Application of a Reusable Chemical Gel Heat Pack to Provide Rodent Cages with Supplemental Heat

Mindy Yarbrough BS, RLAT, Tandy Lamberty AAS, Jamie Tackett CVT RLatg, Chris Manuel DVM, PhD, DACLAM, Jori Leszczynski, DVM, DACLAM
University of Colorado Denver | Anschutz Medical Campus

Introduction

A vital role in animal husbandry is providing care to animals found to be hypothermic. In order to increase vascular circulation and body temperature of hypothermic animals, University of Colorado-Denver applies heat to the external surface of the cage by utilizing chemical gel heat packs (gel packs). To determine the maximum output, longevity and optimal placement of the gel packs, three experiments were conducted.

Materials


Figure 1


Figure 2

Chemical Gel Heat Pack
- Reusable gel heat packs called *Space Gel™* (***Figure 1)***
- Reset after every use in a rice cooker, 20 minute run time
- Heat pack contains sodium-acetate and food coloring inside of a plastic casing, metal disk that initiates the sodium-acetate crystallization to form an energized crystal lattice that produces an exothermic reaction


Figure 3

Infrared Thermometer
- MicroEpsilon IR Thermometer (***Figure 2)***
- Close focus optics allow for temperature measurement of objects as small as 1mm


Figure 4

Data Logger
- Extech RH520A Humidity and Temperature Digital Chart Recorder (***Figure 3)***
- Measured temperature at every one minute interval

Thermal Imager
- Fluke Ti32 Thermal Imager (***Figure 4)***

Methods

Experiment 1: Assessment of Gel Pack Heat Production
- Thermal Imager used to collect temperature of gel packs (***Figure 5)***
- Rapid gel pack activation observed during the first ten seconds of gel pack activation (***Figure 6)***
- Images taken every 5 minutes until 65 minutes. Then every 10 minutes for a total of 2 hours 15 minutes.

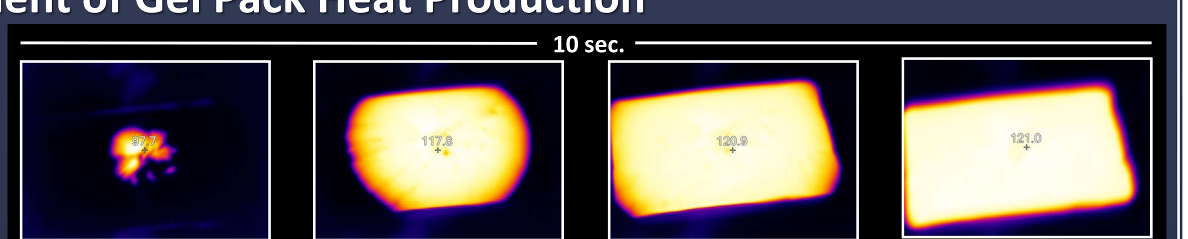


Figure 5: Serial infra-red images

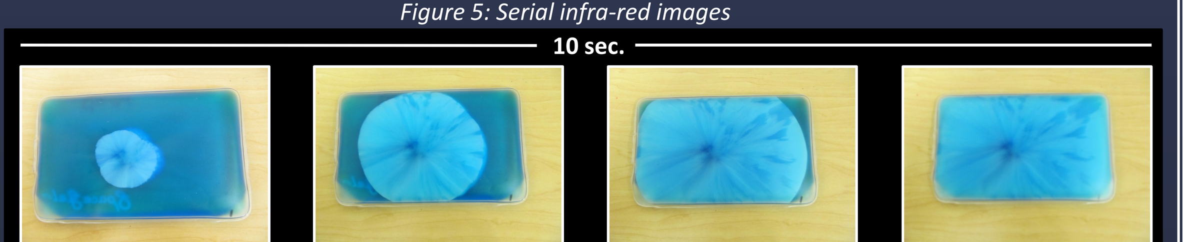


Figure 6: Serial digital photographs corresponding to Figure 5

Experiment 2: Determine Duration of Heat Production Utilizing IR Thermometer
- 3 new gel packs were activated simultaneously
- IR Thermometer measured heat upon activation
- Temperature taken from the center of gel pack at set intervals over 3 hours
- Gel packs were reset continually and at every 10th reset the temperature was monitored
  - Every 5 minutes until 15 minutes,
  - Every 15 minutes until 60 minutes
  - Every 30 minutes until 120 minutes
  - Final measurement at 180 minutes
- Each activation was tallied directly on the Space Gel
- Gel packs were weighed and photographed after every 10th reset


