Comparison of Cooler Preparation Methods for Medication and Vaccine Cold Chain Transport

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INTRODUCTION

Medication and vaccine cold chain transport practices at Northern Health (NH) are currently in line with national recommendations[1], which involve time and resource-intensive processes. A review of cold chain preparation methods was initiated by the COVID-19 pandemic and expansion of local programs and services at NH.

Current literature on vaccine cold chain transport focuses on different packing methods using frozen coolant packs. A recent study found that an increase of coolant packs used in a cooler correlated with longer cold chain albeit with the risk of freezing its contents[2].

An alternative approach to cold chain preparation, using coolant packs stored in refrigerators with altered set points was postulated to improve efficiency without compromising cold chain integrity[3].

AIM

The primary objective is to investigate if the use of pre-conditioned coolant packs reduces time to cold chain when compared to use of frozen coolant packs with conditioning, in plastic and polystyrene coolers.

The secondary objective is to assess the duration of cold chain maintained across both groups and risk of freezing or cold excursions in each group.

METHOD

Control groups consisted of 2 frozen coolant packs with insulation buffers between coolants and the temperature probe. Intervention groups consisted of 4 refrigerated coolant packs without insulation buffers between the coolants and temperature probe (Figure 1).

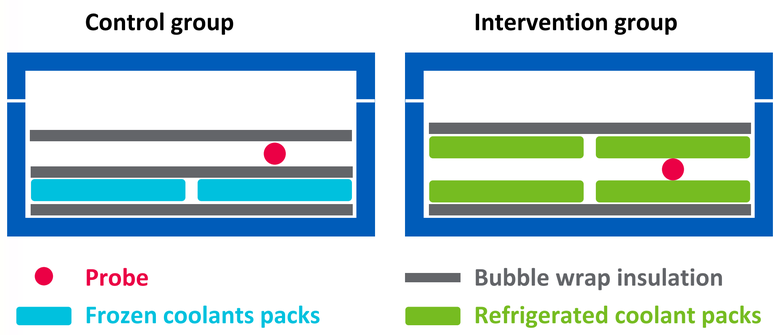

Figure 1. Configurations for control and intervention groups

The number of coolant packs used between control (A, B) and intervention (C, D) groups were determined as the minimum number of required packs necessary to achieve cold chain in each group (Table 1).

Table 1. Setup of individual groups

Group	Coolant pack	Cooler material
A	Frozen (-21°C)	Plastic (25 L)
B	Frozen (-21°C)	Polystyrene (10 L)
C	Refrigerated (3°C)	Plastic (25 L)
D	Refrigerated (3°C)	Polystyrene (10 L)

Simulated medication temperatures were measured by placing probes that were tested for accuracy inside cardboard boxes and set to record at 2 minute intervals.

Experiments were conducted at controlled ambient temperature of 20–24°C.

Time points assessed were i) start of activity, ii) first recorded time in cold chain), iii) first recorded time out of cold chain, iv) duration of cold excursion (if applicable) and v) minimum recorded temperature (Table 2).

RESULTS

Table 2. Mean time to cold chain and duration of cold chain for individual groups

Group	Samples n (%)	Min ambient temp. (°C), mean (SD)	Max ambient temp (°C), mean (SD)	Starting temp. (°C), mean (SD)	Time to cold chain (min), mean (SD)	Duration of cold chain (min), mean (SD)	Min temp. (°C), mean (SD)
A	11 (25)	21.1 (0.3)	22.7 (0.1)	22.3 (0.8)	**13.5 (12.4)**	1000.7 (216.3)	3.9 (1.6)
B	11 (25)	21.0 (0.3)	22.5 (0.2)	21.6 (0.5)	**62.6 (10.9)**	1108.5 (92.5)	-2.4 (1.5)
C	11 (25)	21.3 (0.3)	22.7 (0.2)	20.2 (2.9)	**5.3 (1.6)**	169.3 (23.1)	4.6 (0.3)
D	11 (25)	21.1 (0.4)	22.5 (0.2)	21.0 (1.2)	**5.4 (1.4)**	201.0 (39.6)	4.1 (0.9)

Intervention groups (C, D) combined achieved cold chain 32.7 minutes faster than control groups (A, B) combined ($p < 0.001$). Matching for cooler material; groups C and D achieved cold chain 8.2 and 57.2 minutes faster than their counterparts groups A and B, respectively ($p < 0.001$).

Furthermore, groups C and D combined maintained cold chain 869.5 minutes less than groups A and B combined ($p < 0.001$).

13 of 22 samples in the control groups experienced cold excursions <2°C; no cold chain excursions were observed in the intervention groups.

