The transport of animals is recognised as an important animal welfare concern. Substantive research has been carried out to investigate factors affecting the welfare of farm animals during transportation, but this area has been neglected in rodent welfare research. Efforts have been made to encourage the replacement of live animal transportation with embryo and sperm shipment. Despite this, the numbers of live animal shipments continue to increase. We should look at the barriers to replacing live shipments, and question whether efforts to investigate and implement refinements in rodent transportation are overdue.

The European Union reports statistics triennially on the numbers of animals transported between EU member countries for use in experimental procedures. The number of mice transported has steadily increased, with the most recently published statistics showing that 921,612 mice were transported between EU member countries in 2008. Significant numbers of animals are also transported within individual member countries and from countries outside of the EU. Much of the increase is believed to be due to the increasing availability of genetically altered lines and the demand to exchange these lines globally, although some increases may also relate to the out-sourcing of breeding to commercial companies.

Despite the large number of mice transported annually, no studies have been carried out to look at welfare indicators during transport, or to estimate mortality rates associated with shipment. Anecdotally, mortality rates are considered to be low. This is confirmed in one study on ambient temperature ranges during mouse transport, which reported mortality in one whole shipment out of 127 shipments monitored. Most rodent transportation research has examined post-transport physiological and behavioural parameters, in order to assess appropriate acclimatisation periods prior to the use of the animals in scientific studies. This research has shown that animals have cardiovascular, endocrine, immune, reproductive and behavioural changes following transportation, indicating that they have a marked stress response to transport, so their welfare is likely to be affected during transport.

Many factors are known to affect animal welfare during transport, such as noise, vibration, forceful contact with shipping containers, insufficient consumption of food and water, environmental temperature and humidity, social isolation, and mixing with unfamiliar animals. Regulations and guidelines, based on good husbandry practice, are in place to govern many of these factors. However, there is very little published information on actual conditions experienced during shipment. The only work performed in this area looked at ambient temperatures experienced during shipment. It was found that 49.5% of shipments were exposed to high temperatures (above 29.4°C), and 14.6% of shipments were exposed to low temperatures (below 7.2°C). It is known that mice do not cope well with high temperatures; they lack sweat glands and do not pant, so they depend on saliva spreading, and behavioural adaptations such as burrowing to regulate their temperature. Therefore, the high temperatures reported in this study could result in poor animal welfare, if the shipping container environment restricted such behavioural adaptations.

Studies need to be carried out to look at other factors and to assess how welfare is affected by these factors. Indeed, under the new EU legislation, the lifetime experience of the animal must be considered as part of the severity assessment, so it is difficult to see how such an assessment can be made until we have a better understanding of the welfare impact of transport.

To reduce the transport of live mice, researchers have been encouraged to exchange mouse lines as fresh or frozen embryos or sperm. As well as reducing the numbers of animals transported, this approach also eliminates the biosecurity risk involved in introducing live rodents into a facility. This is an important secondary consideration, as biosecurity breaches can
have major scientific and potential animal welfare implications.

If embryos or sperm are to be transported, several factors may influence whether fresh or frozen materials are shipped. Frozen material can be shipped reliably for long periods by using liquid nitrogen dry shippers, but the high costs and perceived technical difficulties of both freezing and thawing materials have been seen as a deterrent. Some establishments already have active programmes of archiving, either in-house or through centralised mouse repositories, in which case frozen materials are more readily available for distribution. The shipping of fresh material requires less technical expertise and avoids the need for dry shippers. Historically, the survival of fresh material has been a concern, but newer methods have considerably extended its survival during transportation. Embryos can now be shipped at the 2-cell stage for up to 52 hours, and epididymal sperm have shown good fertility up to 96 hours after cold storage.\(^4\)\(^5\) Despite this, good co-ordination between establishments is required, and there is also a risk that delays in shipment or poor embryo yields will lead to the application of unnecessary procedures to animals at the receiving facility.

Until recently, embryos were the most common material exchanged, but recent improvements in methodologies for freezing sperm for IVF have meant that researchers are now switching to archiving and distributing sperm. The advantage of this approach is that adequate sperm can usually be obtained from two male mice, whereas large numbers of donor females are required to provide sufficient embryos. However, it must be remembered that sperm are haploid cells — a factor which could be problematic, if the phenotypes of interest were dependent on multiple chromosomal loci or on an extensive breeding scheme.

Although the transport of sperm and embryos reduces the numbers of live animals transported, we must acknowledge the welfare costs associated with this approach. The standard practice is to surgically transfer embryos into recipient females, and further animals may also be required to undergo superovulation or vasectomy procedures. If this is to be considered a refinement to shipping live animals, then we need to consider how we could refine or replace these procedures and encourage the adoption of these improved techniques. One such refinement is a non-surgical method of embryo transfer, whereby embryos are introduced via the cervix. This technique has been shown to be efficient, and avoids the requirement for surgery.\(^6\)

It is difficult to understand why rodent welfare during transport has been such a neglected issue. It could be due to the apparent low mortality rates associated with the process, or because there is, in fact, a replacement alternative available in the form of embryo and sperm shipment. However, despite the availability of these alternatives to the shipment of live mice, it is clear that the numbers of animals being transported continue to increase. The shipping of embryos and sperm offer benefits, but it appears that technical aspects of these methods have discouraged their uptake. Continued efforts are required to encourage researchers to adopt these methods, but we also must accept that live animal shipments will always have a place in research, so there is a real and urgent need for research into rodent welfare in transportation.

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