Figure 7- Under cage card holder on ventilated rack

Experiment 3: Determine Optimal Placement of Gel Pack
- Intra-cage temperature logged for 3 hours
- Baseline temperature collected of a cage on
- Ventilated rack
- Animal transfer station (ATS)
- Compare intra-cage rise in heat of a gel pack (20 resets or less) to a warm water recirculating blanket which provides constant heat over time
- Various configurations of gel pack tested (***Figures 7-9***)


Figure 8- Under cage on ATS

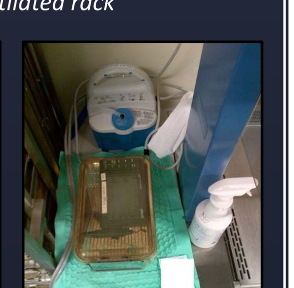


Figure 9- Warm water recirculating blanket on ATS

Results

Experiment 1: Assessment of Gel Pack Heat Production

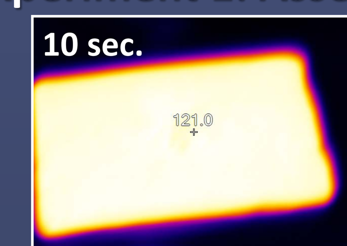


Figure 10-Thermal image of initial activation

Activation temperature = 121°F (49.4°C)

Temperature 3 hours post- activation = 77.3°F (25.2°C)

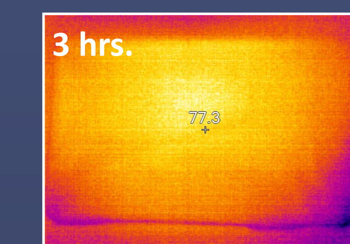


Figure 11-Thermal image 3 hours post activation

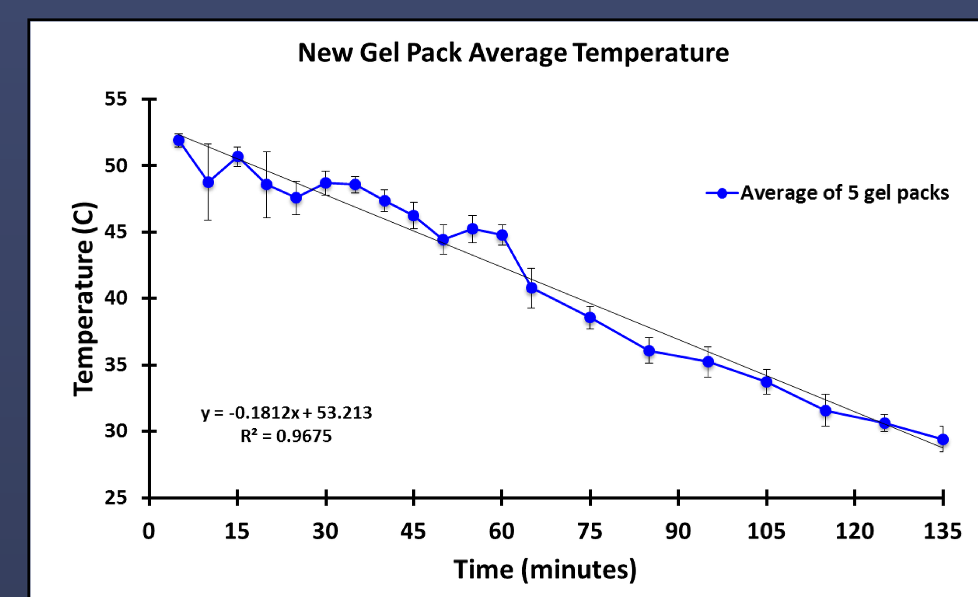


Figure 12-The steady decline in temperature of a gel pack three hours after activation

- Gel pack temperatures average high of 124.2°F (51.2°C) within five minutes (***Figure 12***)
- Gel packs maintained heat for the duration of data collection period and remained above room temperature 72 °F (22.2°C) after the two hour mark
- Within 135 minutes, a linear temperature decrease is seen after the first activation. The rate of temperature loss was roughly 35.6 °F (2°C) per minute.

