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All animal studies were ethically reviewed and carried out in accordance with Animals (Scientific Procedures) Act 1986 and the GSK Policy on the Care, Welfare and Treatment of Animals.

Introduction

Home cage monitoring is not a new technique, the idea of using technology to observe animals over a 24 hour period to help staff monitor welfare and health has been around for many years. Yet there is still a long way to go before the ideal system will be available. If indeed such a system could ever exist? Several criteria need to be considered, and a system that fits all situations may not be feasible. There are a few 'off the shelf' cage monitoring options available, each working in a different way to the other. Selecting the best system for a facility is not as easy as choosing cages, and that is not simple.

The concept of Home Cage Monitoring

As a result of the increased desire to integrate technology into animal facilities, most animal areas now rely heavily on computer databases for daily routines and management. It was only a matter of time before our attention turned towards the animal's cage to see how we could use technology to help us understand the animal more. The idea of having camera peering into animal cages and giving us feedback on their health and welfare has often been considered as the ultimate goal for care we can offer the animals.

Certainly, are there benefits to home cage monitoring:

- Ability to observe nocturnal animal activity during their active period, giving us a greater insight into their behaviour.
- Having an alarm to indicate when an animal may need closer observation due to a change in behaviour or reduction in activity. This will lead to more refined humane endpoints, as we are better able to 'see' the reactions to novel compounds and new models.
- Develop a greater understanding of the animal behaviour, and their interactions with the home cage environment, which may indicate whether the cage furnishings are enabling a more species specific behaviour.

When initially determining what system will work best in a given environment, that the right information is to hand to enable three key areas of focus to be addressed.

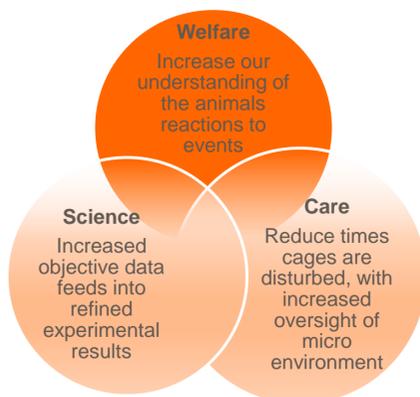


Figure 1; Key areas of focus

Algorithms

The outputs from a home-cage monitoring software rely on the algorithms of code that have been programmed into a computer to give us the answers to complex questions. But how can we be certain the algorithm, which is essentially a set of instructions for a computer, really tells us what is occurring in the cage. Can we be confident a computer interprets behaviour with a good degree of accuracy? The answer is yes, but there is a proviso - the instructions we give the computer must reflect what is happening in the cage. If they do not then the data we get will be false. Avoid asking complicated questions, for example, if you want to know if the mouse in Figure 2 remains healthy over a period of time, use a key indicator as your instruction to the computer rather than lots of key indicators.

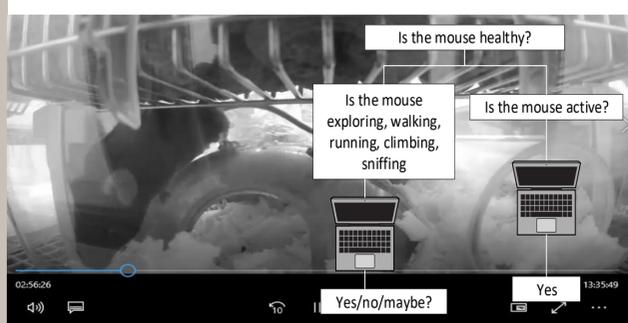


Figure 2; Mouse moving around a cage

Foundation for the algorithm

Algorithms are only as good as the instructions we give them, and those instructions usually come in the form of a recipe, the key ingredient of behaviour monitoring for any species is a well designed ethogram, which is a list of definitions describing the functions of a behaviour to such a degree that an untrained observer will recognise it (see Table 1). It is critical that behaviour and postures are properly defined and consistent, maybe even across the industry for the sake of reproducibility. Other wise the algorithms may be flawed. This is important when the use of camera technology is a primary part of the monitoring system, especially when each movement of the animal has been defined and inputted into a computer.

*Example of ethogram definition *(N.B –see website for full definitions)

Exploration – Goal-directed, typically occurs in the following sequence; search, attend, approach, investigate.

Investigate – Typically multi-modal, and primarily involves olfactory and tactile senses such as olfactory (sniffing)

Sniffing – Rapid twitching movements of the nose, either with the nose in contact with the stimulus, or held in an elevated position in the air.

Table 1; Examples of definitions of behaviour

Welfare

Some justifications of using home cage monitoring is that it improves animal welfare. However, this is not strictly accurate as the presence of a camera or any beams, does not have a direct impact on the well being of the cage occupants. In fact it may have a detrimental effect on their welfare, which they may sometimes express by covering the cameras up (Figure 3).

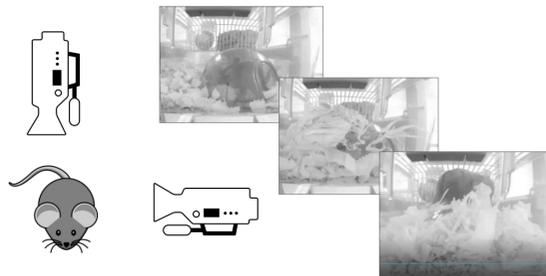


Figure 3; Schematic of mouse activity cameras, mouse covering its red hut shortly after camera placement.

