

Effects of Caging Systems on Animal Welfare, Work Environment and Study Outcome

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Different cage systems can be used to house laboratory rodents, in the table below three of these are compared by categorizing into various categories.

Categories:

- ÷ Negative effect of cage type in this relation
- Indifferent effect of cage type in this relation
- + Positive effect of cage type in this relation
- < Decreased factor compared to other cage types
- > Increased factor compared to other cage types.

Table 1: A comparison of three aging systems: Open cage (also known as conventional cage), ScanTainer (also known as cabinet), and Individually Ventilated Cages (IVC). **Abbreviations:** ACH: Air changes per hour, IVC: Individually ventilated cages, O₂: Oxygen, NA: Non-Available, NH₃: Ammonia, and RH: Relative humidity.

Topic	Open cage	ScanTainer	IVC	Source
Cage environment				
Light	Rats with coverage and limited light is less anxious and stressed.			[1]
	+/÷	+	+/÷	
Light	Light exposure impairs retinal function and structure in rats.			[2-5]
	+/÷	+	+/÷	
Sounds	Chronic ultrasound exposure influence behavior, impair memory and lead to depressive like behavior.			[6-8]
	÷	+	+	
Sounds	Chronic noise change animal body weight, influence behavior, serum concentrations, and gut microbiota composition. However, exposure to moderate levels of noise do not alter the welfare of mice			[9, 10]
	-	-	-	
Smell	Smells are important for social recognition, social cue processing, and communication. Therefore, ability to smell neighbors may increase welfare, but could also influence observational results.			[11, 12]
	+/÷	+/÷	+/÷	
Draught	Mice show preference for cages without draught and IVC cages with air supply in the top of the cage. Air inlet at the level of the mice show a negative effect on body weight and a			[13-16]

	relation to anxiety related behavior. Rats have shown less susceptible to air speed than mice, however high number of ACH can affect heart rate and systolic blood pressure.	
	NA	NA
		+/ \div
NH ₃	IVC keep NH ₃ levels low both in cages and in the stable for at least 7 days independent of position of the cage in rack.	[17-20]
	\div	NA
		+/ $<$ NH ₃
O ₂	IVC above 50 ACH does not influence O ₂ air concentrations or red blood cell count.	[21-23]
	-	-
Particles	IVC decrease particle levels in the cages both at low and medium ACH.	[17]
	-	NA
		+
RH	IVC increase RH within the cages both at low and high ACH.	[17, 21]
	-	-
		+/ \div
Temperature	IVC increase temperature within the cages (1-2 degrees).	[17, 24]
	-	-
		> Temperature
Microbiota		
Microbiota	IVC can be used for at least four weeks without influencing the microbiota of germ-free mice (alternative to gnotobiotic isolators).	[25, 26]
	NA	NA
		+
Inflammation		
Inflammation	IVC decrease inflammation in mice and female rats.	[20, 27]
	> inflammation	NA
		< inflammation
Behavior		
Isolation	Females prefer smelling, hearing, and seeing familiar rats when physically isolated. Males seem indifferent to short term isolation but develop depressive-anxiety like behavior after 6 weeks of isolation.	[28-31]
	+	+
		\div
Anxiety	Cage types does not affect anxiety in mice, except for C57Bl/6J mice, which have decreased anxiety in IVC cages.	[24, 32]
	-	-
		< Anxiety
Locomotion	Caging types does not affect locomotion in mice.	[21, 24, 32]
	-	-
		-
Body weight	Caging types does not influence weight gaining.	[24, 27]
	-	-
		-/$>$ body weight

Work environment			
Work environment	Ventilated husbandry solutions reduce levels of airborne allergen substantially at negative pressure but can be ergonomically less suitable.		[33]
	÷	+ (÷ ergonomic)	+
	Allergen spread and exposure is high within stables and animal facilities with open cages. However, this is minimized in facilities using IVC (especially with negative pressure).		[34, 35]
	÷	NA	+
	Medium to high allergen exposure is observed during cage changing and washing. Cage-changing stations is advised.		[35]
	÷	NA	+

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