing Across Borders*." This theme not only resonates with the global challenges we face today, but also celebrates the diverse approaches and collaborative efforts in medicine and healthcare that transcend geographical boundaries.

In this issue, you will find a collection of insightful articles and research papers that exemplify the spirit of healing across borders. From innovative medical practices that have bridged gaps in healthcare access, to poignant narratives of medical professionals making a difference in underserved communities around the world, each contribution underscores the universal pursuit of health and well-being.

Our journey through this theme has been both enlightening and humbling. It has reinforced our belief in the power of knowledge exchange and collaboration in advancing medical science and healthcare delivery. Through the pages of this journal, we hope to inspire future generations of healthcare professionals to embrace diversity, empathy, and innovation in their practice.

We extend our heartfelt gratitude to all the authors, reviewers, and journal team members who have made this issue possible. Your dedication and passion for advancing medical knowledge are truly commendable.

As we navigate the complexities of a rapidly changing world, let us continue to foster connections, share knowledge, and strive for equitable healthcare solutions for all. May the stories and insights within these pages ignite conversations and actions that contribute to a healthier and more compassionate world.

Thank you for joining us on this journey of exploration and discovery. We hope you find this issue of the McGill Journal of Medicine both informative and inspiring.

Warm regards,

Sera Whitelaw, MSc.
Co-Editor-in-Chief, McGill Journal of Medicine
MD Candidate

Bennet Desormeau, MSc.
Co-Editor-in-Chief, McGill Journal of Medicine
MD Candidate

Foreword: Dr. Preetha Krishnamoorthy

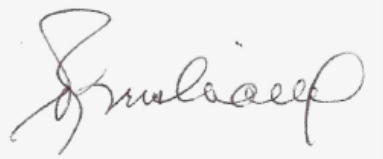
In a world increasingly defined by borders—political, cultural, and social—the theme of this year's journal, "Healing Across Borders," resonates profoundly. As we navigate the complexities of healthcare, we are reminded that our mission transcends boundaries. It is a commitment to serve every individual, regardless of ethnicity, religion, gender, or ability.

This issue features a remarkable collection of articles that highlight both the challenges and triumphs of healthcare in diverse contexts. From exploring access to immunoglobulin treatment for patients during the COVID-19 pandemic to reflecting on children's health experiences in India, each contribution sheds light on the shared human experience of seeking care and understanding. The focus on advance care directives reveals the importance of patient perspectives in improving our practices, while discussions on non-invasive prenatal testing challenge us to consider the ethical dimensions of decision-making in medicine.

As someone deeply invested in medical education, I am genuinely inspired by the dedication of the student authors and their supervisors who have contributed to this journal. Your work is not merely academic; it is a testament to the compassion and commitment that define our profession.

At its core, the essence of healing knows no borders. The challenges we face—be they pandemics, inequalities, or conflicts—demand that we come together, sharing knowledge and resources to support those in need. The MJM embodies this spirit, providing free and open access to research for health science scholars from our university and beyond. It fosters collaboration, encouragement, and a forum for learners to explore the world of research, editing, and publishing.

As you delve into the pages of this issue, I encourage you to reflect on the profound impact we can have as healthcare professionals. Let us embrace our shared responsibility to heal, advocate, and learn from one another. Together, we can forge a path toward a more inclusive and compassionate future for all.



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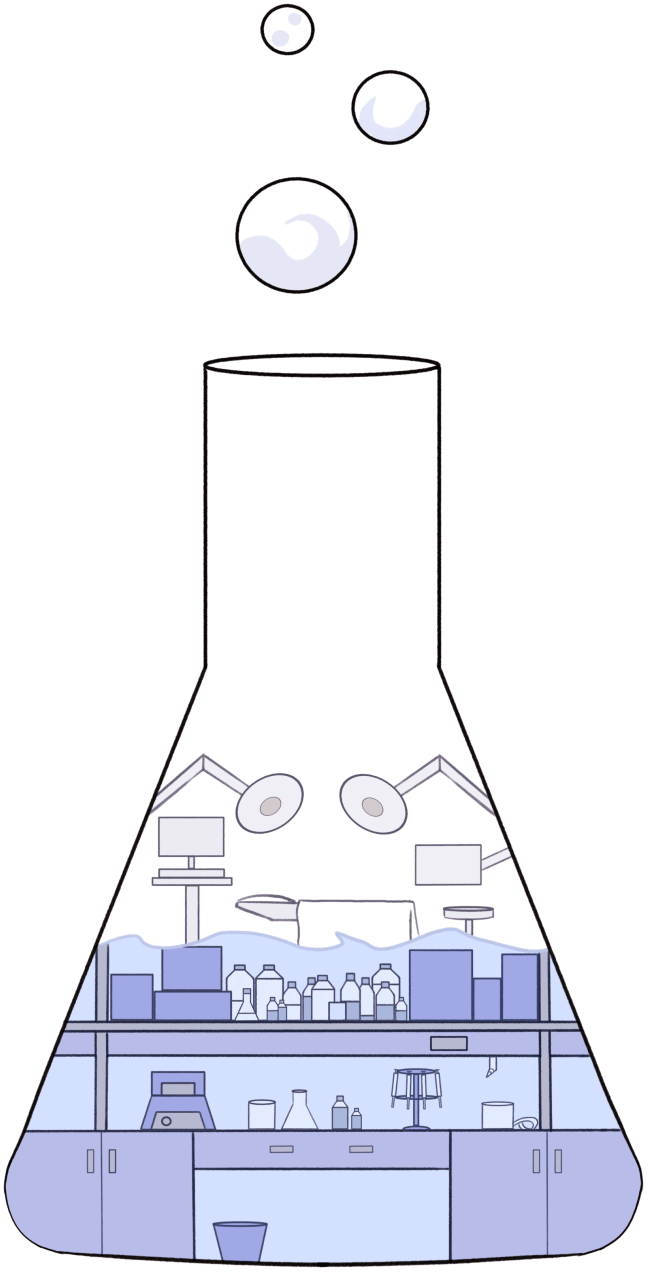
ORIGINAL RESEARCH



ORIGINAL RESEARCH
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Perceived Risk of Pesticide Exposure among School Workers in San Carlos, Costa Rica

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ABSTRACT

Background: There is increasing literature examining the effect of pesticides on people in proximity to pesticide use. However, limited information exists on how bystanders perceive the risk of pesticides to their health. This study aims to explore how school workers perceive the exposure to pesticides in a region where agriculture is the dominant economic driving force, and how these perceptions vary by sociodemographic subgroup. **Methods**: A total of 143 school workers from five districts in the San Carlos region of Costa Rica responded to the Technical Prevention Notes (NTP-578) perceived risk survey. The Mann-Whitney U test along with a Bonferroni control determined the statistical significance between subgroups. The four main sections for analysis of the results were prior knowledge on pesticide-related risks, perception of control over pesticide exposure, perception of current health risk and general knowledge of pesticide exposure. **Results**: Statistically significant differences in perceptions were seen by location, sex, age, level of education and position. Males and teachers exhibited higher levels of prior knowledge of hazards, whereas the older population, people without a university degree and administrators had higher perception of control over exposure to pesticides. **Conclusion**: School workers are knowledgeable on exposure to workplace pesticides and are aware of the severity of risk associated with pesticide exposure. In line with results from other studies, the older population and university educated people had higher perceived control over mitigating affects of pesticides. Our findings suggest that school workers could play a vital role in increasing knowledge dissemination pathways on pesticide-related harms. Further research could help in transforming school workers and bystanders into stakeholders and advocates for buffer zones.

KEYWORDS

pesticide exposure, perception of risk, school workers, reduction of rick, Costa Rica

1 | INTRODUCTION

Understanding the effects of pesticides on human and environmental health is crucial, particularly as research grows on the impact of pesticide exposure for those near their use, such as school workers in regions where agriculture is the dominant economic force. In Costa Rica, pesticides are heavily used to support the production of agricultural crops for the export market. For instance, pineapple production makes up 20% of agricultural exports, accounting for approximately 10% of agricultural land use (1) and contributing close to 2% of the country's Gross Domestic Product in 2023. (2,3) Yet methods seeking to minimize pesticide use, such as organic farming, account for only 0.04% of agricultural land in Costa Rica. (4) The impact of pineapple production on the environment is starkly evident in the case of Diazon, which Costa Rica banned in 2017 after it became the most prevalent pesticide contaminating water sources, including groundwater, wells, and springs. (6) Notwithstanding, dangerous pesticides, including Chlorpyrifos, Difenoconazole, and Bromacil, continue to be widely used in pineapple production. (5-7)

While many studies exist on the physiological effects of pesticide exposure on agricultural workers (8), there have been few studies examining the effects of pesticide exposure on surrounding communities. Bystanders are recognized as people who are near pesticide application but have no direct contact with pesticides. (12) Health effects from pesticide exposure include respiratory effects such as coughing, dizziness, and gestational symptoms. (9) Evidence has shown that pregnant women, children, and fetuses are at especially high risk of health consequences, including neurodevelopmental disorders, birth abnormalities, pre-term birth, and low birthweight. (10, 11)

In the United States of America, 7.4 million cases of acute pesticide-related illnesses were reported in school children between 1998 and 2002. (9) Similarly, a study conducted in Chile monitored urine biomarkers of school children to quantify and assess their exposure to pesticides. The authors also sought to increase knowledge about pesticides through an educational intervention for children and parents and assess participants' perception of risk through two different surveys. However, these measures failed to significantly alter the levels of organophosphates (specifically Chlorpyrifos, Diazinon, Malathion, and Parathion) found in the school children's urine, indicating that people's exposure to pesticides is firmly influenced by proximity to pesticide use and oral consumption. Systemic change is therefore needed to protect individuals from the harmful effects of pesticide exposure. (13)

In Costa Rica, there is a growing body of literature analysing the perception of risk associated with pesticide exposure. This research is imperative for understanding attitudes towards pesticides that can inform education and advocacy. Recent literature revealed that bystanders of aerial spraying of pesticides in the Limon province perceived a high magnitude of risk, indicating perceived negative health outcomes were associated with proximity to pesticide dumping. Social groups, such as ACOMUITA, an indigenous women's organization in Costa Rica, have formed to advocate for education and to oppose pesticide use. This advocacy is in response to men going sterile following intense long-term exposure to pesticides, acute health consequences related to pesticides, and effects on the environment and waterways. (14) However, the perception of pesticide use is not uniformly negative throughout Costa Rica. A study in Talamanca found that men associated pesticides with economic benefit more than fear of health hazards, as the pesticides allowed for monocropping and increased yields. (15) Thus, regional variation in perception of hazards associated with pesticides is likely.

While some studies on risk perception in Costa Rica exist, little research has been conducted on the perception of pesticide use in the northern regions where pineapple production predominates, compared to the Caribbean region, where banana and plantain crops predominate. It is significant to conduct research in both geographical areas, as the pesticide application method varies. With Bananas and Plantains aerial spraying is most common, compared to manual application using trucks or hand packs that are used for pineapples (1, 14) This paper will explore whether school workers in

pineapple producing regions in Northern Costa Rica have similar perceptions and awareness of pesticide exposure risk compared to other geographic regions in Costa Rica, and how these perceptions may vary by sociodemographic subgroup.

2 | METHODS

2.1 | Survey instrument

This survey utilized quantitative methodology to conduct an exploratory study. The 'NTP-578: Perceived Risk, an Evaluative Procedure' survey, designed by Ministerio De Trabajo y Asuntos Sociales España (The Spanish Ministry of Work and Social Services), was used. (15, Appendix 1) The survey contains ten questions with a Likert scale, designed to standardize risk perception for hazards in the workplace and understand workers' priorities.

Surveys were distributed digitally between January 2020 to March 2020 to elementary and secondary school principals in the San Carlos region using random sampling methods. The counties of the San Carlos region in Alajuela Province include Pital, Ciudad Quesada, Aguas Zarcas, Venecia, and the neighboring county of Río Cuarto.

The categories of analysis were divided as follows: age was dichotomized as younger or older than 40; education was dichotomized into 'university degree' versus 'no university degree'; and position was dichotomized into teachers and administrators. Geographic regions were classified as 'agricultural settings' (Pital, Aguas Zarcas, Rio Cuarto) and 'non-agricultural settings' (Ciudad Quesada, Venecia), based on the amount of agricultural land rather than urban or rural distinctions. Survey responses were inputted and analysis was done with encoded data on Jamovi Version 2.3. (16) A Mann-Whitney U test was conducted to evaluate the significance of the difference between socio-demographic subgroups, including age, sex, level of education, position, and location. Bonferonni correction for multiple comparisons was applied, and a p-value < 0.01 was deemed to be significant.

3 | RESULTS

Table 1 displays the socio-demographic breakdown of the 143 respondents to the study; respondents were predominantly female (63.6%), with a median age of 30 (range 20-78 years).

Survey responses to questions one through nine were divided into three focus areas for analysis, and question 10 was analysed separately. Main results fall into prior knowledge of pesticide exposure and the level of perceived control of exposure and health effects. Table 2 displays the results from the Mann-Whitney U test and associated p-value for each socio-demographic group.

3.1 | Prior knowledge of pesticide risk

Questions one, three, and eight assess prior awareness of pesticide exposure in the workplace. For question one, females reported significantly less prior knowledge with a mean score of 4.73(± SD 1.68), while males had a mean score of 5.40 (± SD 1.61). Similarly, teachers had significantly higher awareness than administrators, with a mean of 5.18 (± SD 1.49) and 3.41 (± SD 2.18), respectively. Additionally, people without a university degree appeared to have a lower, but not statistically significant, awareness of pesticide harms with a mean score of 3.30 (± SD 2.21), while people with a university degree had a mean score of 5.10 (± SD 1.58), p 0.013.

Question three had a mean score of 6.15 in the total study population, indicating a high degree of fear regarding harm caused by pesticide exposure.

Question eight had no statistically significant variations across demographic subgroups. However, the average score amongst all participants was 6.15, suggesting that people believe there is a high chance that pesticides put many people in danger.

3.2 | Level of perceived control

Questions two, six, and seven asked respondents to rate their perception of control over pesticide exposure. The questions examined respondents' ability to avoid risk of

	Characteristic	Count	Total	Proportion of Total
Age	< 40	76	143	0.531
	≥ 40	67	143	0.469
Sex	Female	91	143	0.636
	Male	52	143	0.364
Civil Status	With partner	89	143	0.622
	Without partner	54	143	0.378
Education	University degree	133	143	0.930
	No university	10	143	0.070
Position	Teacher	126	143	0.881
	Administration	17	143	0.119
Children	Yes	103	143	0.720
	No	40	143	0.280
Location	Non-agricultural setting	69	143	0.483
	Agricultural setting	74	143	0.517

TABLE 1 Sociodemographic breakdown.

Socio-demographic and job characteristics of school workers in the survey (n= 143).

exposure and their ability to intervene and minimize exposure. The average score for question two among the total study population was 4.82 (± SD 5).

For question six, teachers had significantly lower mean scores than administrators, 3.89 and 5.25 (± SD 1.39), respectively. Similarly, people with a university degree had significantly lower averages than respondents without a university degree, 3.94 (± SD 2.02) and 5.60 (± SD 0.17), respectively.

Teachers had a significantly higher degree of perceived control than administrators, with a mean of 3.62 (± SD 1.90) and 4.94 (± SD 1.64), respectively. Respondents with a university degree had a significantly lower average score of 3.64 (± SD 1.87) than respondents with no university degree, with an average of 5.60 (± SD 0.58). Workers under 40 indicated a significantly lower average score of 3.36 (± SD 1.78) opposed to workers 40 and over with an average of 4.92 (±SD 1.96).

3.3 | Perception of health effects

Questions four, five, and nine asked respondents to indicate their understanding of the severity, duration, and scope of pesticides' effects on human health. No statistical significance was found between any sociodemographic groups. The average score among the study population to question four ("The likelihood you may suffer damage because of this factor" (factor = pesticide exposure))was 5.27 (± SD 1.51), with 73 people rating 6 or 7 (i.e., "very high probability").

Question five had a mean response was 5.97 (± SD 1.21), with 66 people (46.2%) responding with 7. People with a university education tended to have a lower average response than people without a university education. Respondents with a university education had an average of 5.94 (± SD 0.22), whereas those without a university degree had an average of 6.40 (± SD 0.96).

Question nine had low variations between respondents with an average response of 4.68 (± SD 1.86).

3.4 | Magnitude of risk

Question ten was scored out of 100. It asked respondents "how do you assess very serious accident and illness risk associated with the factor indicated at the beginning?" to gain a general risk perception. The average

response was 82.5, with 34 respondents (24.6%) who indicated the magnitude of risk as '100', very high risk.

4 | DISCUSSION

Our study revealed medium to high levels of prior knowledge and perceived control on pesticide exposure, with significant differences based on gender, occupation, and education for some measures, and the majority of respondents expressed high concern about the health risks associated with pesticides.

Our results report females having significantly less prior knowledge of pesticide use than their male counterparts. This was consistent with findings from a study done in Talamanca, Costa Rica. (14) While the study in Talamanca was directed at farm workers, it found that women had little to no relevant knowledge, as their sole knowledge transfer source was their husbands, who had work training or information from other farmers regarding the harms of pesticide exposure. (14)

Regarding gender differences in perceptions of risks associated with pesticide use, two previous surveys in Limon province and in Washington State found that female respondents reported higher severity of risks than their male counterparts. (14, 17) Our study's findings were consistent with these reports; females reported a higher severity of risk than their male counterparts. Explanations for this gender-based variation may include differences in gender roles, where female roles more often comprise caretaking of family and community. (14, 17) Familial pressures may lead to increased fear about factors outside of perceived control, such as environmental exposures, and expectations to be concerned for family or community wellbeing. (14, 17) This also causes pressure to stay in agricultural communities, due to stress linked to job security, shelter, and financial barriers. (18-20) If further research is conducted in the San Carlos region, it is recommended that the effects of pesticide use and exposure on gender roles be further examined.