Experiment 2: Determine Duration of Heat Production Utilizing IR Thermometer

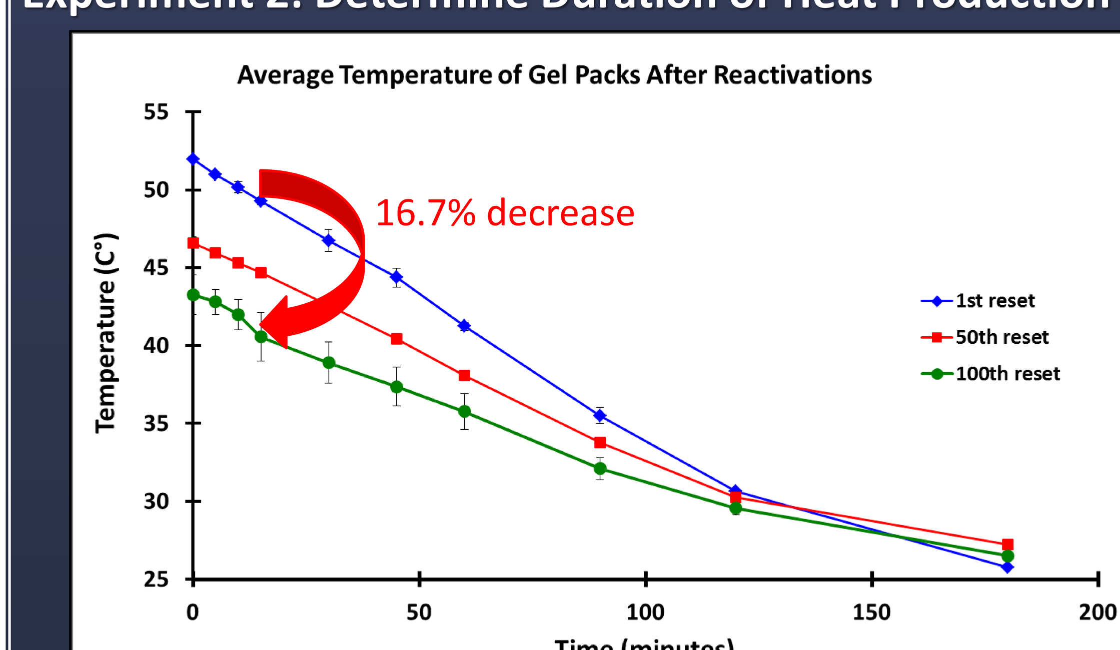


Figure 13- Difference in temperature decline of 3 gel packs at various reset stages during 3 hours of measurement

