

ABSTRACT

Background: Traditional specimen lockboxes are metal with little or no insulation. Often these lockboxes sit outside the doctor's offices exposed to extreme hot and cold temperatures. Ambient seasonal temperatures are overlooked as a contributor to preanalytical variation and laboratory error, and to date, no guidelines or standards exist to improve this phase of the total testing process. In a recent study Dibbern and colleagues (Am J Clin Pathol 2021; 156:866-870), found significant negative effects of sample exposure to ambient temperature while stored in courier lockboxes. Objective: We have designed and tested a prototype insulated insert that fits inside a common sized metal lockbox to offer better protection from extreme temperatures. Methods: Working with California Innovations we created a prototype insulated courier lockbox insert with approximate dimensions of 12" (L) x 9" (W) x 12" (H)". The lockbox had a Styrofoam lining but no other insulation. We compared different high-density foam materials such as high density expanded polyethylene (EPE), high density ethylene vinyl acetate (EVA), and a radiant barrier film laminate; EPE with radiant barrier film was chosen for testing. Air temperature was monitored at the center of the lockbox at 23°C and 31°C and insulated lockbox insert was monitored at 29°C and 32°C ambient temperature. One ice pack was placed at the bottom of the lockbox; two ice packs were placed in the insert, on each side. Results: Air temperature in the lockbox exceeded 21°C at all timepoints; At 29°C and 32°C the insulated courier insert maintained temperatures of 5-11°C and 1-13°C, respectively, for five hours and 13°C or 15°C, respectively, after eight hours. Conclusions: The insulated courier lockbox insert protects specimens for considerably longer than the lockbox alone.

Figure 1: Insulated Lockbox Insert Prototype



BACKGROUND

A common practice among commercial laboratories and hospital outreach laboratories is the use of couriers to shuttle specimens from healthcare providers to a central laboratory. Patient specimens are typically placed in a lockbox, often located outside and exposed to temperature extremes. Recently, investigators have begun to study pre-analytical effects associated with specimen storage and transport, and adverse effects on patient results are recognized (1, 2). No standards have been developed for the use of outdoor courier lockboxes.

In the study by Dinnern *et al.* (2), short term storage (up to 4 hours) of both centrifuged and uncentrifuged lithium heparin specimens was assessed at external temperature of >32°C (mean temperature of 40°C). Lockboxes included two frozen cold packs (cold) or no cold packs (warm). After four hours many results exceeded the clinically significant change limit (SCL), especially in the warm lock boxes, including lactate dehydrogenase, aspartate aminotransferase, glucose, potassium, magnesium, and C-reactive protein. Mean internal temperatures for the cold and warm lockboxes were 18°C (12-23°C range) and 36°C (26-41°C), respectively.

Therefore, we have designed and tested a prototype insulated insert that fits inside a common sized metal lockbox to offer better protection from extreme temperatures.

METHODS

Working with California Innovations (Chicago, Ill) we created a prototype insulated courier lockbox insert with approximate dimensions of 12" (L) x 9" (W) x 12" (H)". We purchased a typical lockbox with a Styrofoam lining. We compared different high-density foam materials such as high density expanded polyethylene (EPE), high density ethylene vinyl acetate (EVA), and a radiant barrier film laminate; EPE with radiant barrier film was chosen for testing. Air temperatures were monitored at the center of the lockbox. Three 250 g (Test 1) or three 300 g frozen ice packs (Test 2) were placed in the insert: two on the sides and one on the bottom. Temperatures were compared with and without ice packs.