The survey done in the Limon Province of Costa Rica also found that older respondents perceived a higher risk of harm associated with pesticide use compared to their younger counterparts. (14) Our study did not find a statistically significant difference in perceived harm or prior knowledge of pesticide exposures. However, other Spanish research on environmental risk perception found that younger generations were more likely to recognize the severity of environmental hazards, including pesticide exposure. (19)

In line with this, our study found the older population (over 40) had a significantly higher perception of their level of control over mitigating a 'risk situation'. Some authors posit that populations with higher levels of knowledge are overconfident, have a higher perception of control over the hazard, and therefore fear the hazard less. (19) However, overconfidence in control of pesticide hazards is not in line with expert knowledge on routes of pesticide exposure. In fact, drift exposure (through inhalation), proximity to pesticide use, and oral pathways (through food consumption) outweigh individual choice when it comes to control over pesticide exposure. A study in Chile found no significant difference in urine metabolites after an educational intervention on exposure pathways. (13) Indeed, external factors such as job security, shelter, and food availability can force people to have continued exposure. (19,20)

The survey done in Talamanca also found that people closer to agricultural settings had more knowledge on pesticides and their associated risks than people in non-agricultural settings. (14) However, in our study, no significant differences were seen between respondents from agricultural and non-agricultural settings. This may be a result of different application techniques used between Talamanca, where Ariel spraying is predominant, and more visible to bystanders than manual spraying application techniques used on Pineapple crops. Nevertheless, while the findings were not statistically significant, people in agricultural settings appeared to report a lower level of knowledge on the effects of pesticide use than respondents in non-agricultural settings. More research into knowledge transfer pathways would be beneficial to understand the content and sources of information about pesticides in these settings.

Perceived Risk											
	Question		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	GR
Sociodemographic Characteristic	Total Population	Mean	4.97	4.82	6.15	5.27	5.97	4.06	3.77	6.15	4.68	82.5
Age	< 40	Mean	4.84	5.00	6.09	5.21	6.04	3.92	3.36	6.11	4.92	79.9
	≥ 40	Mean	5.12	4.61	6.23	5.34	5.90	4.21	4.24	6.21	4.40	85.5
		p	0.119	0.357	0.700	0.745	0.561	0.377	**0.008***	0.619	0.164	0.141
Sex	Female	Mean	4.73	4.80	6.31	5.31	6.07	4.16	3.74	6.21	4.71	83.5
	Male	Mean	5.40	4.85	5.88	5.21	5.81	3.88	3.84	6.06	4.62	80.8
		p	**0.009***	0.696	0.195	0.948	0.219	0.474	0.716	0.375	0.616	0.150
Education	University Degree	Mean	5.10	4.84	6.16	5.28	5.94	3.94	3.64	6.17	4.71	81.8
	No University Degree	Mean	3.30	4.50	6.11	5.20	6.40	5.60	5.60	6.00	4.30	93.8
		p	0.013	0.579	0.996	0.791	0.248	0.013	**0.002***	0.268	0.498	0.051
Position	Teacher	Mean	5.18	4.84	6.18	5.30	5.91	3.89	3.62	6.17	4.72	81.7
	Administration	Mean	3.41	4.65	5.94	5.12	6.41	5.24	4.94	6.00	4.35	89.0
		p	**0.002***	0.739	0.624	0.719	0.129	0.011	**0.007***	0.220	0.420	0.352
Location	Agricultural Setting	Mean	4.80	5.01	6.19	5.25	5.96	3.81	3.65	6.06	4.43	81.0
	Non-Agricultural Setting	Mean	5.14	4.64	6.12	5.30	5.99	4.29	3.89	6.24	4.90	83.9
		p	0.133	0.200	0.404	0.652	0.542	0.169	0.371	0.219	0.120	0.761

TABLE 2 Description of mean response values to NTP 578 perception of risk survey.

Mann-Whitney U test values and statistical significance results to NTP-578 perception of risk survey (n=143).

* $p < 0.01$.

Q1. To what extent are you aware of the risk associated with this factor? (To what extent do you know harm it can cause, and the possibilities of suffering these risks?)

Q2. To what extent do you consider that those responsible for prevention in your company are aware of the risk associated with this factor?

Q3. To what degree do you fear the harm that may result from this factor?

Q4. The likelihood that you may suffer damage (small or large, soon or in the long run) because of this factor is:

Q5. In the event of a risk situation, the severity of the damage that this factor can cause is:

Q6. To what extent can you avoid that this factor originates a risk situation?

Q7. In the event of a risk situation, to what extent can you intervene to control (to avoid or reduce) the risk that this factor can cause?

Q8. To what extent is it a factor that can put into risk many people at once?

Q9. In case of exposure to the risk factor, when do the most harmful consequences of this source of risk appear?

GR. How do you assess very serious accident and illness risk associated with pesticides?

Overall, the responses to the NTP-578 study revealed some discrepancies between respondents and expert knowledge. However, some responses in Table 1 to general knowledge, such as severity, duration, and number of people affected by pesticides (Questions: 4,5, and 9) are in line with expert knowledge. Discontinuities in knowledge come from the perception of control in preventing and mitigating pesticide exposure. Most significantly, this study has revealed that school workers in San Carlos are aware of and fear the effects of pesticide exposure at work. In rating the level of fear of harm from pesticides, respondents had an average score of 6.5 out of 7, with a median answer of 7, indicating a high degree of fear. These results highlight the need to address these fears, such as by ongoing testing of pesticide exposure within school zones and communities.

This study has some limitations. Though we utilized a random sampling method in five targeted locations of the San Carlos Region to optimize randomization, the sample size was small, and thus may not fully reflect the sociodemographic distribution of school workers in this region. In addition, the surveys were distributed in early 2020 at the onset of the COVID-19 pandemic. As a result, it is possible that concerns about the COVID-19 pandemic and its associated health implications may have been more pressing than concerns about pesticide-related harms, resulting in a reduced number of possible survey responses as well as potential devaluing of perceived hazards.

Overall, further research on pesticide use and exposure levels in the San Carlos region is recommended. Firstly, quantifying the exposure to pesticides and the proximity of pesticide use to school zones is crucial to getting an accurate picture of exposure in the San Carlos region. Additionally, further research should be done to examine whether the most common pesticide exposure pathways in the region, such as drift and oral exposure, can be minimized through the implementation of buffer zones between pesticide users and communities. Secondly, it is vital to better understand the knowledge transfer pathways on pesticide-related risks to ensure safe dissemination of accurate information. Further research elucidates ways through which gender roles potentially affect knowledge dissemination through the community. Many populations in this study indicated a high level of perceived control or ability to avoid exposure to pesticides, which is not in line with expert knowledge. We believe that by optimizing knowledge accuracy and level, school workers in San Carlos can become important stakeholders in advocating for pesticide buffer zones and other mitigation strategies, once common exposure pathways have been identified. While previous studies have shown that educational intervention alone has little effect on pesticide exposure routes, advocacy groups similar to those in Talamanca help disseminate accurate knowledge, educational interventions, and political pressure to reduce overall exposure to pesticides. As school workers play a pivotal role in the community, we believe they have the ability to keep communities aware of hazards such as pesticides they are being exposed too.

REFERENCES

1. Alvarado AG. Sustainable pineapple production in Costa Rica. Esri; 2021. Available from: storymaps.arcgis.com/stories/2c3b2463594e48c88b143e14b8d1b025

2. Canapep. Exportación de piña en 2023 (Pineapple exports in 2023). Available from: https://canapep.com/estadisticas/

3. Del Moral-Arroyo M. 20 años buscando la excelencia en la producción de piña de Costa Rica (20 years searching for excellence in Costa Rican pineapple production). Available from: https://www.freshplaza.es/article/9534858/20-anos-buscando-la-excelencia-en-la-produccion-de-pina-de-costa-rica/

4. Willer H, Lernoud J, editors. The world of organic agriculture: Statistics & emerging trends 2017. Frick and Bonn: Research Institute of Organic Agriculture FiBL and IFOAM - Organics International; 2017.

5. Jiménez K, Solano K, Scholz C, Redondo-López S, Mena F. Early toxic effects in a Central American native fish (Parachromis dovii) exposed to chlorpyrifos and difenoconazole. Environ Toxicol Chem. 2021;40(7):1940–9. Available from: http://dx.doi.org/10.1002/etc.5048

6. Valverde BE, Chaves L. The banning of bromacil in Costa Rica. Weed Sci. 2020;68(3):240–5. Available from: http://dx.doi.org/10.1017/wsc.2020.13

7. Shrestha S, Kamel F, Umbach DM, Freeman LEB, Koutros S, Alavanja M, et al. High pesticide exposure events and olfactory impairment among U.S. farmers. Environ Health Perspect. 2019;127(1):17005. Available from:

http://dx.doi.org/10.1289/EHP3713

8. Mena F, González-Ortegón E, Solano K, Araújo CVM. The effect of the insecticide diazinon on the osmoregulation and the avoidance response of the white leg shrimp (Penaeus vannamei) is salinity dependent. Ecotoxicol Environ Saf. 2020;206:111364. Available from: http://dx.doi.org/10.1016/j.ecoenv.2020.111364

9. Alarcon WA, Calvert GM, Blondell JM, Mehler LN, Sievert J, Propeck M, et al. Acute illnesses associated with pesticide exposure at schools. JAMA. 2005;294(4):455–65. Available from: http://dx.doi.org/10.1001/jama.294.4.455

10. Shelton JF, Geraghty EM, Tancredi DJ, Delwiche LD, Schmidt RJ, Ritz B, et al. Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: the CHARGE study. Environ Health Perspect. 2014;122(10):1103–9. Available from: http://dx.doi.org/10.1289/ehp.1307044

11. Larsen AE, Gaines SD, Deschênes O. Agricultural pesticide use and adverse birth outcomes in the San Joaquin Valley of California. Nat Commun. 2017;8(1). Available from: http://dx.doi.org/10.1038/s41467-017-00349-2

12. European Food Safety Authority (EFSA). Guidance on the assessment of exposure of operators, workers, residents and bystanders in risk assessment for plant protection products, 2014. Parma, Italy: European Food Safety Authority; 2014. Available from: efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2014.3874

13. Muñoz-Quezada MT, Lucero B, Bradman A, Steenland K, Zúñiga L, Calafat AM, et al. An educational intervention on the risk perception of pesticides exposure and organophosphate metabolites urinary concentrations in rural school children in Maule Region, Chile. Environ Res. 2019;176:108554. Available from: http://dx.doi.org/10.1016/j.envres.2019.108554

14. Barraza D, Jansen K, van Wendel de Joode B, Wesseling C. Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. Environ Res. 2011;111(5):708–17. Available from: http://dx.doi.org/10.1016/j.envres.2011.02.009

15. Vidal P, Solé Gómez M. Riesgo percibido: un procedimiento de evaluación. Ministerio de Trabajo y Asuntos Sociales España. NTP. 2001;578.

16. The Jamovi Project. Jamovi (Version 2.3). 2022. Available from: https://www.jamovi.org

17. Lehrer N, Sneegas G. Beyond polarization: using Q methodology to explore stakeholders' views on pesticide use, and related risks for agricultural workers, in Washington State's tree fruit industry. Agric Human Values. 2018;35(1):131–47. Available from: http://dx.doi.org/10.1007/s10460-017-9810-z

18. Barraza D, Jansen K, Wesseling C, van Wendel de Joode B. Pesticide risk perceptions among bystanders of aerial spraying on bananas in Costa Rica. Environ Res. 2020;189:109877. Available from: http://dx.doi.org/10.1016/j.envres.2020.109877

19. Subiza-Pérez M, Santa Marina L, Irizar A, Gallastegi M, Anabitarte A, Urbieta N, et al. Who feels a greater environmental risk? Women, younger adults and pro-environmentally friendly people express higher concerns about a set of environmental exposures. Environ Res. 2020;181:108918. Available from: http://dx.doi.org/10.1016/j.envres.2019.108918

20. McCright AM, Xiao C. Gender and environmental concern: Insights from recent work and for future research. Soc Nat Resour. 2014;27(10):1109–13. Available from: http://dx.doi.org/10.1080/08941920.2014.918235

21. Calliera M, Luzzani G, Sacchettini G, Capri E. Residents perceptions of non-dietary pesticide exposure risk. Knowledge gaps and challenges for targeted awareness-raising material in Italy. Sci Total Environ. 2019;685:775–85. Available from: http://dx.doi.org/10.1016/j.scitotenv.2019.06.223

APPENDIX A

| ESTUDIO: RIESGO PERCIBIDO DE USO DE PLAGUICIDAS

Esta investigación tiene como objetivo estudiar los riesgos percibidos del uso de plaguicidas entre docentes y otros miembros del personal de centros educativos en San Carlos y Río Cuarto. Esta encuesta no debería demorar más de cinco minutos en completarse. Si acepta participar en este estudio, se le pedirá que responda las preguntas de la encuesta en la parte de abajo y posterior de esta página lo mejor que pueda. No ponga su nombre en la encuesta, ya que toda la información que proporcione será anónima y confidencial. No hay riesgos o beneficios previsibles para usted como participante. Tiene la oportunidad de hacer preguntas y retirarse de la investigación en cualquier momento, incluso después de haber aceptado participar inicialmente. Negarse a participar o retirarse del estudio, tal como lo entendemos, no creará ningún problema para ninguna de las partes.

¿Tiene usted alguna pregunta?, Si la tuviese en algún momento mientras completa la encuesta, informe a uno de los investigadores.

| ENCUESTA SOBRE USO DE PLAGUICIDAS

Edad: _____ **Sexo:** □ Masculino □ Femenino **Estado Civil:** _____
Hijos: _____ **Pueblo:** _____ **Posición de Trabajo:** _____
Nivel de Educación: □ Primaria completa □ Primaria incompleta □ Secundaria completa
□ Secundaria incompleta □ Bachillerato □ Licenciatura □ Maestría

A continuación, evalúe los siguientes aspectos relacionados con el uso de plaguicidas utilizando una escala de 1 a 7, siendo 1 el más bajo y 7 el más alto.

Recuerde que en cada caso debe rodear el número que mejor represente su evaluación.

1. ¿En qué medida conoce los riesgos asociados con el uso de plaguicidas (en qué medida sabe cuáles son los daños que puede causarle o la posibilidad de experimentar estos daños, etc.)?
   NIVEL DE CONOCIMIENTO MUY BAJO 1 2 3 4 5 6 7 NIVEL DE CONOCIMIENTO MUY ALTO
2. ¿Hasta qué punto cree que los responsables del uso de plaguicidas conocen el grado de riesgo asociado con él?
   NIVEL DE CONOCIMIENTO MUY BAJO 1 2 3 4 5 6 7 NIVEL DE CONOCIMIENTO MUY ALTO
3. ¿Hasta qué punto tiene miedo del daño que puede derivarse del uso de plaguicidas?
   GRADO MUY BAJO 1 2 3 4 5 6 7 GRADO MUY ALTO
4. ¿Cuál cree que es la posibilidad de que personalmente experimente un daño (pequeño o grande, inmediato o posterior) como resultado del uso de plaguicidas?
   MUY BAJA POSIBILIDAD 1 2 3 4 5 6 7 MUY ALTA POSIBILIDAD
5. En el caso de que ocurra un riesgo, la gravedad del daño que puede causar el uso de plaguicidas es de:
   GRAVEDAD MUY BAJA 1 2 3 4 5 6 7 GRAVEDAD MUY ALTA
6. ¿En qué medida puede evitar que los plaguicidas provoquen un riesgo?
   EN MUY BAJO GRADO 1 2 3 4 5 6 7 EN MUY ALTO GRADO
7. En caso de que ocurra un riesgo, ¿en qué medida puede intervenir para controlar (evitar o reducir) el daño que puede causarle el uso de plaguicidas?
   POSIBILIDAD DE CONTROL MUY BAJA 1 2 3 4 5 6 7 POSIBILIDAD DE CONTROL MUY ALTA
8. ¿En qué medida es el uso de plaguicidas un factor que puede dañar a un gran número de personas a la vez?
   GRADO MUY BAJO 1 2 3 4 5 6 7 GRADO MUY ALTO

9. En caso de exposición, ¿cuándo experimenta las consecuencias más perjudiciales del uso de plaguicidas?

INMEDIATAMENTE 1 2 3 4 5 6 7 MUY LARGO PLAZO

10. ¿Cómo califica el riesgo de accidente o enfermedad muy grave asociada con el uso de plaguicidas en general?

Tenga en cuenta que los accidentes o enfermedades muy graves son aquellos que implican una pérdida irreversible de la salud (muerte, pérdida de extremidades y / o habilidades funcionales, enfermedades crónicas que acortan severamente la vida o reducen drásticamente la calidad de vida) ya sea de inmediato o en el medio / largo término.
Califique la magnitud de este riesgo marcando con un círculo el punto en la escala que mejor refleje su opinión, tenga en cuenta que 0 representa un riesgo muy bajo o cero y 100 un riesgo muy alto o extremo.

MUY BAJO 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 MUY ALTO

APPENDIX B

| DIMENSIONAL ASSESSMENT OF PERCEIVED RISK (DAPR-W)

On a scale from 1 to 7, you must assess nine aspects related to the factor. Remember that in each case you must circle the number that best represents your assessment.

Q1. To what extent are you aware of the risk associated with this factor? (To what extent do you know the harm it can cause, the possibilities you have of suffering these risks?)

Very low level of knowledge 1 2 3 4 5 6 7 Very high level of knowledge

Q2. To what extent do you consider that those responsible for prevention in your company are aware of the risk associated with this factor?

Very low level of knowledge 1 2 3 4 5 6 7 Very high level of knowledge

Q3. To what degree do you fear the harm that may result from this factor?

A low degree 1 2 3 4 5 6 7 A high degree

Q4. The likelihood that you may suffer damage (small or large, soon or in the long run) because of this factor is?

Low possibility 1 2 3 4 5 6 7 High possibility

Q5. In the event of a risk situation, the severity of the damage that this factor can cause is?

Low severity 1 2 3 4 5 6 7 High severity

Q6. To what extent can you avoid that this factor originates a risk situation?

At a low degree 1 2 3 4 5 6 7 At a high degree

Q7. In the event of a risk situation, to what extent can you intervene to control (avoid or reduce) the risk that this factor can cause?

Very low possibility of control 1 2 3 4 5 6 7 Very high possibility of control

Q8. To what extent is it a factor that can put many people at risk at once?

Zero degree 1 2 3 4 5 6 7 Very high degree

Q9. In case of exposure to the risk factor, when do the most harmful consequences appear?

Immediately 1 2 3 4 5 6 7 Very long term

How do you assess very serious accident and illness risk associated with the factor indicated at the beginning(*)? Keep in mind that very serious accidents or illnesses are those that entail irreversible health loss (e.g., death, loss of body parts and/or functional capacities, chronic diseases that may shorten life severely or drastically reduce life quality) either immediately or in the long term. Assess the magnitude of this risk by writing a cross (x) on the number that best reflects your opinion. Zero represents very low risk or no risk at all and 100 represents extreme or very high risk.