One important piece of information it does offer is a greater understanding of their activity and behaviour, which then enables us to make changes to their care, environment and study designs that can have a positive direct impact on their welfare. However, for this to occur and improve the welfare of the animals, we need to be sure that we have asked the most appropriate questions for our science and animal care program.

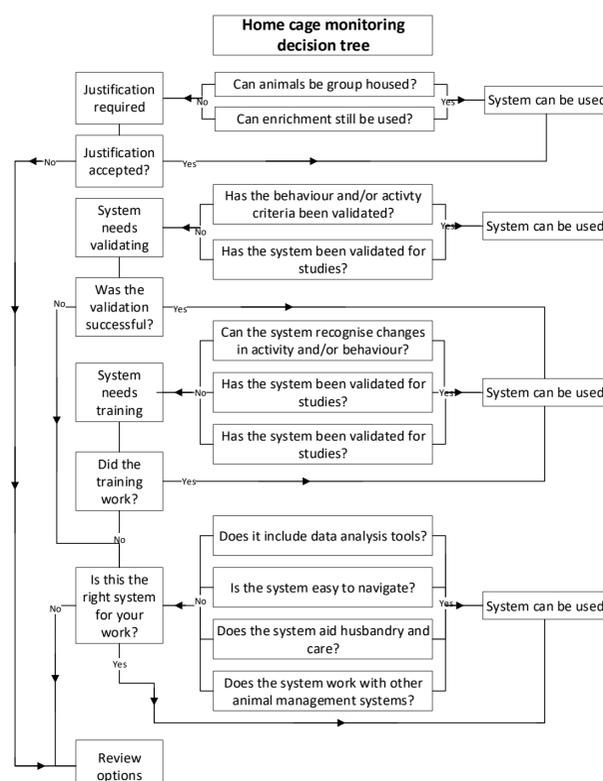


Figure 4; Decision tree for home cage monitoring

Care

Caring for laboratory animals includes husbandry routines, and doing everything we can to meet their needs, and improve their wellbeing. Home cage monitoring can address this to a degree, especially if the animal is not the sole focus. This is only possible if we use a system that monitors the elements of care that can sometimes be missed, especially in a busy unit, such as ensuring every cage has access to water and food, and that every animal is behaving as expected. Even well enriched cages may have a drawback, for example, sometimes a well enriched cage can mask incidents of lameness. Routine husbandry can cause increased anxiety to animals, especially for mice where it is commonly agreed that a reduction in the frequency cages are cleaned may improve their welfare. How frequent this should be needs to be balanced against the need to have a routine that ensures mistakes such as missing cages, are not made. Therefore, these factors are an important element of caring for the animals, and a system that enables us to improve this will, indirectly, benefit the welfare of the animals.

Imagine a situation where you can view two cages. Cage 1 has an activity monitor only and Cage 2 has a camera system. Each system alerts you that there is a problem in a cage. Which cage would you check? If the answer is both, then is a complex camera system necessary for your home cage monitoring?



Figure 5; Which cage would you check if both indicate a problem but only the occupants of one cage are visible?

Science

When we have a greater understanding of the behaviour of animals we can design protocols and studies that fit around the animal to a greater degree than we are currently able to. A system that can give us an objective answer for activity patterns after cage disturbances such as husbandry procedures or a regulated procedure, or a reduction in activity due to an intervention or model design, may enable us to design studies where we can ascertain whether a refinement to a procedure has been successful. We can use this type of data to determine shorter humane end points as we can clearly see when activity is reduced indicating a mouse which may need attention. Figure 6 shows there is high activity within this cage of female C57/BL6J mice when staff are present during the light phase.

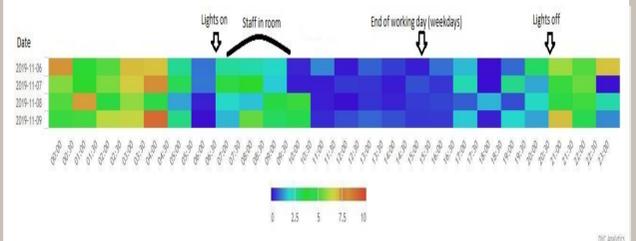


Figure 6; Activity pattern of four female C57/BL6 mice over a four day period.

Without some behaviour data to back it up, subtle changes may be missed, therefore, the use of cameras to validate a system is important to enable us to better understand the behaviour that has led to this activity (for example, increased activity may be due to fighting).

No system will be flexible enough for every situation we encounter, and some hurdles may not be possible to overcome without an invasive procedure such as a subcutaneous microchip to enable us to identify individual animals in a cage, which in turn can cause problems with an MRI scanner.

Conclusions

On balance is the use of cameras that use complex algorithms, to inform researchers on every movement an animal makes, helping or in reality are they over-complicating things for people?

Perhaps true objectivity, and in turn the ability to refine humane endpoints, and improve the welfare of the animals is found in systems where cameras are not the primary source of data. After all these systems can give a more definite answer in terms of a disruption in activity which highlights a potential welfare concern in the cage.