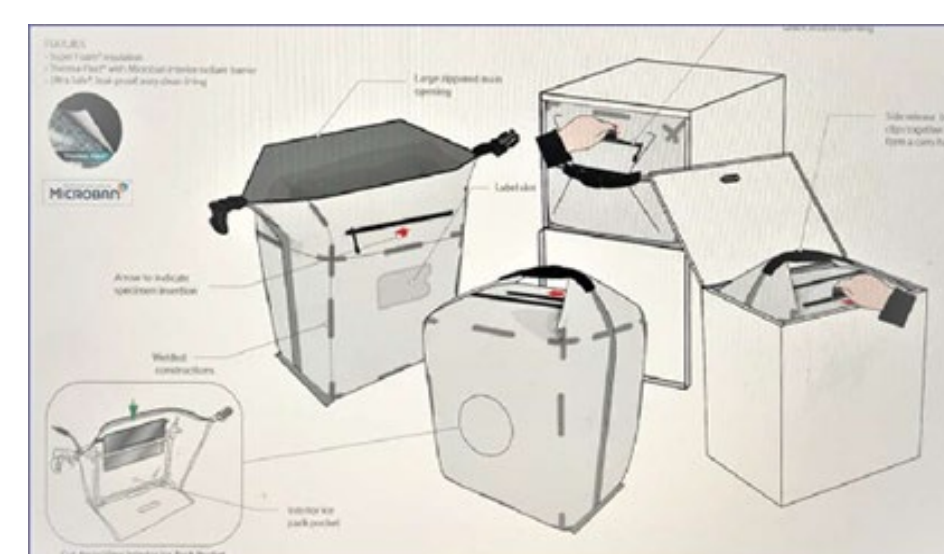


Figure 2: Insulated Lockbox Insert Design

RESULTS

Test 1 750 g ice packs; 3 x 250 g; one on side; two on bottom				
	No Insert	No Insert	Insert	Insert
Hours	F	C	F	C
0	84.23	29.02	40.25	4.58
0.25	87.02	30.57	33.44	0.80
0.5	87.75	30.97	38.49	3.61
0.75	88.06	31.14	43.61	6.45
1	88.19	31.21	46.90	8.28
1.25	89.65	32.03	49.50	9.72
1.5	89.70	32.06	50.96	10.53
1.75	89.47	31.93	51.61	10.89
2	89.37	31.87	51.99	11.10
2.25	89.30	31.83	52.16	11.20
2.5	89.28	31.82	52.39	11.33
2.75	89.28	31.82	52.53	11.41
3	89.60	32.00	51.97	11.10
3.25	90.50	32.50	53.33	11.85
3.5	90.64	32.58	53.74	12.08
3.75	90.26	32.37	53.84	12.13
4	90.10	32.28	54.12	12.29
4.25	90.14	32.30	54.24	12.36
4.5	89.82	32.12	54.71	12.61
4.75	89.93	32.18	54.90	12.72
5	89.67	32.04	54.97	12.76
5.25	89.61	32.01	55.31	12.95
5.5	89.82	32.12	55.20	12.89
5.75	90.64	32.58	56.33	13.52
6	90.20	32.33	56.70	13.72
6.25	89.79	32.11	56.47	13.59
6.5	90.51	32.50	56.70	13.72
6.75	90.40	32.44	57.65	14.25
7	89.92	32.18	57.91	14.39
7.25	89.69	32.05	57.53	14.18
7.5	90.51	32.50	58.77	14.87
7.75	90.30	32.39	58.93	14.96
8	90.78	32.66	59.79	15.44

Test 2 900 g ice packs; 3 x 300 g; two on side; one on bottom				
	No Insert	No Insert	Insert	Insert
Hours	F	C	F	C
0	78.04	25.58	63.52	17.51
0.25	82.72	28.18	40.71	4.84
0.5	83.82	28.79	43.62	6.46
0.75	83.78	28.76	46.59	8.11
1	84.26	29.03	48.22	9.01
1.25	84.48	29.15	49.05	9.47
1.5	84.80	29.34	49.13	9.52
1.75	85.21	29.56	49.58	9.77
2	85.10	29.50	50.10	10.06
2.25	84.83	29.35	50.26	10.14
2.5	85.20	29.55	50.41	10.23
2.75	85.30	29.61	50.75	10.42
3	85.18	29.54	50.55	10.30
3.25	85.03	29.46	50.89	10.50
3.5	85.13	29.51	51.03	10.57
3.75	84.88	29.38	51.22	10.68
4	84.88	29.38	51.59	10.88
4.25	84.88	29.38	51.81	11.01
4.5	85.06	29.48	51.96	11.09
4.75	85.08	29.49	52.04	11.13
5	84.66	29.26	52.26	11.25
5.25	84.28	29.04	52.39	11.33
5.5	84.19	28.99	52.60	11.45
5.75	84.08	28.93	52.69	11.49
6	84.04	28.91	53.02	11.68
6.25	83.68	28.71	53.16	11.76
6.5	83.60	28.67	53.41	11.89
6.75	83.48	28.60	53.60	12.00
7	83.20	28.45	53.90	12.17
7.25	83.15	28.42	53.99	12.22
7.5	82.99	28.33	54.17	12.32
7.75	83.82	28.79	54.12	12.29
8	84.05	28.92	55.59	13.10