Very low 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 Very high

ORIGINAL RESEARCH
McGill Journal of Medicine

A Usability Evaluation of a Touchscreen Workstation on Wheels in a Simulated Emergency Department Workflow

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ABSTRACT

Background: Touchscreens have become ubiquitous in our daily lives, offering a comfortable and natural human-technology interactive experience. There exists a gap in the literature regarding the usability and efficiency of a touchscreen workstation on wheels (WOW) within an emergency department (ED) workflow, specifically with electronic medical record (EMR) systems designed for keyboard and mouse. **Methods:** This was a randomized, controlled, 2-intervention-2-period crossover study comparing a touchscreen to a non-touchscreen WOW. Participants were asked to complete a series of seven tasks that are typically done in the ED followed by the completion of a post-study questionnaire. **Results:** A total of 24 people (12 attendings, 12 resident physicians) participated in the study. Results from the linear mixed model regression analyses showed no evidence to reject the hypothesis that the average time to complete each task and the average total time to complete all tasks combined were similar ($p>0.05$) between the touchscreen and non-touchscreen WOW. Results from the post-study questionnaire using a 7-point Likert scale (Figure 1) demonstrated that the majority (>50%) of participants agreed to most questions favoring intention to use (BU), ease of use (PEOU), perceived usefulness (PU), and attitude towards utilization (AU) of the touchscreen WOW. **Conclusion:** This study builds on previous work on touchscreen devices by specifically evaluating the usability and efficiency of touchscreen WOWs in a controlled, simulation-based setting, differentiating from prior studies on tablets at the bedside. Future studies, should evaluate the impact of touchscreen-friendly EMR designs on clinical workflows in the ED.

KEYWORDS

healthcare information technology, touchscreen, workflow efficiency, emergency department, electronic medical records

1 | INTRODUCTION

Emergency Departments (EDs) serve as crucial entry points to hospitals, providing immediate care to patients with diverse medical needs. However, the high patient volume often leads to overcrowding, resulting in delayed care and emergency access blocks, the number one safety concern in first-world EDs (1–3). Timely care in the ED is essential for improving patient outcomes and reducing mortality rates (4–8). A recent study conducted in 2019 that analyzed ED data from 25 Canadian hospitals found that improvements that can increasing tasks performed at the bedside and reducing tasks at the stationary workstation have been observed to reduce workflow interruptions, decrease errors of omission, and increase time with patients and their families, which improved patient satisfaction and thus optimized provider service (9). Though technological innovations and information technology (IT) solutions have the potential to improve healthcare delivery, limited research exists on the specific mechanisms by which these solutions impact ED operations.

Touchscreens have become ubiquitous in our daily lives, offering a comfortable and natural human-technology interactive experience (10,11). A prospective pilot study conducted in a large level 1 ED introduced touchscreen tablet computers at the bedside, reducing physicians' time away from patients by 38 minutes per shift (12). Physicians reported positive perceptions of these devices, considering them clinically useful, efficient, easily portable, easy to disinfect, and improved overall patient care. While portable tablets show promise, their adoption can be limited regarding universal accessibility, operational capacity, security, fragility, interface quality, and compatibility with EMRs and associated software. Furthermore, the specific aspects of these interventions, such as portability or touchscreen functionality, that contribute to improved workflow efficiency require further investigation.

Our study aims to assess workflow efficiency and perceived usability of a touchscreen interface compared to a mouse-based interface on a standard workstation on wheel (WOW) with common tasks performed on two existing electronic medical record (EMR) systems in the emergency department (ED).

2 | METHODS

2.1 | Study Design

We performed a randomized, controlled, single-center, 2-intervention-2-period crossover study. The study subjects included a convenience sample of 12 resident physicians and 12 staff emergency physicians of the McGill University Health Center (MUHC), a large tertiary and quaternary academic teaching center in Montreal, Canada, who regularly use the existing MedUrge and Oacis EMRs for clinical care. The study involved the completion of the following EMR tasks in tandem with a ten-minute break in between interventions:

Task 1: Open a triage note and identify blood pressure via MedUrge
Task 2: Open most recent patient chart via Oacis
Task 3: Order CBC and CHEM7 bloodwork via Oacis
Task 4: Order chest x-ray imaging via Oacis
Task 5: Order acetaminophen medication via MedUrge
Task 6: Request a cardiology consult via MedUrge
Task 7: Discharge patient home via MedUrge

In keeping with a crossover design, all participants were evaluated for the completion of the same tasks using each of the two interventions. One intervention (A) involved completing the tasks with a non-touchscreen WOW (non-touchscreen monitor, keyboard, mouse) whereas the other intervention (B) involved completing the tasks with a touchscreen WOW (touchscreen monitor, keyboard, no mouse). Twelve subjects were randomly selected to perform the tasks in intervention A and then the tasks in intervention B (sequence AB), while the other twelve subjects completed the tasks in the opposite order (sequence BA). No washout period between interventions was introduced given that these are commonly performed EMR tasks and we assumed minimal to no carry-over effect (i.e., that the effect on

time to perform the tasks of the intervention used in the first period did not alter the effect on time to perform the tasks of the intervention used in the second period).

2.2 | User Interface

While both the touchscreen-based and non-touchscreen-based WOWs use the same EMRs user interface, differences exist in their interactions. The EMRs were designed more than a decade ago with the mouse and keyboard in mind, and thus, did not have user interface design considerations for touchscreens. Interaction difference between the mouse action versus touch actions include: 1) dragging of mouse vs movement of finger to find interface of interest, 2) mouse double left-click vs double touch to confirm specific selected options, 3) mouse right-click vs touch and hold to open patient care menus. Other differences may exist between interactions and the EMRs user interfaces but were not observed nor tested in the tasks assigned to participants. It is important to note that in this simulated environment, we did not have the opportunity to modify the design of EMRs user interface.

2.3 | Data Collection and Processing

An asynchronous observation study design was used to collect data during testing; asynchronous in that the interventions were video recorded and analyzed at a later point in time. Research assistants were present before and after the interventions to collect pre- and post-intervention surveys for participant demographic characterization and to assess perceptions of physician users, respectively. Pre- and post-intervention surveys were electronically collected using the Google Forms. To ensure survey completion, the survey responses were confidential although not anonymous.

2.4 | Outcome Measures

The primary outcome of this study was the combined time to complete all tasks sequentially for each of the interventions. Secondary outcomes include the time to complete each individual task as well as all participant's perceptions of touchscreen utility, efficiency, portability, reliability, capacity to improve care, satisfaction, and ease of use.

2.5 | Primary Data Analysis

Descriptive statistics are reported as counts and percentages for categorical variables. For continuous variables, we reported means and standard deviation (SD) if there was evidence that the distribution of values followed a normal distribution, and median and interquartile range otherwise.

Intervention effect was investigated by comparing the average time to complete each task and the average total time to complete all tasks with the touchscreen and the non-touchscreen WOWs. Data was analyzed using standard methods for a 2-treatment, 2-period crossover design for continuous data (15,16). For each comparison, we used a mixed linear regression model with the type of intervention as the main independent variable, adjusting for period of measurement and the sequence of intervention, as fixed effects, and subject level variability as a random effect, to consider that subjects are observed under both types of intervention. We did not account for carry over effect as it was assumed to be negligible in our study design. Furthermore, the analysis adjusted for age, sex, level of training, experience with computers, touchscreen devices, touchscreen computers, Medurge and Oacis.

On each model, assumptions on the model errors (randomness, normality, and homogeneity of variances) and the presence of possible influential observations or outliers were assessed with diagnostic plots of the model residuals. Robust standard errors (SE) were used to adjust for violations of the homogeneity of variances assumption, if applicable. Statistical tests of hypothesis were two-sided and with a 5% level of significance. Results of the linear models are reported as estimated adjusted means and SE, as well as differences in adjusted means between interventions with 95% confidence interval (CI). (13) All analyses were conducted in R version

4 (R Core Team 2020).

We have estimated that 24 participants would be sufficient to detect a difference in the mean total time to complete both interventions in tandem by 30 seconds between the touchscreen WOW and the non-touchscreen WOW workflow with 80% power and a significant level of 5%. Considering there are no previous studies comparing similar workflows in the recent literature, we decided to use a pre-specific effect size of 0.8, which amounts to assuming a within-subject standard deviation for the total time to complete both interventions in tandem of 35 seconds. (14). We have computed the sample size using a standard formula for 2-treatment, 2-period cross-over trials. Post assessment, a technology acceptance model (TAMS) post-study survey (15) was administered to assess the subjects' perception of touchscreen utility, efficiency, portability, reliability, capacity to improve care, satisfaction, and ease of use (Table 1). Ad-hoc analysis assessing correlations between two variables was done using Spearman's correlation coefficients.

3 | RESULTS

3.1 | Demographics of Study Participants

A total of twenty-four practicing physicians from the MUHC volunteered to participate in this study (Table 2). Post-study questionnaire data was excluded for one participant due to insufficient time to complete the questionnaire.

Post-Survey Questions
Perceived Ease of Use (PEOU)
PEOU1: I find the WOW with touchscreen easy to use.
PEOU2: Interacting with the WOW with touchscreen does not require a lot of mental effort.
PEOU3: Switching from WOW without touchscreen to the WOW with touchscreen (or vice versa) is an easy transition for me.
PEOU4: It is easy to get the WOW with touchscreen to do what I want it to do.
PEOU5: It is easier to use the WOW with touchscreen than the WOW without touchscreen.
Perceived Usefulness (PU)
PU1: The WOW with touchscreen will make my work more efficient.
PU2: The WOW with touchscreen will be easy to disinfect.
PU3: The WOW with touchscreen will minimize errors.
PU4: The WOW with touchscreen will improve overall workflow.
PU5: The WOW with touchscreen will be more useful than the non-touch screen version.
Attitude Towards Utilization (AU)
AU1: I feel that implementation of the WOW with touchscreen is a good idea.
AU2: I feel that implementation of the WOW with touchscreen should be a priority.
AU3: Overall, I have positive feelings towards implementing the WOW with touchscreen.
AU4: I believe physicians should use the WOW with touchscreen instead of the WOW without touchscreen.
Behavioral Intention to Use (BU)
BU1: Assuming I have access, I intend on using the WOW with touchscreen.
BU2: If given the option to use either the WOW without touchscreen or the WOW with touchscreen, I would use the touchscreen version.

TABLE 1 Physician attitudes regarding use of touchscreen workstation on wheels

Variable		
Age (years), median (IQR)		34.5 (28.8–42.8)
Sex (Male), n (%)		19 (79.2%)
Training, n (%)	Attending	12 (50.0%)
	PGY1	4 (16.7%)
	PGY2	3 (12.5%)
	PGY3	1 (4.2%)
	PGY4	2 (8.3%)
	PGY5	2 (8.3%)
Dominant Hand (Right), n (%)		23 (95.8%)
Experience with computers, n (%)	Average	2 (8.3%)
	Slightly above average	3 (12.5%)
	Experienced	12 (50.0%)
	Very experienced	7 (29.2%)
Experience with touchscreen computers, n (%)	No experience	1 (4.2%)
	Somewhat experienced	2 (8.3%)
	Slightly below average	4 (16.7%)
	Average	6 (25.0%)
	Slightly above average	5 (20.8%)
	Experienced	4 (16.7%)
	Very experienced	2 (8.3%)
Experience with touchscreen devices, n (%)	Slightly above average	2 (8.3%)
	Experienced	9 (37.5%)
	Very experienced	13 (54.2%)
Experience using MedUrge (months), median (IQR)		36 (14–102)
Experience using Oacis (months), median (IQR)		49.5 (26–102)

TABLE 2 Physician demographics and experience (N=24).
IQR: 25th percentile–75th percentile. PGY: post-graduate year.

3.2 | Primary Results

Results from the mixed model regression analysis showed that, after adjusting for period, sequence of intervention, and the covariates of interest, there was no significant evidence to reject the hypothesis that the mean total times to complete all tasks in tandem were the same between the two interventions (p=0.08, Table 3). The adjusted total time to complete intervention means were 89.7 (SE 10.6) and 96.5 (SE 10.6) seconds. For the mouse WOW and touchscreen WOW, respectively, with a two-sided 95% CI of (-0.9, 14.5). Similar results were obtained for each task separately (Figure 1).

Results from the post-study questionnaire assessed along a 7-point Likert scale (Figure 1) demonstrated that the majority (>50%) of the participants agreed on all questions regarding attitude towards utilization (AU), behavioral intention to use (BU), perceived ease of use (PEOU), and perceived usefulness (PU) of the touchscreen WOW, except question PEOU5 and PU3. The Spearman's correlation coefficient between experience using touchscreen computers and ease of use of a touch-

Task Sequence	Time to Complete Intervention (seconds), Adjusted Mean (SE)			
	Mouse	Touchscreen	95% CI	p-value
Task 1. Open a triage note and identify blood pressure via MedUrge	3.1 (1.4)	3.5 (1.4)	0.4 (-0.3, 1.2)	0.35
Task 2. Open most recent patient chart via Oacis	6.2 (1.1)	5.7 (1.1)	-0.5 (-1.5, 0.4)	0.23
Task 3. Order CBC and CHEM7 bloodwork via Oacis	13.5 (4.8)	15.3 (4.8)	1.9 (-2.0, 5.8)	0.33
Task 4. Order chest x-ray imaging via Oacis	18.2 (3.0)	20.1 (3.0)	1.9 (-0.4, 4.2)	0.10
Task 5. Order acetaminophen medication via MedUrge	28.3 (5.4)	30.0 (5.4)	1.7 (-2.1, 5.6)	0.36
Task 6. Request coronary care unit consult via MedUrge	13.9 (2.6)	15.1 (2.6)	1.2 (-1.4, 3.9)	0.34
Task 7. Discharge patient home via MedUrge	6.7 (1.8)	6.8 (1.8)	0.1 (-0.7, 0.9)	0.76
Total Time	89.7 (10.6)	96.5 (10.6)	6.8 (-0.9, 14.5)	0.08

TABLE 3 Adjusted mean time elapsed to complete interventions.

screen WOW was found to be 0.6 (95% CI (0.2, 0.8)). The correlation between experience using Oacis and perceived usefulness of the touchscreen with WOW was -0.4 (95%CI (-0.7, -0.01)).

4 | DISCUSSION

To our knowledge, this is the first study to evaluate the impact of a touchscreen interface on workflow efficiency and perceived usability using a WOW and existing EMRs designed for non-touchscreens, mouse and keyboard interactions. Our study showed that in an environment simulating 7 commonly performed EMR tasks in the ED, there was no evidence to suggest a difference between the non-touchscreen and touchscreen WOW in terms of time to complete each task or all the tasks combined, while demonstrating an overall positive perceived benefit. On average, participants completed all the tasks (combined) faster the second time they performed them regardless of which apparatus was tested first. This is likely explained by participants' ability to become accustomed to the apparatus and perform tasks more efficiently in the subsequent trial. Indeed, despite having an average of approximately 5 years of experience using the EMRs through the standard, non-touchscreen WOW apparatus, the workflow efficiency of participants, ranging from year 1-5 resident and attending physicians, was not significantly impacted by switching from the standard to the touchscreen WOW. This suggests that if a touchscreen WOW is implemented in the ED, there likely will not be a meaningful obstacle of adjusting to the touchscreen. This can also be influenced by the carry-over effect, where exposure to the tasks during the first trial may facilitate the subsequent trial. Despite this effect, participants demonstrated consistent task completion rates across both methods by their second exposure. This study builds on previous work on touchscreen devices by specifically evaluating the usability and efficiency of touchscreen WOWs in a controlled, simulation-based setting, differentiating from prior studies on tablets at the bedside.

Our study, which showed no isolated difference in the average time to complete the combined tasks, suggests that more tasks could be performed on a touchscreen WOW at the bedside, without losing the efficiency of standard mouse and keyboard workstations. Therefore, a touchscreen interface is feasible and does not hinder the workflow or usability. Currently, the MUHC sites, presumably along with other sites healthcare institutions, have touchscreen devices being used

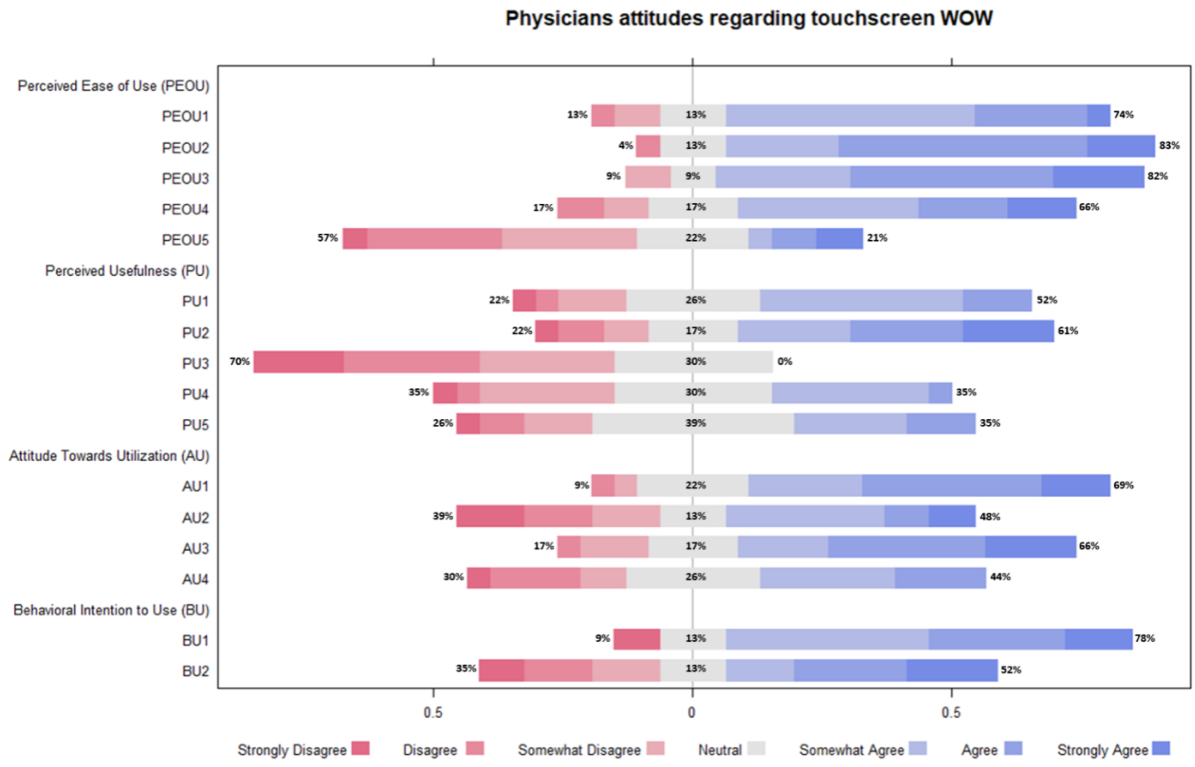

FIGURE 1 Physician attitudes regarding touchscreen WOW

with EMR systems designed for traditional input (keyboard and mouse). Indeed, touchscreen WOWs do not degrade or negatively impact physician performance, even though the EMR systems used were originally designed for use with a keyboard and mouse rather than a touchscreen.

