Impact of IVC design in Animal Welfare and Standardization

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Transparent Plastic Open Cage (Conventional)

- **1144B** Eurostandard Type II
  - 332x150x130mm – Floor Area 335cm²
- **1145T** Eurostandard Type II
  - 369x156x132mm – Floor Area 435cm²
- **1264C** Eurostandard Type II
  - 267x207x140mm – Floor Area 370cm²
- **1284L** Eurostandard Type II L
  - 365x207x140mm – Floor Area 530cm²
- **1290D** Eurostandard Type III
  - 425x266x155mm – Floor Area 820cm²

**Plastic Selection**
- Polycarbonate (PC)
- H-Temp Polysulfone (PSU)
- U-Temp Polyetherimide (PEI)

**Guinea Pigs**
- **1291H** Eurostandard Type III H
  - 425x266x185mm – Floor Area 800cm²
- **1500U** Eurostandard Type IV S
  - 480x375x210mm – Floor Area 1500cm²
- **1354G** Eurostandard Type IV
  - 595x380x200mm – Floor Area 1820cm²
- **2000P**
  - 610x435x215mm – Floor Area 2065cm²

**Rats/Hamsters**
- **2150U** Eurostandard Type IV S
  - 480x375x210mm – Floor Area 1500cm²
- **2154F**
  - 480x265x210mm – Floor Area 940cm²

*As well suitable for Rats*

**Mice**
- **1291H** Eurostandard Type III H
  - 425x266x185mm – Floor Area 800cm²
- **1290D** Eurostandard Type III
  - 425x266x155mm – Floor Area 820cm²

*TECNIPLAST*

**innovation through passion**
Individually Ventilated Cages

In the 90’s confirmed scientific importance and success of **transgenic mice** leaded to:

- Development and diffusion around the world of **thousands of different colonies**
- Increased need to house small **isolated groups** of animals from different sources
- Housing of colonies with different microbiological **status** and quarantine requirement
- Confirmed need to **protect the clean colonies** from the dirty ones
- Need to **stop the growing “allergy” problem** (working environment improvements)

**IVCs to manage higher standard requirements**
IVC vs. Conventional Cages

Some of the established advantages of IVCs

- Bioexclusion
- Biocontainment
- Breeding performances
- Diminish Smell, ammonia, hair, debris, bedding in the room
- Density, operational, workload, costs (ROI)

IVCs are the result of high skills in housing design, air treatment engineering, plasticware technology, electronics and sensors.
Cages: design and variables

The “3 R” concept of Lab Animal Science

- Reduction
- Refinement
- Replacement

STANDARDIZATION

ANIMAL WELFARE
DIFFERENT IVC SYSTEMS HAVE DIFFERENTIAL INFLUENCE ON ANIMAL BEHAVIOUR

“The environment in which a laboratory animal is housed can influence its behaviour and welfare, acting as a potential confounding factor [...]”

“[…] different IVC systems can influence mouse behaviour […] exhibiting more anxiety related behavior”

“[…] the term IVC cannot be generalized across IVC systems, because variation between these systems may well have differential influences on mouse behaviour…”

REFERENCE:
The effect of two different Individually Ventilated Cage systems on anxiety-related behaviour and welfare in two strains of laboratory mouse
O. Burman, L. Buccarello, V. Redaelli, L. Cervo
Explanation Oliver Burman’s study - (University of Lincoln, UK)

Behavioural test: the Elevated Plus Maze
Explanation Oliver Burman’s study - (University of Lincoln, UK)

Behavioural test: the Open Field
**Explanation Oliver Burman’s study - (University of Lincoln, UK)**

<table>
<thead>
<tr>
<th>Behavioural Study</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Elevated Plus Maze</td>
<td>In XXXXX cages increased defaecation in the EPM, decreased time spent in the open arm of the EPM, and increased time spent in the starting position in the EPM = <strong>HIGHER STRESS LEVEL IN XXXXX CAGES</strong></td>
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<tr>
<td>Open Field</td>
<td>Mice housed in XXXXXXXX cages spent less time in the central/internal zone of the arena, suggesting reduced confidence compared to those mice housed in Tecniplast <strong>HIGHER STRESS LEVEL IN XXXXX CAGES</strong></td>
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IVC: design and variables

Air Changes per Hour (ACH) in the cage

75 ACH
Air Changes per Hour (ACH)

A recent correlation to Hypoxia in mice

«while with [IVC manufacturer’s name omitted] IVC the “oxygen levels within IVCs was **20.5% as compared to 21%**” and consequently “mice housed within IVCs had a 9.7%, 8.6%, and 8.8% increase in red blood cell count, hemoglobin, and hematocrit,(respectively) and a 16.7% increase in platelets.”