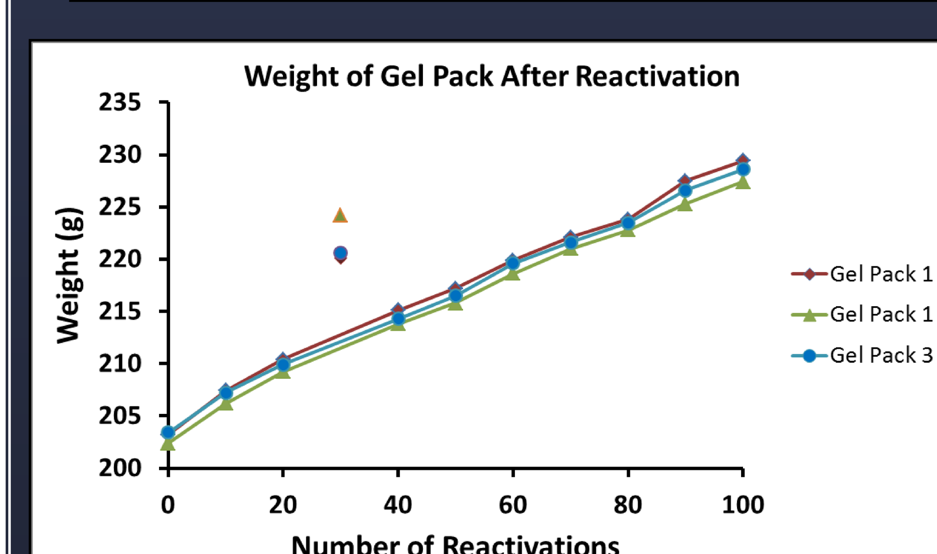


Figure 14- The change in weight over time

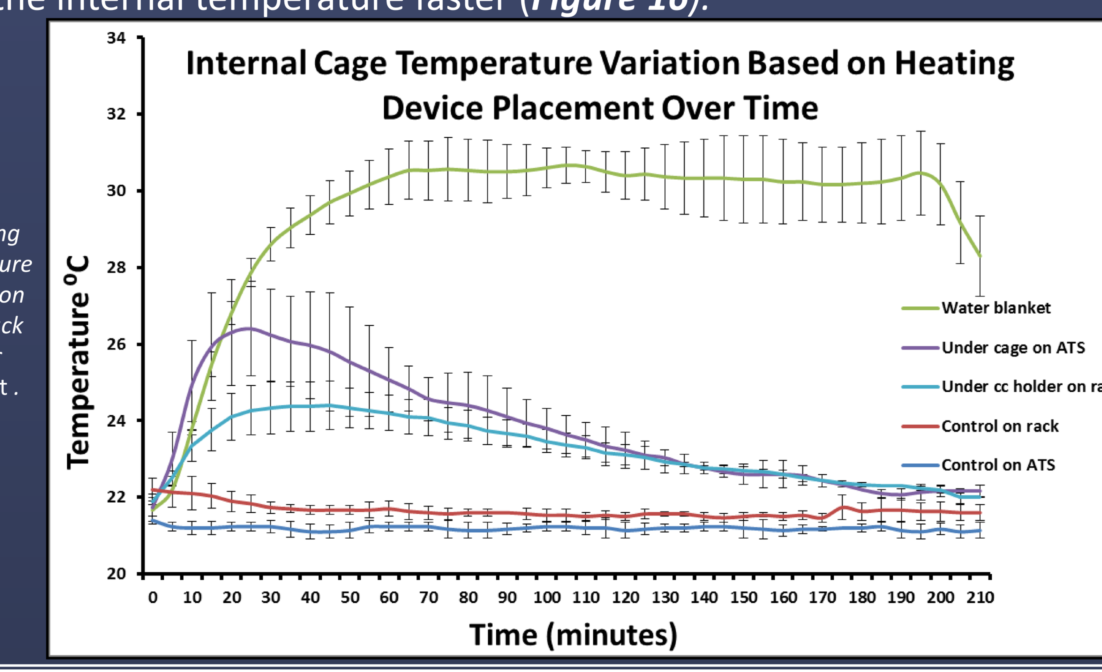
- There was a 16.7% decrease (***Figure 13)*** in gel pack heat between the 1st and 100th reset.
- A linear increase in weight was identified over the length of the experiment (***Figure 14***)
- At the 40th reset the gel packs were weighed while still warm and skewed the data
- Average weight gain was 12.5% or 15 grams
- The gel packs transitioned from turquoise to a dark magenta (***Figure 15***) after 100 activations.

Figure 15 – Photographs taken after every 10 activations to show color transition

Results continued

Experiment 3: Determine Optimal Placement of Gel Pack
- The warm water recirculating blanket maintained a constant temperature inside the cage, once the maximum temperature of 87.3 °F (30.7 °C) was reached. The maximum intra-cage temperature reached by the gel pack under the cage was lower at 79.9 °F (26.6 °C).
- The most effective placement of an activated gel pack was under the cage, placed on the ATS.
- 3 hours post activation of the gel pack, the intra-cage temperature was above room temperature 72°F (22.2°C).
- The warm water recirculating blanket heated the internal temperature of the cage at a rate of 32.1 °F/minute (0.06°C/minute) while the gel pack under the cage on the ATS heated up at a rate of 32.3 °F/minute (0.15°C/minute) until the maximum temperature was reached. The gel pack heated the internal temperature faster (***Figure 16***).

Figure 16- Comparing the control temperature of a cage on a rack, on an ATS with a gel pack and a warm water recirculating blanket .