Given that there were no differences in time to complete commonly performed ED tasks between the touchscreen and non-touchscreen WOW groups, further studies need to evaluate if touchscreen WOW may be an appropriate addition to facilitate ED workflow. In addition, allowing the users the option of using mouse, keyboard, and touchscreen could cater to individual preferences of which modality enables efficiency in the right context. Future studies could evaluate the impact on ED workflow of using all three modalities compared to the standard mouse and keyboard interactions. Perhaps customized interactions involving all three modalities may yield faster time to complete certain tasks in a simulated environment, or improve clinical efficiency.

Furthermore, our survey results demonstrated an overall perceived user benefit associated with the use of touchscreen WOWs based on the positive attitude towards utilization and intention to use the touchscreen WOW of resident and attending physicians. Interestingly, while the majority (>50%) of the participants agreed on the total perceived benefit of the touchscreen WOW, they did not find it is easier to use than the non-touchscreen WOW and did not feel that the touchscreen WOW would minimize errors. For all participants, this was their first interaction with the touchscreen WOW on EMRs they have been using with mouse and keyboard interactions for as long as 102 months (median MedUrge use = 36 months, median Oacis use = 50 months). Such an interaction, under a controlled, "testing" environment, can make participants more prone to errors.

The findings from the study were likely not influenced by participants' experience with touchscreen computers, as there was a balanced distribution of ex-

perience amongst participants. Though perhaps among cohorts with more experience with touchscreen computers, participants may complete tasks faster using a touchscreen than a non-touchscreen WOW. Furthermore, ad-hoc results suggest that users with more touchscreen experience are more likely to find the touchscreen addition to the standard WOW easier to use than those with less experience, evidenced by Spearman's correlation coefficient. We also found that users with more experience on a software (Oasis) traditionally designed for a non-touchscreen apparatus will be less likely to find the touchscreen addition useful. The correlation coefficient value (<0.60) suggests that there may be room for customization of the software to adapt to a touchscreen WOW, which perhaps over time, will enable users to perceive that the touchscreen WOW is indeed useful.

Our results add to the existing knowledge on touchscreen modalities in clinical practice. Results by Horng et al. (12) showed that the use of touchscreen tablet computers for direct patient care reduced physicians' time spent at the workstation by 38 minutes per shift, thereby potential increasing time by the bedside. However, their inferior operating capacity compared to computers limit their generalizability across powerful software such as EMRs, in addition to the EMRs lack of touchscreen design considerations (16). Further studies could investigate the workflow efficiency impact of tablet computers vs touchscreen WOWs in busy clinical environments such as the ED.

The existing EMRs user interface, developed more than a decade ago leveraged the design considerations that may seem intuitive with a mouse, but are not equally intuitive when using a touchscreen. Key design considerations include the size of clickable boxes, and radial buttons, both of which require larger target areas to facilitate touch screen interactions. Another key design issue is the use of the mouse left double click, and the mouse right click, which require a non-intuitive learning curve of using the double touch tap and the touch and hold, respectively to achieve the required interactions. These innate differences in user interface interactions of the touchscreen and mouse with the EMR (described in the methods section) likely contributed to outcomes from the study including participants' perceptions of ease of use and capacity to minimize errors of the touchscreen WOW. These specific differences in the functions between the touchscreen and mouse WOW were not tested and warrant further study to optimize user interactions with EMRs. In the current study, we were unable to change EMR user interfaces which were built for a mouse dominant, non-touchscreen WOW. However, the touchscreen interface interaction was found to be objectively similar to the standard non-touchscreen interface regarding workflow efficiency showing no significant differences in average time to complete tasks commonly done in the ED while demonstrating an overall positive perceived benefit. We recommend further studies to assess the impact of touchscreen WOW models on workflow efficiency and healthcare provider perceived benefit with modern EMRs who have interfaces that are designed to be touchscreen friendly.

We acknowledge some limitations of our study. The majority of the participants in the study were male, right-hand dominant, and had an average of 5 years of experience with Medurge and Oacis EMRs, likely making it relatively more challenging for experienced users accustomed to the use of the standard non-touchscreen WOW to operate a touchscreen WOW. This study was done in a simulated environment and does not reflect real clinical environment user experience. Although the testing environment used identical interfaces with different input methods (touchscreen versus non-touchscreen), this study uniquely isolates the impact of the touchscreen interface as implemented with existing EMR designs. While we did not track errors made by participants using each intervention, we encourage others to do so if essential.

5 | CONCLUSION

In this simulated ED environment, the use of a touchscreen WOW demonstrated adequate functionality. We were unable to find a significant difference between the non-touchscreen and touchscreen WOW in terms

of time to complete tasks, while showing an overall positive perceived benefit from resident and attending physicians in the ED. A touchscreen WOW may potentially replace a non-touchscreen WOW in the ED, but this requires more research with modern EMRs that have incorporated touchscreen user interface design considerations.

REFERENCES

1. Kellermann AL. Crisis in the emergency department. N Engl J Med. 2006 Sep 28;355(13):1300–3. DOI: 10.1056/NEJMp068194

2. Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. Ann Emerg Med. 2008 Aug;52(2):126–36. DOI: 10.1016/j.annemergmed.2008.03.014

3. Fatovich DM, Nagree Y, Sprivulis P. Access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia. Emerg Med J. 2005 May;22(5):351–4. DOI: 10.1136/emj.2004.018002

4. Geelhoed GC, Klerk NH. Emergency department overcrowding, mortality and the 4-hour rule in Western Australia. Med J Aust. 2012 Mar;196(4):1–1. DOI: 10.5694/mja11.11159

5. Sprivulis PC, Da Silva J-A, Jacobs IG, Frazer ARL, Jelinek GA. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. Med J Aust. 2006 Mar 6;184(5):208–12. DOI: 10.5694/j.1326-5377.2006.tb00202.x

6. Richardson DB. Increase in patient mortality at 10 days associated with emergency department overcrowding. Med J Aust. 2006 Mar 6;184(5):213–6. DOI: 10.5694/j.1326-5377.2006.tb00203.x

7. Guttmann A, Schull MJ, Vermeulen MJ, Stukel TA. Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada. BMJ. 2011 Jun 1;342:d2983. DOI: 10.1136/bmj.d2983

8. Viccellio A, Santora C, Singer AJ, Thode HC Jr, Henry MC. The association between transfer of emergency department boarders to inpatient hallways and mortality: a 4-year experience. Ann Emerg Med. 2009 Oct;54(4):487–91. DOI: 10.1016/j.annemergmed.2009.03.006

9. Innes GD, Sivilotti MLA, Ovens H, McLelland K, Dukelow A, Kwok E, et al. Emergency overcrowding and access block: A smaller problem than we think. CJEM. 2019 Mar;21(2):177–85. DOI: 10.1017/cem.2018.433

10. Wu X, Xi T. Study on Design Principle of Touch Screen with an Example of Chinese-Pinyin 10 Key Input Method in iPhone. In: Advances in Ergonomics in Design. Springer International Publishing; 2016. p. 639–50. DOI: 10.1007/978-3-319-41983-1_70

11. Travis C, Murano P. A comparative study of the usability of touch-based and mouse-based interaction. Int J Pervasive Comput Commun. 2014 Apr;10(1):115–34. DOI: 10.1108/IJPCC-01-2014-0012

12. Horng S, Goss FR, Chen RS, Nathanson LA. Prospective pilot study of a tablet computer in an Emergency Department. Int J Med Inform. 2012 May;81(5):314–9. DOI: 10.1016/j.ijmedinf.2012.01.002

13. Gates S, Ealing E. Reporting and interpretation of results from clinical trials that did not claim a treatment difference: survey of four general medical journals. BMJ Open. 2019 Sep;9(9):e024785. DOI: 10.1136/bmjopen-2018-024785

14. Cohen J. Statistical Power Analysis for the Behavioral Sciences [Internet]. 2013. Available from: http://dx.doi.org/10.4324/9780203771587

15. Adams DA, Nelson RR, Todd PA. Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication. Miss Q. 1992;16(2):227–47. DOI: 10.2307/249577

16. Orphanides AK, Nam CS. Touchscreen interfaces in context: A systematic review of research into touchscreens across settings, populations, and implementations. Appl Ergon. 2017 May;61:116–43. DOI: 10.1016/j.apergo.2017.01.014

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COMMENTARY

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Understanding Lessons From the COVID-19 Pandemic in Creating Healthcare Initiatives for Indigenous Populations

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ABSTRACT

Over the course of the pandemic, Indigenous peoples in Canada experienced firsthand the devastating impact of COVID-19. Despite facing challenges, Indigenous communities, with the support of government organizations, were able to limit the spread of the SARS-CoV-2. Forming collaborative initiatives and integrating Indigenous medicinal practices with public health approaches shows promise in our ability to create effective and culturally-informed healthcare policies.

KEYWORDS
Public Health, Health Policy, Indigenous Health

1 | BACKGROUND

From providing support to affected individuals to regulating public health policy, the resilience of healthcare systems worldwide continues to be tested by the COVID-19 pandemic. As of November 2023, there have been a total of 4.8 million documented coronavirus cases in Canada. (1) However, it is important to consider how different populations in Canada were impacted because the burden of disease was not equally shared. More specifically, COVID-19 cases were 188% greater for on-reserve First Nation community members compared to the general population in Canada. (2) Moreover, Indigenous peoples presented with significantly higher rates of COVID-19 symptoms compared to those with non-Indigenous status (49.3% versus 42.9%, re-

spectively, p = 0.04). (3) This may have occurred due to structural and systemic factors faced by Indigenous peoples such as poverty, crowded housing, and limited access to healthcare, making them more susceptible to contracting COVID-19. (4, 5) Their increased vulnerability justifies the need for additional resources to contain the virus and limit its devastating effects, with efforts from the government and local Indigenous communities. In this perspective article, we highlight some of the initiatives, reflecting on the lessons learned from these positive action responses that can ultimately be implemented in the future.

2 | COVID-19'S DIFFERENTIAL IMPACT

The COVID-19 pandemic appears to have exacerbated existing disparities with regards to providing healthcare to minority groups. Overall, compared to majority ethnocultural groups, ethnic minorities and immigrants in North America reported higher rates of COVID-19 infection, hospitalization and death, and higher levels of distress and mental health issues. (6) Looking beyond Canada, comparisons can be drawn between Indigenous communities across the world. Indigenous peoples in Canada, when compared to Australia, New Zealand, and the United States, were estimated to have the highest percentage of complete vaccinations. (7) Taking this into consideration, it may be argued that Canada's Indigenous peoples were better equipped to handle the pandemic compared to those in other developed countries. We propose that due to the Canadian government's response in providing financial resources, along with community-led initiatives, the Indigenous peoples of Canada were able to better mitigate some of the adverse effects of the pandemic.

3 | GOVERNMENT-LED PANDEMIC RESPONSE INITIATIVES

The Canadian government developed a specific supportive response for Indigenous communities during the COVID-19 pandemic. Specifically, the government established an Indigenous Community Support Fund ($290 million) and research grants targeting COVID-19 in Indigenous communities ($3 million). (7) However, such responses were observed in other countries as well, which raises the question of what specifically might have led to Canada's relatively high vaccination rates among this group. A major factor was the collaborative efforts between Indigenous groups and provincial governments. For example, First Nations organizations such as the First Nations Health and Social Secretariat of Manitoba (FNHSSM), Assembly of Manitoba Chiefs, Southern Chiefs Organization, and Manitoba Keewatinowi Okimakanak Inc. worked together with the province of Manitoba to establish a First Nations Pandemic Response Coordination Team (PRCT). The First Nations PRCT deployed teams of nurses and other health professionals from the FNHSSM to assist First Nation communities with COVID-19 testing and contact tracing. (7) The lack of consistent and reliable data has and continues to be a limiting factor when organizing public health initiatives, but the PRCT's swift negotiation and enactment to allow access to First Nations surveillance data may have played a pivotal role in addressing the data issue. (7) We believe that the Canadian government's approach strengthened existing and fostered new relationships that should last beyond the pandemic. These alliances may be used to tackle other healthcare challenges in Indigenous communities, such as healthcare accessibility and youth mental health. Ultimately, we believe that combatting the pandemic using a combination of both public health and Indigenous knowledge appears to have catalyzed Canada's success in reaching vaccination goals among Indigenous communities. Indeed, though financial resources are important, it would have proved difficult to tackle health-centric issues without cultural consultation, community support, and the integration of Indigenous peoples' perspectives.

4 | COMMUNITY-LED PANDEMIC RESPONSE INITIATIVES

Although government-led initiatives were crucial in achieving vaccination goals, vaccinations only played a partial role in helping limit the spread of coronavirus. In addition to the government-led responses, Indigenous peoples in Canada implemented several successful community-led initiatives. Local groups created culturally-relevant public health measures and campaigns. For example, the Nishnawbe Aski nation produced handwashing posters and instructions in various languages. (2) Several Indigenous communities also asserted community health orders that best aligned with their needs. Fort McKay First Nation and Peerless Trout First Nation implemented curfews and reduced the number of community gatherings, with the goal of protecting vulnerable members. (2) Inuit communities in Manitoba employed similar curfews, but acknowledging their profound impact on community cohesion, they creatively began adapting community events to virtual settings. The Qanuinngitsiarutiksait hosted three virtual events around the holiday season in 2020, which were deemed successful considering the sizable number of attendees. (8) Lastly, communities also formed local task forces to assist in regulating mandates and supporting self-isolation. Uniquely, Curve Lake First Nation used a flag system that allowed families to communicate if their household needed water, food, or had a sick member. (2)

Such strategies were also fueled by a unique motivation among many Indigenous communities to protect their Elders and other older Indigenous community members facing a higher risk of fatality from COVID-19. Their pivotal roles in maintaining Indigenous languages, as well as intergenerational teaching and passing down of meaningful cultural practices, were emphasized by Indigenous scholars and leaders when planning for the pandemic. This may have encouraged Canadians to partake in immunization efforts to reap the benefits of herd immunity and experience less severe symptoms. (9, 10)

Furthermore, Indigenous knowledge of cultural and healing practices and traditional subsistence activities were used to complement the implementation of vaccination efforts, as well as promote mask mandates and curfews during social gatherings. This helped in achieving the vision of whole-being health by prioritizing resilience through emotional, mental, spiritual, and physical support throughout the pandemic. (11) According to Petrov et al., (11) Indigenous peoples' testimonies further support this as they significantly attributed the regulation of the spread of COVID-19 among their communities to such holistic efforts.

It is also important to acknowledge the improvements made in pandemic planning. In the initial stages of the pandemic, there was insufficient COVID-19-related information and a lack of accurate representation felt by specific Indigenous communities, making it difficult to strategically develop a pandemic response plan. (8) However, with research teams incorporating Indigenous community members and local initiatives collaborating with Indigenous Elders, unique community needs were better voiced, understood, and thus accordingly planned for. For example, the Inuit community in Manitoba achieved better recognition through the pandemic, which partially led to their inclusion in Manitoba's Legislative Assembly's land recognition statement. (12) This is crucial when taking into consideration that, according to Nigel et al., Indigenous populations perceived the pandemic to be more of a threat to their culture, compared to other populations who deemed it as more of a health or material threat. This view made it even more important to better understand Indigenous cultures to help them fight the pandemic. Since it is valued deeply by Indigenous peoples, respecting and adapting practices to specific Indigenous cultures is an important lesson that can be extrapolated to projects beyond just pandemic planning.

Therefore, although the government provided funding and vaccines during the pandemic, we strongly believe that these local initiatives supplemented the government's efforts while also demonstrating the resilience and sovereignty of Indigenous communities in Canada. In the future, we propose that the government should directly attempt to support such initiatives in conjunction with the local groups to facilitate the imple-

mentation and improve the efficacy of health-focused programs.

5 | CONCLUSION

The collaborative efforts between public and Indigenous health organizations took steps in the right direction in addressing healthcare disparities during the COVID-19 pandemic. It seems evident that forming effective healthcare policies requires a complementary balance between government-led programs and proactive action led by local Indigenous communities. Further studies should be conducted to identify key factors and stakeholders that facilitated successful collaborative efforts and assess their applicability in future pandemic and non-pandemic settings.