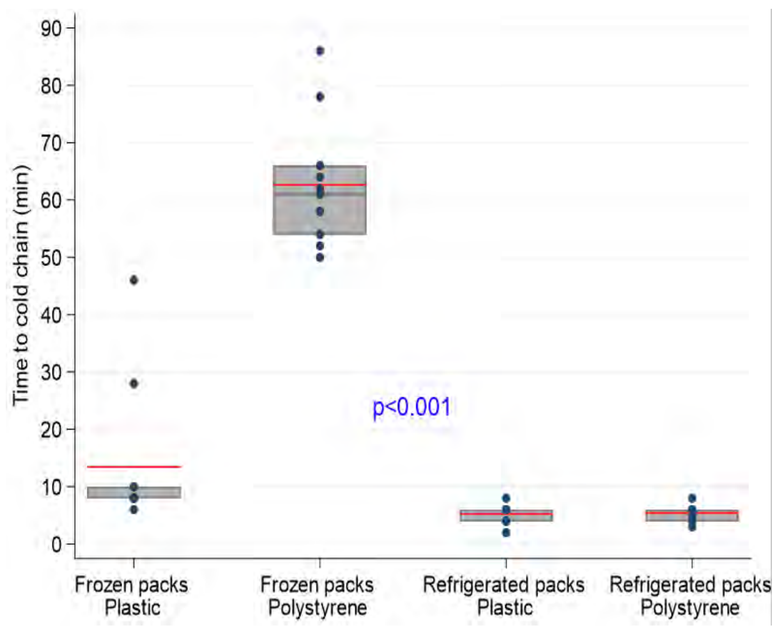

Figure 2. Time to cold chain achieved in each group

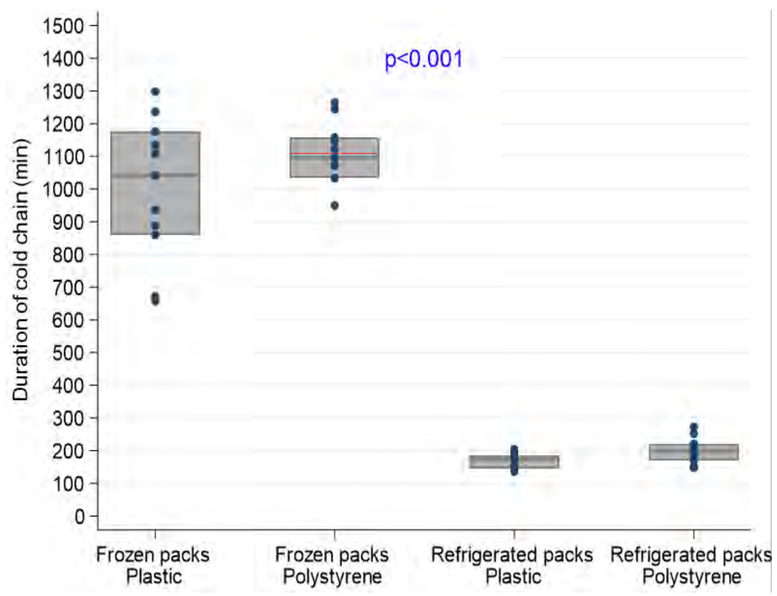

Figure 3. Duration of cold chain maintained in each group

DISCUSSION

Use of refrigerated coolant packs significantly reduces preparation time and monitoring, with no observed risk of cold excursions. This is useful for situations requiring expedited preparations, but also serves as a method to boost workplace efficiency while maintaining consistency in approach.

Within the frozen configurations, the group with plastic coolers (larger volume) actually resulted in shorter durations of cold chain and less cold excursions. This is attributed to greater residual air in the coolers, consistent with results seen in the study by Ng et al.[2]

Although duration of cold chain in the intervention groups were significantly shorter than the control groups, a mean cold chain duration of 185 minutes has great utility, with the majority of intra and inter-campus transport across Northern Health taking no more than 3 hours.

These results do not displace need for cold chain monitoring. However, these results do inform our local practices at NH with more tailored preparation methods for a range of given situations.

LIMITATIONS

Results of this study are highly specific to the coolant packs, coolers and ambient temperature range that were used in our study, reducing its generalisability without further testing.

Not all groups were equally comparable due to different coolant pack quantities and cooler volumes.

CONCLUSION

The use of pre-conditioned coolant packs greatly shortens the time it takes to prepare a cooler for cold chain conditions at the cost of maintaining cold chain for a shorter total duration of 2–3 hours.

Future work should be aimed towards completing the experiment, adjusting different variables and study materials to evaluate greater applicability and inclusion of alternative methods for cold chain preparation.

REFERENCES

1. Australian Government Department of Health. NATIONAL VACCINE STORAGE GUIDELINES – strive for 5 3rd edition. [Internet]. Canberra ACT. 2019. [cited 2022 April 27]. 58p. Available from: https://www.health.gov.au/sites/default/files/documents/2020/04/national-vaccine-storage-guidelines-strive-for-5.pdf
2. Ng CZ, Lean YL, Yeoh SF, Lean QY, Lee KS, Suleiman AK, et al. Cold chain time- and temperature-controlled transport of vaccines: a simulated experimental study. Clin Exp Vaccine Res. 2020 Jan;9(1):8-14. doi: 10.7774/cevr.2020.9.1.8. Epub 2020 Jan 31. PMID: 32095436; PMCID: PMC7024728.
3. Hibbs BF, Miller E, Shi J, Smith K, Lewis P, Shimabukuro TT. Safety of vaccines that have been kept outside of recommended temperatures: Reports to the Vaccine Adverse Event Reporting System (VAERS), 2008-2012. Vaccine. 2018 Jan 25;36(4):553-558. doi: 10.1016/j.vaccine.2017.11.083. Epub 2017 Dec 14. PMID: 29248264.