Conclusions

Gel packs quickly produce heat and within 5 minutes, a new gel pack can reach up to 124.2°F (51.2°C). Two hours after activation, new gel packs remained elevated above room temperature at 84.9° F (29.4 °C). A 16.7% decrease in maximum temperature was seen after 100 activations. After 60 activations, the gel packs were within 41°F (5°C) or ~90% of the maximum temperature of new gel packs. The recommendation for discard of gel packs is after the 60 activation mark. This is roughly when the gel packs begin to change from purple to magenta. Utilizing a rice cooker (boiling water) to reset the gel packs resulted in a weight increase and a significant color change. While this change was observed, it is unknown if this impacted the functionality of the gel packs during the study, although it did provide a visual cue for disposal of the gel packs.

The gel pack under the cage on the animal transfer station resulted in a slightly quicker rate of increase of intra-cage temperature than the warm water recirculating blanket. The gel pack achieved a maximum internal cage temperature of 82.2°F (27.9 °C), less than the warm water recirculating blanket maximum internal cage temperature of 87.3°F (30.7°C). These elevated internal cage temperatures fall within the reported mouse thermo-neutral zone of 78.8-93.2 °F (26-34° C) (*Guide for the Care and Use of Laboratory Animals*, NRC 2011, p 43). The ultimate goal of the gel packs is to provide heat in the quickest means possible to a hypothermic animal.

Circulating warm water blankets provide constant heat but are bulky and expensive, limiting their availability. In comparison, reusable chemical gel heat packs are inexpensive, can be distributed to multiple areas and easily cleaned in between uses to limit biosafety and cross contamination concerns. We conclude that the gel packs were effective at increasing intra-cage temperature to provide supplemental heat for two hours post activation and can be utilized in multiple locations, independent of health status, with limited fear of cross contamination.

Product Information

Spacedrapes, Inc.
3989 Rupp Rd.
Manchester, MD 21102
USA
Tel: 443 507 5197
www.spacedrapes.com

The poster collaborators and University of Colorado have no affiliation with Space Drapes, Inc.

Acknowledgements

- Thank you to the Office of Laboratory Animal Resources for providing funding to buy the infra-red thermometer.
- Thank you to Spacedrapes, Inc for donating gel packs for this project.
- Thank you to Jesse Walklett for acquiring imagers and thermometers for our use over the past year.
- Thank you to John Yarbrough for your assistance with data analysis and graph creation.

ABSTRACT

Application of a Reusable Chemical Gel Heat Pack to Provide Rodent Cages with Supplemental Heat

Mindy Yarbrough[1], Tandy Lamberty[1], Jamie Tackett[1], Chris Manuel[1], Jori Leszczynski[1]

1. Office of Laboratory Animal Resources, University of Colorado Denver, Aurora, CO, United States.

A vital role in animal husbandry is providing care to rodents found to be hypothermic after an automatic watering system failure. One method of applying heat is to use an external warming device to warm the home cage. Circulating water blankets provide constant heat but are bulky and expensive, limiting their availability. In comparison, reusable chemical gel heat packs are inexpensive and can be distributed to multiple areas to limit concerns of cross contamination. The goal of this study was to determine if gel packs are a viable option for providing supplemental heat by determining the amount of heat generated, the duration of heat, arrangement of gel pack and cage for efficient heat transfer, and the product lifespan. Three gel packs were activated and reset 100x and their temperatures were measured using an infrared thermometer to determine the lifespan of the product. A second set of gel packs were used to determine the optimal placement in contact with the cage to increase intra-cage temperature. A variety of orientations were attempted including placing the gel pack under the cage or under the cage card holder, as compared to a circulating water blanket which went under the cage. It was determined that new gel packs reached a maximum temperature of 51.9°C, which decreased to 43.3°C after 100 resets. A color change from aqua to pink and gradual weight increase of 8.7 ± 0.2 g correlated with the overall number of gel pack resets. Placement of the gel pack under the cage provided the most efficient and rapid increase in intra-cage temperature of all positions tested. The gel pack achieved a maximum intra-cage temperature of 26.5 ± 1.2°C after 26.3 ± 4.2 min and returned to room temperature (21.7 ± 0.1°C) after 185.3 ± 1.2 min. The maximum intra-cage temperature achieved by the water blanket was 30.8 ± 0.6°C after 91 ± 19 min which was maintained indefinitely. We conclude that the gel packs were effective at increasing intra-cage temperature until 50-60 resets and the color change to magenta allowed for a standard disposal without keeping track of resets. Gel packs effectively provide supplemental heat for two hours post activation and can be utilized in multiple locations independent of health status with limited fear of cross contamination.