REFERENCES

1. Canada PHA of. aem. 2020 [cited 2022 Jun 27]. COVID-19 daily epidemiology update. Available from: https://health-infobase.canada.ca/covid-19/

2. Benji J, Tomasky G, Kaufman K, Miles R. Impacts of COVID-19 on Indigenous Communities in Canada. The Health & Fitness Journal of Canada. 2021;14(4):22–34. doi: 10.14288/hfjc.v14i4.358

3. Lapointe-Shaw L, Rader B, Astley CM, Hawkins JB, Bhatia D, Schatten WJ, et al. Web and phone-based COVID-19 syndromic surveillance in Canada: A cross-sectional study. PLOS ONE. 2020 Oct 2;15(10):e0239886. doi: 10.1371/journal.pone.0239886

4. Paula Arriagada, Hahmann, Tara, O'Donnell, Vivian. Indigenous people in urban areas: Vulnerabilities to the socioeconomic impacts of COVID19. Statistics Canada [Internet]. 2020 May 26; Available from: https://publications.gc.ca/site/eng/9.887759/publication.html

5. Government of Manitoba. COVID-19: race, ethnicity, indigeneity (REI) analysis Wave three. Available from: https://www.gov.mb.ca/health/publichealth/surveillance/docs/rei_analysis_w3.pdf

6. Lou NM, Noels KA, Zhang YSD, Kurl S. Ethnic minority, immigrants, and Indigenous people's well-being disparities in Canada during the COVID-19 pandemic: The mediating role of threat perceptions. Int J Intercult Relat. 2022 May;88:148–56. doi: 10.1016/j.ijintrel.2022.04.006

7. Clark, T. C., Best, O., Bourque Bearskin, L., Wilson, D., Power, T., Phillips-Beck, T., et al. COVID-19 among Indigenous communities: Case studies on Indigenous nursing responses in Australia, Canada, New Zealand, and the United States. Nursing Praxis in Aotearoa New Zealand. 2021;37(3), 71-83. doi: 10.36951/27034542.2021.037

8. Lavoie JG, Clark W, McDonnell L, Nickel N, Dutton R, Kanayok J, et al. Mitigating the impact of the COVID-19 pandemic on Inuit living in Manitoba: community responses. Int J Circumpolar Health. 82(1):2259135. doi: 10.1080/22423982.2023.2259135

9. Kaplan HS, Trumble BC, Stieglitz J, Mamany RM, Cayuba MG, Moye LM, et al. Voluntary collective isolation as a best response to COVID-19 for indigenous populations? A case study and protocol from the Bolivian Amazon. The Lancet. 2020 May 30;395(10238):1727–34. doi: 10.1016/S0140-6736(20)31104-1

10. Nelson SE. Older Indigenous people, Elders, and planning in Canada: a call for thoughtful engagement. 2021 Jul;10–3. doi: 10.25316/IR-18037

11. Petrov AN, Welford M, Golosov N, DeGroote J, Devlin M, Degai T, et al. Lessons on COVID-19 from Indigenous and remote communities of the Arctic. Nat Med. 2021 Sep;27(9):1491–2. doi: 10.1038/s41591-021-01473-9

12. Land Acknowledgement [Internet]. [cited 2023 Dec 5]. Available from: https://www.gov.mb.ca/legislature/about/land_acknowledgement.html

COMMENTARY
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Information Management During A Complex Meta-Analysis Project: A Practical Guide for Organizing Data Extraction

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ABSTRACT

Information management is a key part of conducting a systematic review and meta-analysis. Preferred Reporting Items for Systematic Reviews and Meta-Analyses clearly summarizes essential steps during the meta-analytic project and their reporting. Preparing for data extraction is generally suggested to be done at the stage of the protocol. However, in complex projects that aim to synthesize data from studies performed over a long time period or with a wide variability in study protocols, it is often impossible to fully account for all variations in data presentation before completing the full text screening. Here, we describe a protocol to methodically consider different aspects of the selected studies in order to update the data extraction template for the meta-analytic portion of the project. The protocol incorporates a process of identifying and removing non-compatible studies prior to the extraction of study-level outcomes, which is important for avoiding a potential confirmation bias. Using this protocol in combination with a pre-established data coding scheme simplifies data extraction and informs the subsequent meta-analysis.

KEYWORDS
Meta-analysis, Protocol, Spacefight, Data Management

1 | INTRODUCTION

Conducting a systematic review and meta-analysis is a complex process that requires significant organizational efforts (1-3). Many steps of this process are described in detail and clearly summarized in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist (4), including steps for data extraction and coding (3) for which several specific protocols, such as TIDieR (5) and DECiMAL (6), have been developed. It is generally advised to specify data extraction items before the full text reviews (3). However, this requires a prior knowledge of all the relevant data types and dimensions which is not always possible, especially in projects with significant variability in individual study protocols, specific parameters that measure the

outcomes, or methodology used in different papers. In our experience, such projects involved studies analyzing data from a long time period with historical changes in experimental approaches (7-11), as well as projects aimed at summarizing the findings from basic science studies that use a variety of study designs aimed to understand the same or similar outcomes (12-14). Importantly, this variability often only becomes apparent after the full text inclusion is complete, making it difficult to prepare for this challenge. Having completed multiple meta-analytic projects on a diverse number of subjects (8, 10, 12-14), we report the protocol we developed to methodically screen the full text studies and update the coding table for extracting parameters for meta-analysis.

2 | THE PLACE OF THIS PROTOCOL IN THE META-ANALYSIS PROJECT

In meta-analytical projects, the authors expect that quantitative data are available for their research question. After screening the studies retrieved from the relevant databases, the researchers arrive to a set of full text papers that can be small (7), reasonable with <50 studies (13-15), or quite large with 50-200 studies (8-10, 12). Even when the number of papers is small, each paper may contain multiple independent datasets of interest, such as measurements in different age, sex, or disease populations (13, 15). Further, the research question may be answered with a variety of different outcomes (7, 9, 15), dramatically increasing the complexity of information management. While general guidelines suggest that the next step is data extraction into the pre-defined coding tables, in many complex projects it is time-intensive, frustrating, and premature to engage in extraction of outcome measures at this stage. Instead, we suggest employing the following strategy that allows to update/develop coding tables focusing on the information most important for the meta-analysis project, while identifying incompatible studies prior to extraction of outcomes. This approach is important to prevent potential confirmation bias; that is, removing data that do not fit the hypothesis.

2.1 | STEP 1: Record key study characteristics and types of outcomes reported

With selected full texts retrieved, the key identifying characteristics of each study should be recorded such as: the author, year it was conducted, country where it was conducted, sample size, study type, population characteristics, etc. If PICO framework (P: Patient, problem or population, I: Intervention, C: Comparison, control or comparator; O: Outcome) (16) is used, this step focuses on the P of PICO. Assessment of study quality should be initiated as planned, in general using one of the established quality assessment tools that addresses potential biases relevant to their research question (2, 17). In addition, potential shortcomings of reporting specific to the current project may become apparent and can be included in the updated quality assessment checklist. The table resulting from this stage of analysis provides a general overview of the available information. Table 1 generated from our study of bone health in spacefaring rodents (9) illustrates how details important for the research project, such as the space mission, the year it was conducted, mission duration, the number of samples, and the bones measured were summarized. Please note, that while the coding table designed prior to the start of the project would always include general information (author, year, space mission), other details (such as the fact that different bone were analyzed in different studies) may not be known prior to full text analysis and are included at this stage.

2.2 | STEP 2: Identify studies reporting duplicate/overlapping information

In a systematic review, the reviewers may encounter several articles that report the outcomes of the same studies/populations that may not be apparent without careful analysis of full text articles. This may happen when the same results are reported together with dif-

ferent aspects of the whole study (8),when the updates for the same population are published during continuous recruitment (8), or when the same dataset is used for normalizing in the studies focused on different outcomes (18). While some authors clearly identify when the same findings are reported in subsequent papers, more often publications are treated as self-contained, and the reviewer needs to ensure that the datasets included in the meta-analysis are independent. Analyzing the table produced in the previous step helps to identify potentially overlapping studies that were conducted in the same year or location, have the same sample size, report identical measurement outcomes, etc. In our example (Table 1), the results of three space missions, STS-131, Bion-M1 and CRS10, were reported in multiple manuscripts. Comparison of the reported measurements demonstrates that Maupin et al. 2019 (19) and Dadwal et al. 2019 (20) report the outcomes in the same set of bones, while other studies report the parameters for different bones from the animals that went on the same missions. When two articles report overlapping data, one of the articles should be excluded from the meta-analysis based on a pre-defined criteria (for example, the one that includes less information, exhibits lower reporting quality, or achieves a lower quality score).

2.3 | STEP 3: Select parameters for analysis

Now we can determine which parameters have been reported in enough studies for meta-analysis and which measurements are compatible. If the dataset contains many different parameters, we suggest generating a new table where each parameter has its own column (Table 2). The same parameters can be given different names in different studies (due to different conventions in different groups or historical changes in nomenclature). Similarly, the same name can be given to different parameters. The same or similar parameters can also be measured using different methods. Keeping track of parameter definitions, measurement units and techniques allows to distinguish between different effect sizes. The table generated at this step allows to determine the number of instances the study-level outcomes are reported for each parameter, and thus the feasibility of a meta-analysis for different parameters. From the example in the Table 2, there is enough studies for meta-

Author, Year	Space Mission	Year	N	Bones Analyzed
Lloyd et al. 2015(21)	STS-108	2001	12	Vertebrae, Humerus, Femur, Tibia
Ortega et al. 2013(22)	STS-118	2007	13	Femur, Tibia
Tavella et al. 2012(23)	MDS	2009	3	Femur
Blaber et al. 2013(24)	STS-131	2010	15	Pelvis
Blaber et al. 2014(25)	STS-131	2010	15	Femur
Berg-Johansen et al. 2016(26)	Bion-M1	2013	30	Caudial vertebrae
Gerbaix et al. 2017(27)	Bion-M1	2013	30	Lumbar vertebrae, Femur
Gerbaix et al. 2018(28)	Bion-M1	2013	30	Calcaneus, Navicular, Talus
Shiba et al. 2017(29)	CRS-9	2016	12	Femur
Dadwal et al. 2019(20)	CRS-10	2017	10	Sternum, Vertebra, Tibia, Humerus
Maupin et al. 2019(19)	CRS-10	2017	28	Sternum, Vertebrae, Tibia, Humerus, Femur,
Tominari et al. 2019(30)	CRS-12	2017	3	Humerus, Tibia

TABLE 1 Example of the table describing details of the studies selected after full text screening for the project examining the effect of spaceflight on mouse bone tissue (9).

Author, Year	Space Mission	Bone Volume Fraction (BV/TV)	Marrow Area (Ma.Ar)	Cortical Porosity (Ct.Po)
Lloyd et al. 2015(21)	STS-108	Humerus, Tibia (NS)		
Ortega et al. 2013(22)	STS-118	Femur, Tibia (NS)		
Tavella et al. 2012(23)	MDS			
Blaber et al. 2013(24)	STS-131	Pelvis (%)		
Blaber et al. 2014(25)	STS-131	Femur (%)	Femur (mm^2)	Femur (%)
Berg-Johansen et al. 2016(26)	Bion-M1	Vertebrae (C) (%)		
Gerbaix et al. 2017(27)	Bion-M1	Vertebrae (L3,T12), Femur (%)	Femur (mm^2)	
Gerbaix et al. 2018(28)	Bion-M1	Calcanius, Talus Navicular, (%)		Calcaneus, Talus Navicular, (%)
Shiba et al. 2017(29)	CRS-9	Femur (%)		
Maupin et al. 2019(19)	CRS-10	Sternum, Tibia, Vertebrae (L4), Humerus (%)	Rib, Humerus, Femur, Tibia (mm^2)	
Tominari et al. 2019(30)	CRS-12	Humerus, Tibia (%)		
Number of Missions		**7**	**3**	**2**

TABLE 2 Example of the table describing several parameters reported in the studies selected to assess the effect of spaceflight on mouse bone tissue (9).

analysis of bone volume fraction in humerus, tibia, and femur and of marrow area in femur. However, there are only two datasets reporting cortical porosity in different bones. Thus, cortical porosity can be removed from the list of parameters to extract for analysis.

After candidate parameters for meta-analysis with at least three study-level outcomes are selected, we can determine whether measurements reported in different studies are compatible by comparing their measurement units and techniques. Ideally, the outcomes in all studies were obtained using the same methodology and reported on the same scale. However, in practice this may not be so, since meta-analyses often include papers performed at different times and places. Researcher must exhibit autonomous judgement for excluding certain studies as not compatible or choosing to combine the data while keeping track of implied assumptions and looking for opportunities to test them. For example, the relative amount of bone tissue (Bone volume/tissue volume, BV/TV %) can be obtained from 2-dimentional histological measurements or from 3-dimentional computed tomography. The studies reporting these outcomes could be designated as non-compatible, or the researchers can decide to combine them and explore in subgroup analysis if this introduces significant heterogeneity (7). At the end of this step, the set of parameters that will be included in meta-analysis is determined. All articles originally selected that do not report the chosen parameters or report incompatible outcomes (such as Tavella et al. 2012 in Table 2) will be excluded.

2.4 | STEP 4: Define important covariates

With a good idea about the content of selected studies, now the reviewer should update the coding table for the covariates that can potentially affect the outcome. While key parameters can generally be identified before the start of the project, now, when the differences between the included studies are recorded, ad-

ditional covariates may come into focus. Such covariates may be relevant to the specifics of included studies, such as genetic variants, surgery, treatment, measurement techniques, etc. Some covariates may make the data incompatible with the rest of the dataset, for example when something had happened in a small subset of studies and is biologically plausible to create significant difference in the outcome. The reviewer may decide to remove such articles as incompatible. The extraction table should be updated to include all the important covariates, which then can be analyzed during the meta-analytic study. The quality assessment checklist can also be updated for the quality of reporting of additional covariates.

2.5 | STEP 5: Extract relevant information, assess compatibility, and remove inconsistent reporting

Finally, the researcher has a template for extracting information regarding participants (step 1-2), outcomes (step 3) and covariates (step 4). It is a good practice to test this form by two independent reviewers, who later discuss disagreements and then adjust the form if necessary. Using the finalized template, the information can be extracted from all the papers, now together with the quantitative data for the study level outcomes and associated variance. Next, when the quantitative study-level outcomes are available and necessary data transformation is performed to ensure that units of measurements are consistent, we recommend checking for drastically different values. While it is wrong to exclude the study based on the difference in reported values, this may also be an indication of data extraction error. If no typing error was found, one should also check for potential discrepancy between the description and values given in the original paper, as mistakes in reporting do happen (we have encountered a study reporting a parameter as “normal”, yet the value was at least 1000-fold higher than normal). Attempts should be made to contact the author(s) and clarify these discrepancies. If efforts to contact the original authors are unsuccessful, it is safer to exclude the measured outcome or study than to make additional assumptions regarding the values. Final additions to the quality assessment checklist can now be made for the quality of the outcome reporting. Completing this step will result in having a dataset ready for quantitative synthesis using the meta-analytic model of your choice.

3 | CONCLUSION

We describe a protocol for information management during meta-analysis projects addressing research questions that involve variability in individual study approaches or methodologies that measure the outcomes. Such questions are more likely to arise in meta-analysis of basic science studies (2), which often employ exploratory methods rather than standardized clinical outcomes, and thus require a more open approach for managing the information to be included in the meta-analysis. Because of an open information management, the reviewers should at every step be cognizant of potential bias in their assessment, and carefully record the reasons for the exclusion of an individual study from the meta-analysis. Our protocol provides methodical guidelines for such an assessment, highlights potential difficulties that the reviewers may encounter, and suggests ways to address these difficulties in a clear unbiased way.

4 | DECLARATION OF CONFLICTING INTERESTS

The Authors declare that there is no conflict of interest.

REFERENCES

1. Borenstein M, Higgins JP. Meta-analysis and subgroups. Prevention science : the official journal of the Society for Prevention Research. 2013;14(2):134-43. DOI:10.1007/s11121-013-0377-7

2. Mikolajewicz N, Komarova SV. Meta-Analytic Methodology for Basic Research: A Practical Guide. Front Physiol. 2019;10:203. DOI:10.3389/fphys.2019.00203

3. Johnson BT, Hennessy EA. Systematic reviews and meta-analyses in the health sciences: Best practice methods for research

syntheses. Social science & medicine (1982). 2019;233:237-51. DOI:10.1016/j.socscimed.2019.05.035

4. Page MJ, Moher D, McKenzie JE. Introduction to preferred reporting items for systematic reviews and meta-analyses 2020 and implications for research synthesis methodologists. Research synthesis methods. 2022;13(2):156-63. DOI:10.1002/jrsm.1535

5. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ (Clinical research ed). 2014;348:g1687. DOI:10.1136/bmj.g1687

6. Pedder H, Sarri G, Keeney E, Nunes V, Dias S. Data extraction for complex meta-analysis (DECiMAL) guide. Systematic reviews. 2016;5(1):212. DOI:10.1186/s13643-016-0368-4

7. Steer K, Stavnichuk M, Morris M, Komarova SV. Bone Health in Patients With Hematopoietic Disorders of Bone Marrow Origin: Systematic Review and Meta- Analysis. J Bone Miner Res. 2017;32(4):731-42. DOI:10.1002/jbmr.3026

8. Stavnichuk M, Mikolajewicz N, Corlett T, Morris M, Komarova SV. A systematic review and meta-analysis of bone loss in space travelers. NPJ Microgravity. 2020;6:13. DOI:10.1038/s41526-020-0103-2

9. Fu J, Goldsmith M, Crooks SD, Condon SF, Morris M, Komarova SV. Bone health in spacefaring rodents and primates: systematic review and meta-analysis. NPJ Microgravity. 2021;7(1):19. DOI:10.1038/s41526-021-00147-7

10. Goldsmith M, Crooks SD, Condon SF, Willie BM, Komarova SV. Bone strength and composition in spacefaring rodents: systematic review and meta-analysis. NPJ Microgravity. 2022;8(1):10. DOI:10.1038/s41526-022-00195-7

11. Moussa MS, Goldsmith M, Komarova SV. Craniofacial Bones and Teeth in Spacefarers: Systematic Review and Meta-analysis. JDR Clin Trans Res. 2022:23800844221084985. DOI:10.1177/23800844221084985

12. Mikolajewicz N, Mohammed A, Morris M, Komarova SV. Mechanically stimulated ATP release from mammalian cells: systematic review and meta-analysis. J Cell Sci. 2018;131(22). DOI:10.1242/jcs.223354

13. McKee TJ, Perlman G, Morris M, Komarova SV. Extracellular matrix composition of connective tissues: a systematic review and meta-analysis. Sci Rep. 2019;9(1):10542. DOI:10.1038/s41598-019-46896-0

14. Dsouza C, Komarova SV. Characterization of Potency of the P2Y13 Receptor Agonists: A Meta-Analysis. Int J Mol Sci. 2021;22(7). DOI:10.3390/ijms22073468

15. Mikolajewicz N, Bishop N, Burghardt AJ, Folkestad L, Hall A, Kozloff KM, et al. HR-pQCT Measures of Bone Microarchitecture Predict Fracture: Systematic Review and Meta-Analysis. J Bone Miner Res. 2020;35(3):446-59. DOI:10.1002/jbmr.3901

16. Schardt C, Adams MB, Owens T, Keitz S, Fontelo P. Utilization of the PICO framework to improve searching PubMed for clinical questions. BMC Med Inform Decis Mak. 2007;7:16. DOI:10.1186/1472-6947-7-16

17. Buccheri RK, Sharifi C. Critical Appraisal Tools and Reporting Guidelines for Evidence-Based Practice. Worldviews Evid Based Nurs. 2017;14(6):463-72. DOI:10.1111/wvn.12258

18. Mikolajewicz N, Sehayek S, Wiseman PW, Komarova SV. Transmission of Mechanical Information by Purinergic Signaling. Biophys J. 2019;116(10):2009-22. DOI:10.1016/j.bpj.2019.04.012

19. Maupin KA, Childress P, Brinker A, Khan F, Abeysekera I, Aguilar IN, et al. Skeletal adaptations in young male mice after 4 weeks aboard the International Space Station. npj Microgravity. 2019;5(1):21. DOI:10.1038/s41526-019-0081-4

20. Dadwal UC, Maupin KA, Zamarioli A, Tucker A, Harris JS, Fischer JP, et al. The effects of spaceflight and fracture healing on distant skeletal sites. Scientific Reports. 2019;9(1):11419. DOI:10.1038/s41598-019-47695-3

21. Lloyd SA, Morony SE, Ferguson VL, Simske SJ, Stodieck LS, Warmington KS, et al. Osteoprotegerin is an effective countermeasure for spaceflight-induced bone loss in mice. Bone. 2015;81:562-72. DOI:10.1016/j.bone.2015.08.021

22. Ortega AM, Bateman TA, Livingston EW, Paietta RC, Gonzalez SM, Stodieck LS, et al. Spaceflight Related Changes in Structure and Strength of Mouse Trabecular and Cortical Bone From the STS-118 Space Shuttle Mission. Proceedings of ASME 2013 Summer Bioengineering Conference; Sunriver, Oregon, USA. V01AT08A0052013.