«No differences on mean Red Blood Cell (RBC) count and related parameters [...] were seen between mic from the two systems (ventilated and open) [...] The number of Air Changes per Hour (75) in the GM500 IVCs is probably the key point»

G. Milite «GM500 Green Line Individually Ventilated cages: their normoxic atmosphere and its impact on haematological parameters of mice»
IVC: design and variables

Position of the air valves for supply and exhaust, in the cage
DIFFERENT IVC SYSTEMS HAVE DIFFERENTIAL INFLUENCE ON ANIMAL BEHAVIOUR

“The location of the air supply influenced the choice of the mice, who preferred having the air supply in the cover to that in the wall of the cage”

REFERENCE:
Individually Ventilated Cages: Beneficial for Mice and Men?”
Baumans Vera, Schlingmann Freek, Vonck Marlice and Van Lith Hein A.: Contemporary Topics, Jan 2002
Explanation Vera Baumans study- (Utrecht University, Holland)
IVC: design and variables

Speed of the air at Animal Level
MICE CLEARLY REJECTED CAGES WITH A NOTABLE AIR SPEED

“[…] some of the systems have the air blown into the cage just above the bedding, and an earlier study has shown that the air speed for that kind of ventilation may lead to air speeds above 0.5m/s.”

“[…] Mice do react to draughts, whereas they do not seem to be affected by a high number of air changes delivered without draught, which underlines the importance of applying draught-free IVC systems […]”

REFERENCE:
Mice prefer draught-free housing
T. C. Krohn and A. K. Hansen
Laboratory Animals 2010; 44: 370–372
Explanation T.C. Krohn’s study – (University of Copenhagen, Denmark)

Test n.1: ACH
Explanation T.C. Krohn’s study – (University of Copenhagen, Denmark)

Test n.2: Air Speed

Lower Air Speed (<0.5 m/s)  Higher Air Speed (>1 m/s)
AIR SPEED AT ANIMAL LEVEL

Air speed in the cages should not exceed 0.2-0.3 m/s, in any position accessible to the animals.
We want to avoid this...!!!
Computational Fluid Dynamics
Velocity Streamlines

AIR INLET IN THE TOP

AIR INLET IN THE BOTTOM
Video 3D Velocity Streamlines
IVC: design and variables

Positioning and type of Air handling Units

- Vibrations and effects on breeding efficiencies
- Levels of ultrasound generated by the blower
Positioning of the Blower

Vibrations and effects on breeding efficiencies

« Some mouse colonies that could not \textit{breed successfully} in racks with mounted blower ventilation (and thus were housed in static caging) have bred effectively using this cage ventilation system. Our suspicion is that the lack of vibration and/or sound was a significant factor.»


Levels of ultrasound generated by the blower to be considered too, for animal welfare
IVC: design and variables

Enrichment

• Impact on behaviour and standardization – standard enrichment
Enrichment

Impact on behaviour and standardization – standard enrichment

«The Mouse House [...] resulted in significant increases in several positive behaviours and significant reductions in negative behaviours»

D. Key, A. Hewett «Developing and testing a novel cage insert, the Mouse House, designed to enrich the lives of laboratory mice without adversely affecting the science» Animal Technology and Welfare August 2002
Enrichment

Impact on behaviour and standardization - Double Decker Cage

«The rats in the IVC system were less aggressive when handling them, [...] and it was also less hierarchic fight. [...] The new IVC cage with upper floor seems to increase the well being of the animals»
A.C. Eklöf et al. «Exposure and density of rat allergens for personnel and in the animal room a comparison between novel IVC equipment for rats and conventional open cages» 2010 AALAS published poster

«The rats appeared to be more active in the Tecniplast cage as they were able to stretch and stand upright; Tecniplast housed rats were observed to be calmer and easier to handle during cage changing»
C. Harvey-Clark et al. «Comparison of different bedding materials and caging systems for rats at the Centre for Disease Modeling» 2011 CALAS published poster
Thank you !!!