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Research Personnel Exposure to Carbon Dioxide During Euthanasia Procedures

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Environmental Health & Safety[1] and Vivarium[2] | Rowan University School of Osteopathic Medicine, Stratford, N.J.

BACKGROUND

Carbon dioxide (CO_2) is a commonly used euthanasia agent in animal facilities. This procedure is carried out by replacing oxygen with carbon dioxide in animal cages, thus providing a quick and painless method of euthanasia. Unfortunately, there has been limited research on the potential effects of human exposure to CO_2 during euthanasia procedures.

Following a previous carbon dioxide exposure study in the vivarium at Rowan SOM in 2016[1], the CO_2 cylinders and euthanasia chambers have been relocated to room 153 Science Center and the vivarium has adopted a localized exhaust that helps remove the contaminant at the source.

While the results from the 2016 study were within the Occupational Health and Safety (OSHA) and American Conference of Governmental Industrial Hygienist (ACGIH carbon dioxide exposure limits, the research team replicated the study to ensure compliance at the new euthanasia chamber location.

METHODS

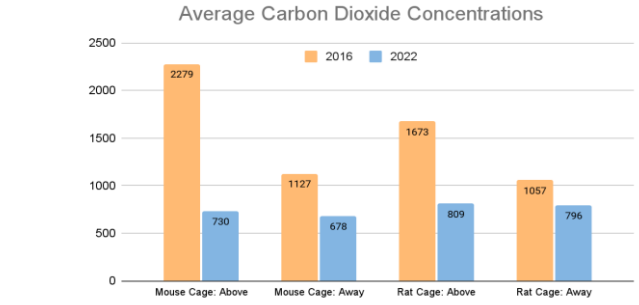
Carbon dioxide measurements were recorded while mimicking the vivarium's euthanasia procedure as required in the vivarium's CO_2 euthanasia Standard Operating Guideline (SOG).

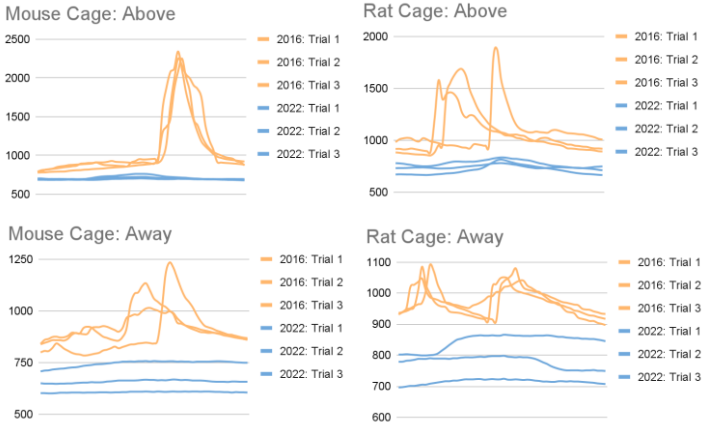
The carbon dioxide concentrations in the room were measured with a IAQ-Calc 7545 (TSI, Inc.; Shoreview, Minnesota) during a mock euthanasia procedure. These measurements were taken prior to turning on the gas, for the duration of the gas introduction into the euthanasia chamber, during the dwell time, after the lid was removed while mimicking animal removal, and until the concentrations returned to baseline level.

The flow of carbon dioxide through the animal cage occurred for three minutes. Measurements were taken directly above the euthanasia chamber (equivalent to 66 inches off the floor) and 60 inches away from the euthanasia chamber at 66 inches off the floor. Each trial was performed with the door to the room closed.

Three trials were performed with a mouse cage (Allentown PC75JHT75JAG, high temperature plastic mouse cage [75 in^2], Allentown, NJ) and a rat cage (Allentown PC10198HT, high temperature plastic rat cage [105.79 in^2], Allentown, NJ) at the two locations indicated above.

RESULTS

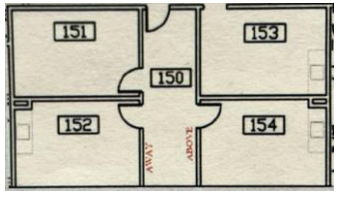




Carbon dioxide levels were significantly lower in this study than the results of the 2016 study. The 2022 measurements display relatively linear carbon dioxide levels compared to the previous study which had dramatic increases during peak concentrations.

Concentrations for the mouse cage both above the euthanasia chamber and 66 inches away had an average peak of 730 ppm and 678 ppm, whereas the 2016 study had an average of 2279 ppm and 1127 ppm respectively. Concentrations for the rat cage both above the euthanasia chamber and 66 inches away had an average peak of 809 ppm and 796 ppm, whereas the 2016 study had a high of 1673 ppm and 1057 ppm respectively.

The results are specific to room 153 Science Center. The room size, configuration, frequency of euthanasia procedures, number of air exchanges per hour, and airflow dynamics will directly affect the outcome of other facilities.



DISCUSSION

CO_2 is the fourth most common gas present in the earth's atmosphere with an ambient concentration of about 350 ppm. CO_2 is a colorless, odorless non-flammable gas that is present in the atmosphere at 0.035%. The OSHA Permissible Exposure Limit (PEL) and ACGIH Threshold Limit Value (TLV) for an 8-hour exposure to CO_2 is 5,000 ppm. Symptoms begin to appear once the exposure limit is surpassed.

10,000 ppm (1.0%)	Typically no effects, possible drowsiness
15,000 ppm (1.5%)	Mild respiratory stimulation for some people
30,000 ppm (3.0%)	Moderate respiratory stimulation, increased heart rate and blood pressure, ACGIH TLV-Short Term
40,000 ppm (4.0%)	Immediately Dangerous to Life or Health (IDLH)
50,000 ppm (5.0%)	Strong respiratory stimulation, dizziness, confusion, headache, shortness of breath
80,000 ppm (8.0%)	Dimmed sight, sweating, tremor, unconsciousness, and possible death

Symptoms of Carbon Dioxide Exposure Beyond Recommended Limits [2]

The AVMA Guidelines for Euthanasia of Animals view CO_2 as conditionally acceptable for euthanasia of those species in which aversion or distress can be minimized. Rodents must be euthanized by trained personnel using appropriate technique, equipment, and agents. Upon completion of the procedure, death must be confirmed by an appropriate method, such as ascertaining cardiac and respiratory arrest or noting an animal fixed and dilated pupils.

CONCLUSION

Research personnel who follow the current SOG for euthanizing rodents at Rowan SOM are not exposed to levels of carbon dioxide that exceed the OSHA limit. The localized exhaust plays an essential role in the dramatic decrease in carbon dioxide levels.

REFERENCES

1. Boyle, Thomas Research Personnel Exposure to Carbon Dioxide During Euthanasia Procedures Poster Presented at the 20th Annual Rowan SOM Research Day; May 2016, Stratford, NJ
2. USDA. (2022). *Carbon Dioxide Health Hazard Information Sheet.* FSIS Environmental, Safety and Health Group. https://www.fsis.usda.gov/sites/default/files/media_file/2020-08/Carbon-Dioxide.pdf
3. American Veterinary Medical Association. (2020). *AVMA Guidelines for Euthanasia of Animals* https://www.avma.org/sites/default/ files/2020-02/Guidelines-on-Euthanasia-2020.pdf