23. Tavella S, Ruggiu A, Giuliani A, Brun F, Canciani B, Manescu A, et al. Bone turnover in wild type and pleiotrophin-transgenic mice housed for three months in the International Space Station (ISS). PLoS One. 2012;7(3):e33179. DOI:10.1371/journal.pone.0033179

24. Blaber EA, Dvorochkin N, Lee C, Alwood JS, Yousuf R, Pianetta P, et al. Microgravity induces pelvic bone loss through osteoclastic activity, osteocytic osteolysis, and osteoblastic cell cycle inhibition by CDKN1a/p21. PLoS One. 2013;8(4):e61372. DOI:10.1371/journal.pone.0061372

25. Blaber EA, Dvorochkin N, Torres ML, Yousuf R, Burns BP, Globus RK, et al. Mechanical unloading of bone in microgravity reduces mesenchymal and hematopoietic stem cell-mediated tissue regeneration. Stem Cell Research. 2014;13(2):181-201. DOI:10.1016/j.scr.2014.05.005

26. Berg-Johansen B, Liebenberg EC, Li A, Macias BR, Hargens AR, Lotz JC. Spaceflight-induced bone loss alters failure mode and reduces bending strength in murine spinal segments. J Orthop Res. 2016;34(1):48-57. DOI:10.1002/jor.23029

27. Gerbaix M, Gnyubkin V, Farlay D, Olivier C, Ammann P, Courbon G, et al. One-month spaceflight compromises the bone microstructure, tissue-level mechanical properties, osteocyte survival and lacunae volume in mature mice skeletons. Sci Rep. 2017;7(1):2659. DOI:10.1115/SBC2013-14785

28. Gerbaix M, White H, Courbon G, Shenkman B, Gauquelin-Koch G, Vico L. Eight Days of Earth Reambulation Worsen

Bone Loss Induced by 1-Month Spaceflight in the Major Weight-Bearing Ankle Bones of Mature Mice. Front Physiol. 2018;9:746. DOI:10.3389/fphys.2018.00746

29. Shiba D, Mizuno H, Yumoto A, Shimomura M, Kobayashi H, Morita H, et al. Development of new experimental platform 'MARS'-Multiple Artificial-gravity Research System-to elucidate the impacts of micro/partial gravity on mice. Scientific reports. 2017;7(1):10837. DOI:10.1038/s41598-017-10998-4

30. Tominari T, Ichimaru R, Taniguchi K, Yumoto A, Shirakawa M, Matsumoto C, et al. Hypergravity and microgravity exhibited reversal effects on the bone and muscle mass in mice. Sci Rep. 2019;9(1):6614. DOI:10.1038/s41598-019-42829-z

APPROACH TO

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Syncope

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ABSTRACT

Syncope, the transient and abrupt loss of consciousness with spontaneous recovery, is estimated to make up 1% of all emergency department presentations in Canada. (1) Syncopal cases are enigmatic as patients frequently present themselves as fully recovered from the episode, even though its etiology can still be present and life-threatening. It is up to the clinician to conduct a strong history, physical exam and the appropriate follow-up investigations to confirm a diagnosis. This Approach To article aims to provide an overview and step-wise approach to diagnosing and managing a syncopal presentation.

KEYWORDS
Syncope, TLOC, Cardiac, Orthostatic, Reflex-mediated, Vaso-vagal

1 | QUESTION

A 20-year-old college student presents to the ER for a recent episode of loss-of-consciousness. He had a stressful morning preparing for finals week and grabbed a latte at his local coffee shop before heading to school with his best friend. While standing in line, he began feeling sweaty and nauseous, followed by the sensation of "the world blacking out" before him. He woke up surrounded by people and immediately wondered why they crowded around him. This event has never happened to him before. His friend denies witnessing any tongue biting, incontinence, movement, or injury to the head. The event lasted seconds, and the patient could tell where he was upon waking.

Upon further questioning, he is otherwise healthy, has had no previous surgeries, and does not take medication. Both his parents have high blood pressure, and

Abbreviations: TLOC, transient loss of consciousness.

his maternal grandmother died from a heart attack at age 76. He drinks alcohol occasionally with friends on weekends, does not smoke, and denies consuming illicit drugs.

In the ER, his vital signs are as follows: BP: 127/76, HR: 87, RR: 14, SPO2: 99%, T: 36.4. After 5 minutes in the supine position, his blood pressure was 130/85 mmHg. Immediately after, in the sitting position, his blood pressure was 128/80 and 127/79 when asked to stand upright. His physical exam is unremarkable. What is the next best step?

A. No further testing is needed; reassure the patient and send them home.
B. Order an ECG.
C. Order an EEG.
D. Order a chest X-ray.
E. Order an echocardiogram.

The answer will be addressed at the end of the article, but first, let us explore the approach to syncope.

2 | INITIAL APPROACH

Syncope is a transient, self-limited event with an inability to maintain tone due to acute global cerebral hypoperfusion and is a classification that is part of the umbrella term: transient loss of consciousness (TLOC). (2) The diagnostic approach of syncope specifically, focuses on excluding whether the patient's presentation is due to the other causes of TLOC including, intoxications, metabolic disorders (hypoxemia, hypercapnia and hypoglycemia), psychogenic (subdivided into Psychogenic non-epileptic seizures and psychogenic pseudosyncope) and neurologic mimicker without generalized cerebral hypoperfusion (seizures, cataplexy, intracerebral/subarachnoid hemorrhage, cerebrovascular disorders (transient ischemic attacks and subclavian steal syndrome)) (3,4). Syncope itself can be divided into two main categories: cardiac and noncardiac causes. The latter can be further subdivided into two: reflex syncope (also called neurally mediated syncope) and orthostatic hypotension (4). Now, let's learn how using a solid history, physical exam, and investigations could help narrow the differential diagnosis.

2.1 | History and Physical Exam

Individuals will often present with a primary complaint of "fainting," "blacking out," or "passing out" (5). To obtain an adequate history, one must gather a past medical history, family history, and a history of present illness that includes a review of symptoms and clinical information about the event's evolution. Questions should include what happened before (what the patient was doing or seeing before the event, history of head trauma, associated prodrome, associated symptoms present), during (were there any movements during the event, urinary or fecal incontinence, tongue biting), and after (absence of confusion vs. a prolonged postictal state) the event. Corroboration from witnesses will likewise become vital in diagnosis. With this information, one can start to piece together the cause of syncope (Figure 1).

Cardiac syncope is secondary to an underlying rhythmic, structural, contractile, or cardiopulmonary etiology leading to decreased cardiac output and subsequent cerebral hypoperfusion (7). This presentation is associated with increased morbidity and mortality rates, which require additional workup and hospital admission (8). Cardiac-related syncope is more likely to occur in older male patients with a prior history of cardiac disease. Before the event, patients may have symptoms associated with exertion and report feeling short of breath or experiencing palpitations and/or chest pain. Often, they present without any prodrome, such as a sudden fall (9). As with non-cardiac syncope, the episode will most often have an absence of movement or associated symptoms during the event and complete recovery afterward. It is important to rule out symptoms associated with life-threatening causes, detailed in Figure 1 (i.e., pleuritic pain can be suggestive of a pulmonary embolism) (10). Clinical tools such as the Canadian Syncope Risk Score (CSRC), which predict 30-day serious outcomes not evident during initial ED evaluations of syncope, can be

used to further aid clinicians when dealing with this presentation (11).

Noncardiac syncope is divided into reflex-mediated and orthostatic (12). Orthostatic syncope is due to postural changes with insufficient counter-regulation (requires a postural decrease in BP 20/10 mm Hg). It can be secondary to medication effects (i.e., vasodilators, diuretics, phenothiazine, antidepressants), volume depletion (i.e., internal, or external hemorrhage, diarrhea, vomiting), or neurogenic disorders that can be primary (i.e., Parkinson's disease, and pure autonomic failure) or secondary (i.e., diabetes, amyloidosis) (3,9). Patients typically complain of light-headedness, nausea, and dizziness before the episode. Symptoms on history that are important to rule out are back or abdominal pain, and can be suggestive of a leaking abdominal aortic aneurysm or ruptured ectopic pregnancy. Reflex-mediated syncope, the most common type of syncope, is divided into vasovagal, situational, or secondary to carotid sinus activation (12,13). In this case and beyond linking TLOC to a specific event, patients are likely to have a strong prodrome associated with nausea, pallor, diaphoresis, hyperventilation, and impairment of the senses. Patients often complain of visual blackness and faintness of hearing before the episode occurs (14).

A detailed physical exam provides critical information about the origin of syncope. Orthostatic vitals can help confirm or rule out syncope of orthostatic etiology (14). Firstly, blood pressure and heart rate are taken in a lying position, followed by a sitting position, an immediate standing position, and lastly, taken after 3 minutes of standing. A carotid artery massage with a pause in heart rate 3 seconds or a fall in systolic BP 50 mm Hg can confirm carotid sinus hypersensitivity (6). Furthermore, conducting a detailed cardio-respiratory exam can further assess the underlying cause. Auscultating heart murmurs, extra heart sounds, or signs of respiratory compromise can save a patient from a life-threatening cause of syncope.

2.2 | Initial Investigation

Once a detailed history and physical exam are taken, the Canadian Cardiovascular Society (CCS) recommends a 12-lead ECG to rule in or out a cardiac event, which has implications on prognosis and management (12). ECG findings that must be ruled out are sinus node dysfunction (sinus arrest or block, bradycardia/tachycardia syndrome), atrioventricular conduction system disease (Mobitz type II, high-grade and complete AV block), and supraventricular and ventricular tachycardia (3,4). Suggestive findings that should be ruled out include PR in-

	Types		Underlying causes	Clinical features
Cardiac	Arrythmias		Bradycardia: Sinus node dysfunction Atrioventricular conduction system disease Tachycardia: Supraventricular tachycardia Ventricular tachycardia	Abrupt and unprovoked (most common presentation) Prodromal symptoms: palpitations
	Structural		Massive myocardial infarction Aortic stenosis Mitral valve prolapse Hypertrophic cardiomyopathy Cardiac tamponade	Personal or family history of coronary artery disease (CAD) Related to episodes of exertion Prodromal symptoms: palpitations, dyspnea, chest pain
	Cardiopulmonary		Pulmonary embolism Abdominal aortic aneurysm	
Non cardiac	Reflex mediated	Vasovagal	Prolonged standing Emotional stress Pain or injury	Prodromal symptoms: diaphoresis, dizziness, nausea Related to a precipitating factors (see causes)
		Situational	Cough Laughing gastrointestinal stimulation (swallowing, defecation)	Related to precipitating factors (see causes)
		Carotid sinus	Pressure on the carotid sinuses	Occurs during pressure ie (e.g., massage, shaving, tightening a necktie)
	Orthostatic		Volume depletion (hemorrhage, vomiting) Medications leading to vasodilation Prolonged bed rest Primary autonomic failure: diabetic neuropathy, Parkinson's disease	Related to precipitating factors (see causes): prolonged standing, abrupt changes in positions, dehydration Prodromal symptoms: lightheadedness, nausea, dizziness

FIGURE 1 Etiologies of cardiac and noncardiac causes of syncope (non-exhaustive list). Information taken from (3,6).

terval shortening with delta wave (i.e., Wolf-Parkinson-White syndrome) and prolonged QT interval (indicating a propensity for torsades des pointes). Prolonged monitoring may show a transient but recurring dysrhythmia. (10) Though cardiac monitoring is used in all patients with an acute presentation, its nature and extent (Holter or loop-event monitoring) depend on the frequency, severity of syncope, and suspicion of an arrhythmic etiology (10). Imaging (echocardiogram or stress testing) is conducted only with the clinical suspicion of ischemic, structural, or valvular heart disease. Regular stress testing should also be performed in patients with a high suspicion of syncope secondary to an ischemic cause. When standard imaging is inconclusive in patients with structural heart disease (congenital, inflammatory, or infiltrative heart disease), advanced cardiac imaging (CT, MRI) should be performed. After noninvasive testing, invasive electrophysiology studies (EPS) are only recommended in patients with an abnormal ECG or structural heart disease, which can have therapeutic benefits. Blood work is not recommended in the initial syncope workup unless there is suspicion for a specific condition, and can lead to a diagnosis (9, 12). Certain conditions may include myocardial infarction-troponins, pulmonary embolism-D-dimer, heart failure, NT-proBNP, CBC, and human chorionic gonadotropin testing in women of childbearing age. A hematocrit may explain orthostatic syncope (i.e., occult gastrointestinal bleeding), and a pregnancy test for potential childbearing-aged women is always warranted (i.e., red ectopic pregnancy). Electrolyte testing may show a decreased bicarbonate after a seizure, and hypomagnesemia can explain weakness or irritable myocardium (10).

The American College of Cardiology, American Heart Association, and Heart Rhythm Society guidelines agree with “Choosing Wisely” in discouraging neurologic testing in patients with syncope as a routine test (6,15,16). Brain imaging should only be performed when the intracranial disease is highly suspected as a contributing cause or if there is suspicion of head trauma from the syncopal episode. Without focal neurological findings, carotid artery imaging should not be performed (6). Utilizing the patient’s history, physical exam findings such as orthostatic vitals and carotid artery massage can confirm non-cardiac etiologies of syncope. Tilt table testing, when positive, can help distinguish syncope associated with myoclonic movements (involuntary twitching of muscle groups, known as convulsive syncope) from epilepsy in cases of diagnostic uncertainty (12). If non-cardiac causes are benign, no further workup is necessary for the ED if patient history, physical exam, and initial workup are negative for other life-threatening reasons (3).

Furthermore, it is crucial to consider that diagnostic workup can be done outside the emergency department. The European Society of Cardiology supports video monitoring to help with diagnostic dilemmas of syncope vs epilepsy. TLOC secondary to conversion syndromes when the initial workup is inconclusive (12).

3 | BEYOND THE INITIAL APPROACH

Shared decision-making to respect patients’ needs is a priority when approaching management and care. Below, we explain further management of selected causes of syncope:

3.1 | Vasovagal Syncope (VVS)

If recurrent VVS reduces one’s quality of life, multiple nonpharmacological approaches can aid in symptom management. These include education on the recognition of prodromes and lifestyle modifications such as avoidance/being aware of triggers and situations. Limited evidence supports increased water and salt intake. In younger patients with a sustained prodrome (> 1 minute), it is recommended to do counter-pressure maneuvers (leg-cross, limb/abdominal contract, squat). Lying down quickly is also encouraged with the onset of presyncope.

3.2 | Orthostatic Syncope

The CCS recommends education, reassurance, and adequate salt and water intake as a first-line therapy for patients if there are no contraindications. If non-pharmacologic measures are of no benefit, removal (vs dose adjustment) of any offending medications (such as vasoactive agents) is recommended if there are no clear indications for their use or are no suitable replacements. (3,6) With apparent persistent symptoms, patients are encouraged to try counter-pressure maneuvers (described earlier), compression garments, and head-up tilt sleeping. After nonpharmacological interventions are exhausted, first-line pharmacotherapy includes midodrine, fludrocortisone, or droxidopa (short-term use—not available in Canada) (12).

4 | THE GREAT MIMICKER – SEIZURE

Given the strong association between TLOC and seizures as a differential diagnosis, a non-exhaustive overview of critical clinical findings related to seizures is presented. It should be supplemented with additional resources that further discuss the topic.

To assess seizures as the underlying cause of TLOC, pointed questions about circumstances leading up to the event, the ictal behaviors, and the postictal state can help differentiate it from syncope (3). Risk factors such as infection, trauma, and triggers such as strong emotions, loud music, flashing lights, alcohol intoxication/withdrawal, and drug abuse can precipitate seizures (17). Patients often experience aura or motor symptoms before the event. During the episode, patients can have tongue biting, incontinence, and classic tonic-clonic movement lasting 2-3 minutes. An extended postictal state can likewise lead one to include seizure on the differential with patients experiencing confusion, suppressed alertness, aphasia, hemianopsia, and Todd paralysis (numbness or weakness of one part of the body) (17-19).

5 | ANSWER

B. Order an ECG.

This patient presents with a history suspicious of an episode of transient loss of consciousness, which could indicate a syncopal event. One should therefore aim to tease out whether the primary etiology is cardiac or non-cardiac. Therefore, after obtaining a history and physical exam in the emergency setting, evaluation with an ECG should be the next step to subcategorize the etiology and lend its way to prognosis and management (12).

The Final Outcome... Your 12-lead ECG has a regular rate and rhythm. Given your strong history and absence of physical exam findings, you feel confident that this episode is related to a vasovagal etiology. As such, you feel reassured to send him home, discuss common non-pharmacological approaches to decrease the incidence, and wish him luck on his exams.

REFERENCES

1. Sandhu RK, Sheldon RS, Savu A, Kaul P. Nationwide Trends in Syncope Hospitalizations and Outcomes From 2004 to 2014. Can J Cardiol. 2017 Apr;33(4):456–62.