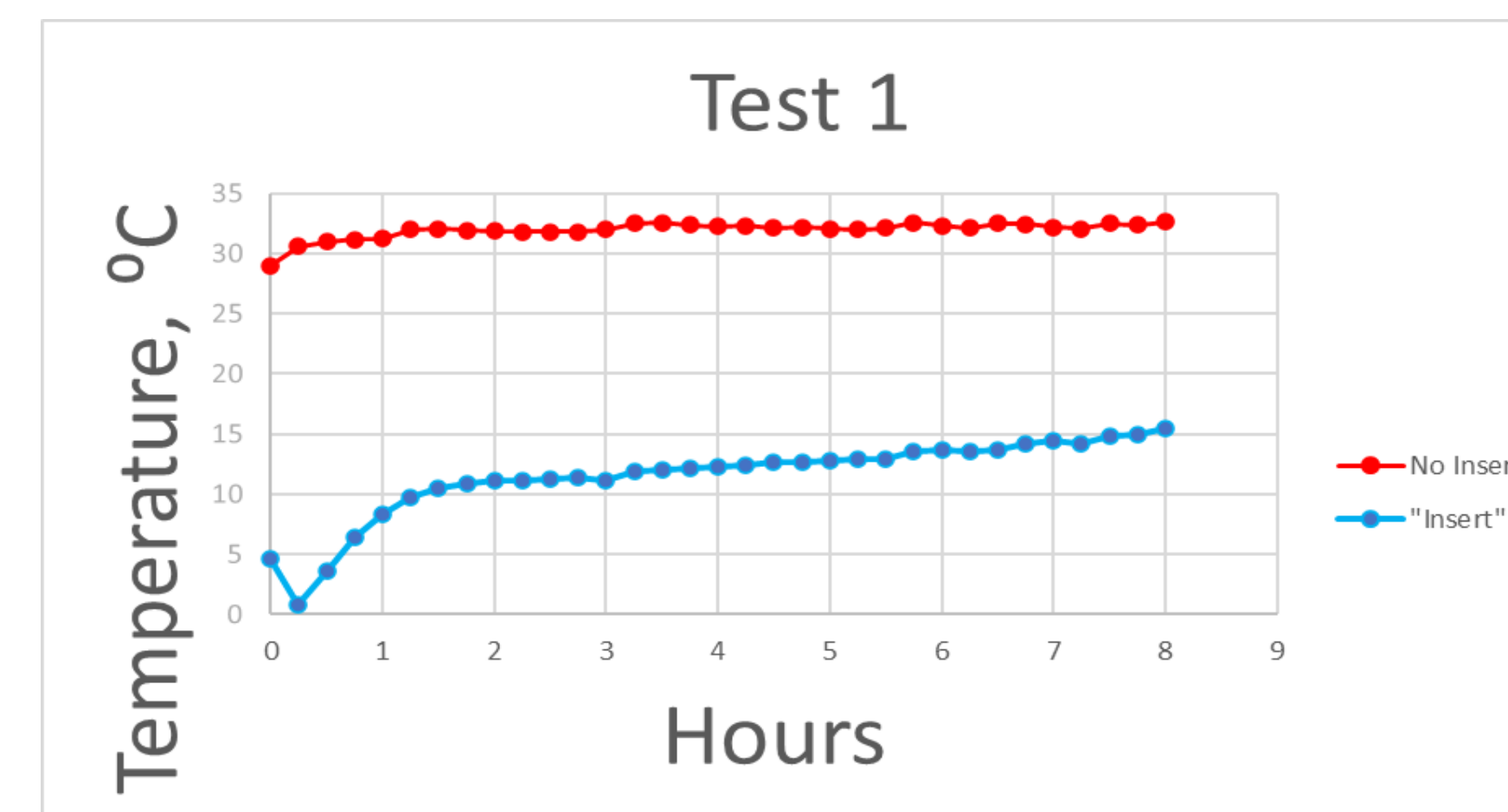


Figure 3: Comparison of air temperatures inside lockbox, with and without insulated insert.

CONCLUSIONS

Air temperature in the lockbox without an insulated insert exceeded 21°C at all timepoints; At 29°C and 32°C ambient temperatures the insulated courier insert maintained temperatures of 5-11°C and 1-13°C, respectively, for five hours and 13°C or 15°C, respectively, after eight hours.

REFERENCES

- Zaninotto M, Tasinato A, Vecchiato G, Legnaro A, Pinato A, Plebani M. Clin Biochem 2017; 50:574-578.
- Dibbern ME, Pierre CC, Wieneck JR. Am J Clin Pathol 2021; 156: 866-870.