2. Goldberger ZD, Petek BJ, Brignole M, Shen WK, Sheldon RS, Solbiati M, et al. ACC/AHA/HRS Versus ESC Guidelines for the Diagnosis and Management of Syncope. J Am Coll Cardiol. 2019 Nov;74(19):2410–23.

3. Brignole M, Moya A, de Lange FJ, Deharo JC, Elliott PM, Fanciulli A, et al. 2018 ESC Guidelines for the diagnosis and management of syncope. Eur Heart J. 2018 Jun 1;39(21):1883–948.

4. Dan L Longo. Harrison's Principles of Internal Medicine. 18th ed. New York: McGraw-Hill; 2012.

5. Benditt DG, Gert Van Dijk J, Sutton R, Wieling W, Lin JC, Sakaguchi S, et al. Syncope. Curr Probl Cardiol. 2004 Apr 1;29(4):152–229.

6. Shen WK, Sheldon RS, Benditt DG, Cohen MI, Forman DE, Goldberger ZD, et al. 2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients With Syncope: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. Circulation [Internet]. 2017 Aug [cited 2023 Feb 6];136(5). Available from: https://www.ahajournals.org/doi/10.1161/CIR.0000000000000499

7. Albassam OT, Redelmeier RJ, Shadowitz S, Husain AM, Simel

D, Etchells EE. Did This Patient Have Cardiac Syncope?: The Rational Clinical Examination Systematic Review. JAMA. 2019 Jun 25;321(24):2448–57.

8. Soteriades ES, Evans JC, Larson MG, Chen MH, Chen L, Benjamin EJ, et al. Incidence and Prognosis of Syncope. N Engl J Med. 2002 Sep 19;347(12):878–85.

9. Runser LA, Gauer RL, Houser A. Syncope: Evaluation and Differential Diagnosis. Am Fam Physician. 2017 Mar 1;95(5):303-312B.

10. American College of Emergency Physicians. Syncope. In: Tintinalli's Emergency Medicine Manual. 7th Edition. New York: McGraw-Hill Education; 2018. p. 21–3.

11. Mark Ramzy. Validation of the Canadian Syncope Risk Score. REBEL EM blog [Internet]. 2020 Apr 20; Available from: https://rebelem.com/validation-of-the-canadian-syncope-risk-score/

12. Sandhu RK, Raj SR, Thiruganasambandamoorthy V, Kaul P, Morillo CA, Krahn AD, et al. Canadian Cardiovascular Society Clinical Practice Update on the Assessment and Management of Syncope. Can J Cardiol. 2020 Aug;36(8):1167–77.

13. Hatoum T, Sheldon R. A Practical Approach to Investigation of Syncope. Can J Cardiol. 2014 Jun 1;30(6):671–4.

14. Syncope in adults: Management and prognosis - UpToDate [Internet]. [cited 2023 Jan 8]. Available from: https://www-uptodate-com.proxy3.library.mcgill.ca/contents/syncope-in-adults-management-and-prognosis

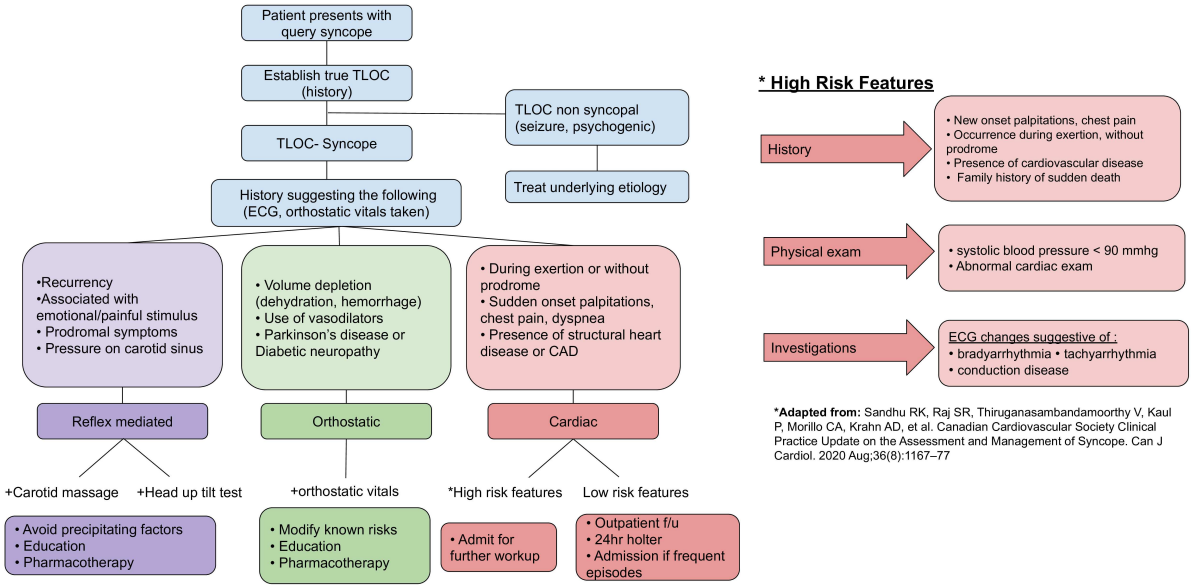
15. Canadian Association of Emergency physicians. Choosing Wisely Canada. 2017 [cited 2023 Jan 30]. Emergency Medicine. Available from: https://choosingwiselycanada.org/recommendation/emergency-medicine/

16. Pournazari P, Oqab Z, Sheldon R. Diagnostic Value of Neurological Studies in Diagnosing Syncope: A Systematic Review. Can J Cardiol. 2017 Dec;33(12):1604–10.

17. Leibetseder A, Eisermann M, LaFrance Jr WC, Nobili L, von Oertzen TJ. How to distinguish seizures from non-epileptic manifestations. Epileptic Disord. 2020;22(6):716–38.

18. Steven C Schachter, MD. Evaluation and management of the first seizure in adults. Uptodate [Internet]. 2022 Oct 26; Available from: https://www-uptodate-com.proxy3.library.mcgill.ca/contents/evaluation-and-management-of-the-first-seizure-in-adults

19. Blume WT, Lüders HO, Mizrahi E, Tassinari C, Van Emde Boas W, Engel Jr. J Ex officio. Glossary of Descriptive Terminology for Ictal Semiology: Report of the ILAE Task Force on Classification and Terminology. Epilepsia. 2001;42(9):1212–8.



FLOWCHART 1 Flowchart summarizing an approach to syncope and initial management. Information taken from (3,6,12).

APPROACH TO
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Dysphagia

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ABSTRACT

Dysphagia, characterized by difficulty swallowing, requires a comprehensive approach to manage and treat the condition effectively. This involves collaboration among a multidisciplinary team, including speech-language therapists, nurses, physicians, occupational therapists, and physical therapists, to provide thorough evaluation and personalized interventions. The article will provide an overview of the diagnostic process, including patient history, clinical assessments, and instrumental evaluations to identify underlying causes of dysphagia. Management options such as dietary modifications, swallowing therapy, medications, and, in some cases, surgical interventions will be discussed, highlighting the importance of individualized care plans. Effective communication and mutual respect among healthcare team members are crucial for a holistic strategy to address the challenges of dysphagia.

KEYWORDS
Swallowing difficulty, Oropharyngeal dysphagia, Swallowing disorders, Dysphagia management, Swallowing therapy, Dysphagia rehabilitation

1 | QUESTION

Ms. A, a 55-year-old woman, arrives at the clinic troubled by a persistent six-month ordeal of escalating difficulty swallowing solid foods. She describes a disconcerting sensation of solid foods sticking in her throat, frequently resulting in bouts of coughing and regurgitation. While she doesn't report any painful swallowing, she notes an unintended weight loss of approximately 5 kg over the past few months. Additionally, she occasionally experiences heartburn but denies any history of smoking or alcohol consumption. Her medical history discloses hypertension and hypothyroidism, both managed with regular medications. Ms. A expresses concern and a palpable unease due to the distressing nature of her symptoms, emphasizing their persistent and progressively worsening nature.

Ms. A presents as a well-nourished individual; however, she expresses distress related to eating due to her dysphagia symptoms. The physical examination reveals no noticeable cervical lymphadenopathy, and her neck appears supple without evident masses or swelling. Palpation of the neck doesn't reveal any noticeable masses. Assessment of cranial nerves shows no abnormalities, and her gag reflex remains intact. Further systemic examination, including abdominal assessment, doesn't yield any remarkable findings. The examination points to a lack of overt physical signs in the cervical region or any evident systemic abnormalities that might suggest an obvious cause for the dysphagia.

Considering the patient's history of progressive dysphagia for solids with associated weight loss, what would be the next best step in the initial evaluation of this patient?

A. Upper endoscopy (esophagogastroduodenoscopy).
B. Barium swallow.
C. Esophageal manometry.
D. Computed tomography (CT) scan of the chest and abdomen.
E. Swallowing evaluation by a speech-language pathologist.

2 | ANSWER

A. Upper endoscopy stands as the foremost diagnostic modality for the assessment of dysphagia, especially in cases presenting with progressive symptoms or concomitant weight loss. This procedure enables direct visualization of the esophagus, stomach, and duodenum, facilitating the identification of structural anomalies, inflammatory processes, strictures, tumors, or any pathological condition contributing to dysphagia. This test can help determine the underlying etiology, thereby guiding subsequent management strategies based on the identified findings. While alternative tests such as barium swallow and esophageal manometry may provide valuable information, upper endoscopy surpasses them by offering direct visualization and biopsy capabilities, establishing it as the preferred initial diagnostic approach in this context.

3 | INITIAL APPROACH

3.1 | Brief Overview of Dysphagia

Dysphagia, denoted by the challenge or delay in swallowing, encompasses both the objective impediment of bolus transit and the subjective experience of this delay by the patient. This dual perspective is crucial, acknowledging that some individuals may not perceive the swallowing delay despite objective test indications of dysphagia. Additionally, sensory neural dysfunction plays a role in either amplifying or diminishing a patient's sensation of swallowing difficulty. Predominantly observed among the elderly due to age-related changes in muscles and nerves involved in swallowing, as well as a higher incidence of conditions like stroke and neurodegenerative diseases. It typically emanates from two primary sources. The first category involves mechanical obstructions such as Schatzki rings, esophageal strictures, carcinoma, or conditions like eosinophilic esophagitis. The second source pertains to motility disorders of the esophagus, encompassing spasms, achalasia, and ineffective motility/scleroderma. Dysphagia may manifest as intermittent or continuous and may selectively affect solid foods (indicative of mechanical obstruction) or both solid and liquid intake (associated with motility disorders). This nuanced understanding assists healthcare professionals in discerning the varied etiologies of dysphagia, allowing targeted diagnostic and therapeutic strategies for optimal patient care. (1)

3.2 | Evaluation for Dysphagia

Dysphagia, serving as a cardinal symptom indicative of structural or neuromuscular disorders in the oropharynx or esophagus, demands meticulous differentiation from sensations like globus and odynophagia. When confronted with the evaluation of dysphagia, otolaryngologists adhere to a comprehensive approach, involv-

ing intricate history-taking, thorough ENT physical examinations, and fiberoptic nasopharyngolaryngoscopy to assess the various phases of swallowing. Specialized investigations, such as radiography, esophageal endoscopy, ultrasonography, pH-metry, and manometry, may be requisite for arriving at a definitive diagnosis (Table 1). The collaborative synergy among otolaryngologists, radiologists, gastroenterologists, neurologists, and swallowing therapists assumes paramount significance. This interdisciplinary approach not only facilitates the identification of the underlying cause but also ensures the implementation of effective treatment strategies for the diverse spectrum of dysphagia cases encountered in clinical practice. (2)

3.3 | Diagnostic Evaluation for Dysphagia

The diagnostic assessment for dysphagia encompasses various methods to determine the underlying cause and severity of swallowing difficulties. An initial crucial step involves a comprehensive history-taking and physical examination. Effective history-taking in dysphagia aims to pinpoint the onset, duration, triggers, and associated symptoms to distinguish between true dysphagia and other sensations like globus or odynophagia, determining the anatomical site and underlying cause in most cases. Physical examination for dysphagia assesses swallowing function by evaluating the strength and symmetry of swallowing-related muscles, including the tongue, facial muscles, shoulder shrug, oral structures during swallowing, and cranial nerve function. (3) Diagnostic procedures encompass the videofluoroscopic swallow study (VFSS), a radiographic assessment wherein patients ingest diverse food and liquid textures while under the observation of a radiologist. This procedure aims to evaluate swallowing coordination and identify potential concerns, such as the risk of aspiration. The VFSS provides a dynamic visualization of the swallowing process, enabling precise assessment and aiding in the elucidation of specific issues related to the oropharyngeal and esophageal phases of deglutition. Deglutition in humans consists of three phases: oral, pharyngeal, and esophageal. The oral phase is voluntary and includes an oral preparatory and oral propulsive phase, while the pharyngeal and esophageal phases are reflexive. Each phase is defined by the location of the food bolus as it moves toward the stomach. (4)

The fiberoptic endoscopic evaluation of swallowing (FEES) involves the insertion of a flexible endoscope through the nasal passage to directly visualize the pharynx and larynx during the act of swallowing. This procedure facilitates the identification of structural and functional abnormalities (such as aspiration) within the upper aerodigestive tract. Esophagogastroduodenoscopy (EGD) employs a flexible tube equipped with a camera to meticulously examine the esophagus, stomach, and upper small intestine. The main objectives of EGD include diagnosing conditions such as severe heartburn, gastrointestinal bleeding, abdominal pain, dysphagia, and unexplained weight loss. It also serves to monitor the progression and treatment effectiveness in diseases like Crohn's disease, peptic ulcers, cirrhosis, and esophageal varices. EGD allows for tissue sampling for biopsy and can be used for therapeutic interventions such as esophageal dilation for strictures. (5)

A barium swallow involves the ingestion of a barium-containing liquid for radiographic visualization, facilitating the detection of esophageal abnormalities, such as strictures or tumors. Complementary to this, esophageal manometry assesses muscle pressure and coordination during the act of swallowing, providing valuable diagnostic insights into motor disorders, such as achalasia or esophageal spasms. These diagnostic procedures contribute to a comprehensive understanding of esophageal function and structure, aiding clinicians in the precise identification of underlying issues. (6)

3.4 | Additional Investigations for Dysphagia

A complete blood count (CBC) can be utilized as a diagnostic tool, unveiling potential indicators of infection or anemia that may impact swallowing function. Ane-

mia, defined as a decreased red blood cell count, can compromise oxygen delivery to the muscles involved in swallowing, potentially impairing their function. Infections may also lead to weakness and fatigue, disrupting the coordination of swallowing muscles. Together, these conditions can contribute to dysphagia and hinder safe swallowing. In addition to a CBC, an electrolyte panel including sodium, calcium, potassium and magnesium can be employed to assess muscle function, providing crucial insights into the physiological aspects of swallowing. Abnormal electrolyte levels can cause muscle weakness or cramping, potentially impairing the coordination and strength needed for effective swallowing. Given the intricate interplay of thyroid function with dysphagia, thyroid function tests are also pertinent in the diagnostic process. Further, inflammatory markers such as C-reactive protein (CRP) or erythrocyte sedimentation rate (ESR) play a pivotal role in identifying inflammation associated with dysphagia-causing conditions. In cases suspected to be autoimmune, specific markers, including anti-nuclear antibodies (ANA) or anti-thyroid antibodies, are examined to aid in the precise diagnosis of dysphagia etiology. (7)

It is worth noting that blood tests often provide limited information regarding the specific etiology of esophageal dysphagia. Although inflammatory or immune markers may aid in the diagnosis of certain chronic systemic conditions, their relevance to dysphagia may not be definitive. For instance, a patient may present with hypothyroidism; however, further investigations are necessary to exclude alternative etiologies before attributing dysphagia solely to hypothyroidism. Consequently, comprehensive diagnostic evaluations such as barium swallow studies, esophageal manometry, endoscopic assessment, and advanced imaging modalities should be considered to thoroughly investigate the underlying cause of dysphagia. (5,6)

Imaging techniques, such as computed tomography (CT) scans and magnetic resonance imaging (MRI), stand as indispensable imaging modalities in the comprehensive assessment of dysphagia. The CT scans deliver intricate imaging of neck structures, facilitating the identification of potential abnormalities or obstructions that may contribute to swallowing difficulties. On the other hand, MRI produces high-resolution images of soft tissues, affording an enhanced visualization of swallowing muscles and adjacent structures. (8,9) pH monitoring, commonly employed in the diagnosis of gastroesophageal reflux disease (GERD) by assessing esophageal acidity, may find relevance in individuals experiencing dysphagia with symptoms indicative of reflux-related concerns. (10) A flowchart summarizing the approach to the diagnosis of dysphagia is found on Flowchart 1.

4 | BEYOND THE INITIAL APPROACH

4.1 | Management of Dysphagia

The aspects of dysphagia management have been described in Table 2.

- **Medications:** Nifedipine appears to be a promising option for managing dysphagia. It has been shown to significantly reduce lower esophageal sphincter pressure, which can improve swallowing function in patients with esophageal motor disorders. Additionally, formulations of nifedipine have been found effective in treating pylorospasm, which may enhance gastric emptying in patients with gastroparesis. (11) Calcium channel blockers (CCBs), including drugs such as verapamil, nifedipine, diltiazem, fendiline, nitrendipine, nimodipine, and nisoldipine, can impact esophageal motility by relaxing smooth muscle tissue through the inhibition of calcium influx into cells. This relaxation can decrease lower esophageal sphincter pressure, potentially improving swallowing function in patients with esophageal motor disorders. However, careful dosing is important to avoid potential complications such as reflux. (11,12)
- **Rehabilitation:** The comprehensive management of dysphagia entails a multifaceted approach, incorporating compensatory strategies, direct therapeutic techniques, and indirect therapeutic techniques.

Compensatory strategies involve modifications to feeding techniques, adjustments in posture, and alterations in food consistency to alleviate symptoms, without necessarily addressing the underlying physiological issues. In contrast, direct therapeutic techniques seek to modify swallowing physiology through sensory stimulation methods, such as active neuromuscular electrical stimulation (NMES) applied with concurrent swallowing exercises. Additionally, certain cases may require surgical or medication-based interventions. Indirect therapy methods, on the other hand, focus on enhancing the neuromuscular control required for swallowing without directly inducing a swallow, such as passive NMES without EMG-guided biofeedback. (13,14)

Assessments such as video fluoroscopic studies serve a dual purpose, functioning not only as diagnostic tools but also as efficacy trials for selected therapies. Videofluoroscopic studies, such as video fluorography, are instrumental in diagnosing and evaluating swallowing disorders. These studies provide real-time imaging of swallowing function, allowing clinicians to identify pathologic findings in dysphagia and globus patients, which aids in guiding treatment decisions. Additionally, autofluorescence bronchoscopy is a diagnostic tool that can detect pre-neoplastic and neoplastic lesions, facilitating early intervention and treatment planning. The integration of a comprehensive treatment plan necessitates a thorough consideration of a patient's oropharyngeal anatomy, medical status, cognitive abilities, and behavioral characteristics. These diverse approaches highlight the intricacy of dysphagia management, underscoring the significance of tailored, holistic treatment plans for individuals with swallowing difficulties. (15)

- **Compensatory strategies:** The management of dysphagia varies significantly across different healthcare settings. This variation is often due to disparities in resources and care practices. Many facilities lack essential support, such as dedicated speech therapists or access to specialized professionals, limiting their ability to conduct thorough assessments. Screening methods tend to be non-standardized and limited, often using basic water swallow tests without instrumental assessments. As a result, dysphagia care often focuses on compensatory strategies such as modifying food consistency and feeding techniques rather than rehabilitative interventions like swallow exercises. While many healthcare professionals believe that the overall care quality for individuals with dysphagia is satisfactory, this perception may be influenced by limited knowledge of dysphagia symptoms, implications, and treatment options. Therefore, it is critical to improve awareness of dysphagia among healthcare professionals and expand training opportunities for screening, assessment, and management. (16)

- **Dietary modifications:** In the management of dysphagia, thickened liquids play a crucial role in enhancing swallowing safety by facilitating bolus control and reducing the risk of aspiration. However, their utilization introduces unintended physiological consequences. While they do not compromise water availability, the absorption of medications is affected, impeding drug release, especially in denser fluids. As viscosity increases, taste perception diminishes, and sensations of fullness, along with reduced thirst, elevate, diminishing the motivation to consume. The prescription of small volumes at frequent intervals is common but challenging due to unappealing taste and decreased intake resulting from prolonged oral processing. The modification of food and liquid textures is essential for safer swallowing. (17)

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- **Surgical interventions:** Surgical interventions, such as cricopharyngeal myotomy and laryngeal suspension, are directed at either restoring functionality or preventing severe aspiration. A crucial consideration in determining the most effective treatment strategies is a comprehensive understanding of the prognosis associated with the underlying causative disease. Surgical interventions, such as thyroidectomy for large goitres, can alleviate esophageal compression and improve dysphagia. Nonetheless, procedural interventions like dilation are more commonly employed for dysphagia management. Dilation is a safe and effective approach with minimal risk of complications, offering significant relief for patients with benign pharyngoesophageal strictures and improving oral food intake for most patients. For achalasia-related dysphagia, Heller myotomy is a surgical option that provides long-term relief. (18)

- **Feeding tubes:** Tube feeding, encompassing nasogastric tubes (NGT) or percutaneous endoscopic gastrostomy (PEG) tubes, serves as a prevalent method for providing nourishment and hydration to individuals experiencing dysphagia. In the acute phase of stroke or amyotrophic lateral sclerosis (ALS), short-term feeding through NGT is the preferred choice, while PEG tubes are employed for sustained nutritional support. Implementing tube feeding has demonstrated correlations with heightened survival rates and plays a crucial role in averting complications, such as malnutrition and aspiration pneumonia. This intervention becomes indispensable for ensuring adequate nutritional intake and mitigating associated health risks in individuals with dysphagia. (19)

- **Collaborative care:** Coordinated dysphagia management necessitates a collaborative, multidisciplinary team, incorporating specialists like speech-language therapists, nurses, physicians, occupational therapists, physical therapists, and others. This collective approach ensures a thorough evaluation and diverse treatment strategies tailored to address the complexities of swallowing difficulties. Successful outcomes depend on effective communication and mutual respect among team members, harnessing each professional's expertise to formulate a comprehensive dysphagia care plan. (20,21)

REFERENCES

1. Azer SA, Kanugula AK, Kshirsagar RK. Dysphagia. [Updated 2023 Nov 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://pubmed.ncbi.nlm.nih.gov/32644600/

2. Halama AR. Clinical approach to the dysphagic patient. Acta Otorhinolaryngol Belg. 1994;48(2):119-126.

3. Cook IJ. Diagnostic evaluation of dysphagia. Nat Clin Pract Gastroenterol Hepatol. 2008;5(7):393–403. https://pubmed.ncbi.nlm.nih.gov/18542115/

4. Bill J, Rajagopal S, Kushnir V, Gyawali CP. Diagnostic yield in the evaluation of dysphagia: experience at a single tertiary care center. Dis Esophagus. 2018;31(6):1-6.

5. Wilkinson JM, Codipilly DC, Wilfahrt RP. Dysphagia: Evaluation and Collaborative Management. Am Fam Physician. 2021;103(2):97-106.

6. O'Horo JC, Rogus-Pulia N, Garcia-Arguello L, Robbins J, Safdar N. Bedside diagnosis of dysphagia: A systematic review. J Hosp Med. 2015;10(4):256–265.

7. Park MI. Approach of dysphagia. Korean J Gastroenterol. 2021;77(2):57–63.

8. DePippo KL, Holas MA, Reding MJ. The Burke dysphagia screening test: validation of its use in patients with stroke. Arch Phys Med Rehabil. 1994;75(12):1284-1286.

9. Kornfehl J. Bildgebende Techniken bei Erkrankungen des Pharynx - Erwartungen und Anforderungen des Klinikers. Radiologe. 2000;40(7):596–600.

10. Butt I, Kasmin F. Esophageal pH Monitoring. [Updated 2023 Feb 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://pubmed.ncbi.nlm.nih.gov/31971729/

11. Carmona-Sánchez R, Valerio-Ureña J, Valdovinos-Díaz MA. Utilidad de la lidocaína en gel en la manometría esofágica [Usefulness of gel lidocaine in esophageal manometry]. Rev Gastroenterol Mex. 2001;66(3):137-140.

12. Mascarenhas A, Mendo R, O'Neill C, Franco AR, Mendes R, Simão I, Rodrigues JP. Current approach to dysphagia: A review focusing on esophageal motility disorders and their treatment. GE Port J Gastroenterol. 2023;30(6):403–413.

13. Bracciano AG. Neuromuscular Electrical Stimulation. Physical Agent Modalities: Theory and Application for the Occupational Therapist. Taylor & Francis. 2024 Jun 1.

14. Logemann JA. Approaches to management of disordered swallowing. Baillieres Clin Gastroenterol. 1991;5(2):269–280.

15. Speyer R, Sandbekkbråten A, Rosseland I, Moore JL. Dysphagia care and management in rehabilitation: A national survey. J Clin Med. 2022;11(19):5730. 16. Cichero JA. Thickening agents used for dysphagia management: effect on bioavailability of water, medication and feelings of satiety. Nutr J. 2013;12(1):1-8.

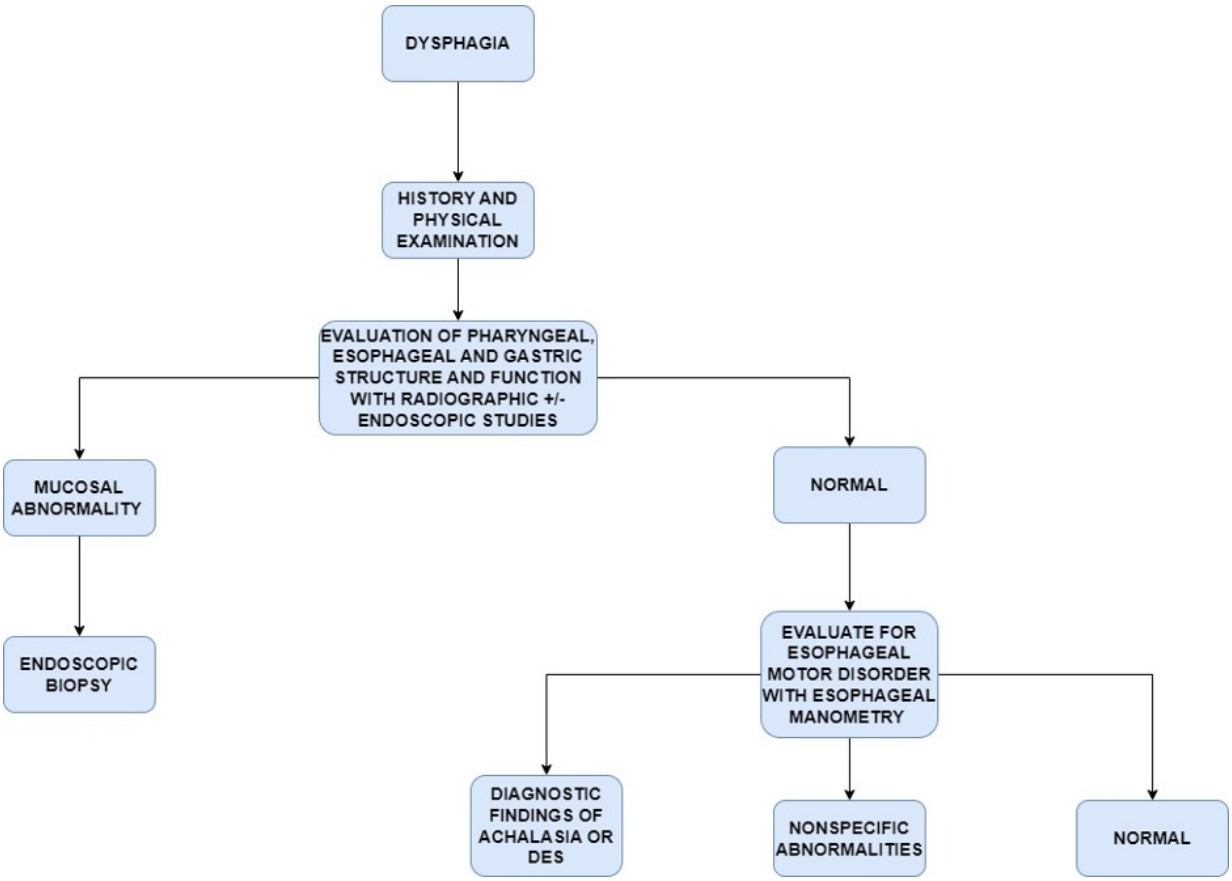
17. Martins D, Pires S, Pimentel-Nunes P, Almeida Silva R, Dias CC, Dinis-Ribeiro M. Endoscopic Dilation of Pharyngoesophageal Strictures: There Are More Dimensions than a Diameter. GE Port J Gastroenterol. 2018;25(6):291-298.

18. Rowat A. Enteral tube feeding for dysphagic stroke patients. Br J Nurs. 2015;24(3):138–145.

19. Cools-Lartigue J, Jones D, Spicer J, Zourikian T, Rousseau M, Eckert E, Alcindor T, Vanhuyse M, Asselah J, Ferri LE. Management of dysphagia in esophageal adenocarcinoma patients undergoing neoadjuvant chemotherapy: Can invasive tube feeding be avoided? Ann Surg Oncol. 2015;22(6):1858–1865.

20. Wu C, Zhu X, Zhou X, Li C, Zhang Y, Zhang H, Shen M. Intermittent tube feeding for stroke patients with dysphagia: a meta-analysis and systematic review. Ann Palliat Med. 2021;10(7):7406–7415.

21. Heritage M. A collaborative approach to the assessment and management of dysphagia. Int J Lang Commun Disord. 2001;36(S1):369–374.



FLOWCHART 1 Approach for diagnosis of dysphagia
Adapted from (3-10).

5 | TABLES & FIGURES

Examination Method	Description
Detailed History-Taking	Comprehensive inquiry into the patient's dysphagia symptoms, duration, associated conditions, and aggravating/alleviating factors.
ENT Physical Examination	Thorough examination of the oropharynx, neck, and cervical lymph nodes to identify any visible masses, structural abnormalities, or signs of inflammation.
Fiberoptic Nasopharyngolaryngoscopy	A procedure involving a flexible endoscope passed through the nose to visualize the oropharyngeal and laryngeal structures during swallowing.
Radiography	Imaging studies such as barium swallow or videofluoroscopic swallow study to observe bolus movement and identify structural or functional abnormalities.
Esophageal Endoscopy	Involves inserting a flexible tube with a camera to examine the esophagus for inflammation, strictures, tumors, or other abnormalities.
Ultrasonography	Imaging technique to visualize structures in the neck and assess for any abnormalities affecting swallowing.
pH-metry and Manometry	Specialized tests measuring acidity in the esophagus and assessing esophageal muscle function during swallowing, are helpful in diagnosing motility disorders or reflux.

TABLE 1 Physical examination for dysphagia

Adapted from (2).

Aspects	Description
Medications	Nifedipine and other calcium channel blockers (CCBs) relax smooth muscle in the esophagus and lower esophageal sphincter by inhibiting calcium influx, potentially improving swallowing function. These effects can also alleviate esophageal spasms and reduce pressure.
Rehabilitation	Involves compensatory strategies, direct therapy, and assessments. Tailored plans for improved swallowing..
Compensatory Strategies	Disparities in dysphagia care practices. Focus on feeding modifications over rehabilitation.
Dietary Modifications	Thickened liquids aid bolus control but impact medication absorption and taste perception.
Surgical Interventions	Multifaceted approach including medications, rehab, and surgeries. Aim to restore function or prevent severe aspiration.
Feeding Tubes	NGT for short-term use, PEG for prolonged support. Improve survival and prevent complications.
Collaborative Care	Multidisciplinary approach involving specialists. Comprehensive evaluation and treatment strategies.

TABLE 2 Management of dysphagia

Adapted from (11-21).

FINE ARTS

FINE ARTS

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VR over Matter

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ABSTRACT

Medical procedures, like IV insertions and pin removals, may cause pain and anxiety in children. While preventable, high rates of procedural pain persist in hospitals. The use of distraction, such as virtual reality (VR), offers a non-pharmacological approach for pain and anxiety management during medical procedures. More specifically, VR is an immersive technology that brings the user into a three-dimensional world that looks and feels real. The illustration depicts how VR works to decrease pain perception through the analogy of a tug-of-war between pain signaling and VR. During a medical procedure, a child's attention may be focused on the IV poke, increasing pain perception. However, if the child is immersed in a VR game during their medical procedure, the VR pulls the brain's attention away from the IV poke towards an imaginary and pleasant world. As VR is immersive and interactive, it consumes more attention than pain, thereby decreasing pain perception and winning the tug-of-war. Despite the evidence for VR, there is a 20-year gap in the implementation of VR across child healthcare settings. Our team is currently investigating the barriers, facilitators, and contextual challenges for VR use in child healthcare, and in parallel, developing tools to disseminate research evidence and facilitate integration of VR into the standard of care. This illustration serves as a reminder of how VR is thought to help with pain management. To learn more about VR, visit: https://www.mcgill.ca/virtualrealityforchildcare/

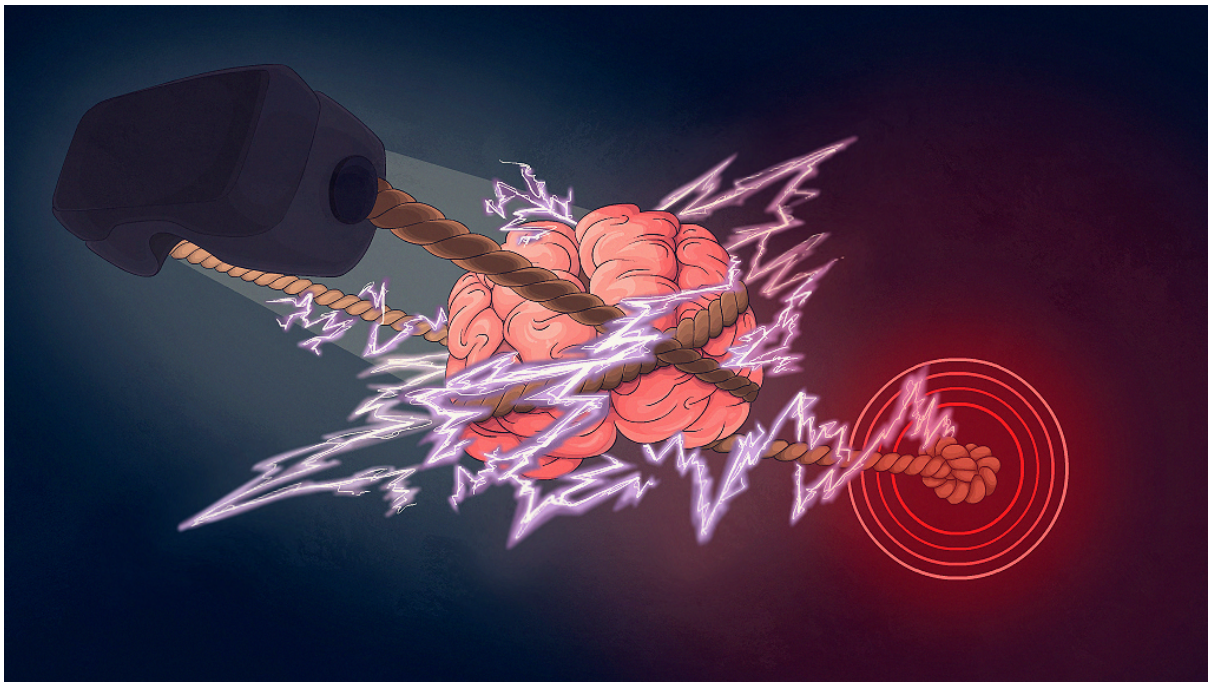
KEYWORDS

Virtual reality, Pain, Pain management, Distraction, Art

REFERENCES

1. Addab S, Hamdy R, Le May S, Thorstad K, Tsimicalis A. The use of virtual reality during medical procedures in a pediatric orthopedic setting: A mixed-methods pilot feasibility study. Paediatr Neonatal Pain. 2022. Available from: https://doi.org/10.1002/pne2.12078

2. Addab S, Hamdy R, Thorstad K, Le May S, Tsimicalis A. Use of virtual reality in managing paediatric procedural pain and anxiety: An integrative literature review. J Clin Nurs. 2022;31(21-22):3032–59. Available from: https://doi.org/10.1111/jocn.16217



ORIGINAL ARTWORK 1 VR vs Pain

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