The ARRIVE Guidelines: Speaker Notes
Animal Research: Reporting In Vivo Experiments

This document contains speaker notes compiled by the NC3Rs[1] to accompany the downloadable ARRIVE guidelines presentation. The presentation and speaker notes have been designed to be used in licensee training courses.

SLIDE	NOTES
1	Introduction
	This presentation is aimed at providing an overview of the ARRIVE guidelines, why they were developed and how they can be used when reporting animal research.
2	Contents
	This is an overview of the slides in this presentation. Each slide answers a specific question about the ARRIVE guidelines.
3	What are the ARRIVE guidelines?
	▪ The ARRIVE guidelines were developed by NC3Rs in collaboration with researchers, statisticians and journals editors. ▪ The guidelines consist of a 20 item checklist of the key information that should be included in a manuscript (Title, Abstract, Introduction, Methods, Results, and Discussion) to ensure comprehensive and transparent reporting. ▪ The objective of the ARRIVE guidelines is to maximise the amount of high quality data from a minimum number of experiments to avoid unnecessary animal use. ▪ The checklist contains the minimum amount of information to ensure that a study can be reviewed, analysed and repeated.
4	Why were the ARRIVE guidelines developed?
	The ARRIVE guidelines were developed following a review of the quality of research using animals in the UK and US – (Kilkenny et al., 2009. Survey of the Quality of Experimental Design, Statistical Analysis and Reporting of Research Using Animals. *PLoS One.* 4 (11) e7824) The survey looked at: ▪ The quality of experimental design, statistical analysis and the reporting of animal studies ▪ A total of 271 articles describing publically funded animal research in the US and UK, including experiments using mice, rats and non-human primates. The survey was co-funded by the NC3Rs and the National Institutes for Health/Office of Laboratory Animal Welfare (NIH/OLAW) in consultation with members of the NC3Rs Experimental Design Working Group (independent, unpaid experts in experimental design and statistics), information specialists to search published databases, and two independent statisticians to collect and analyse the data. The survey identified areas for improvement in:

Experimental design

- Only **12%** of the studies reported the use of randomisation.
- Only **14%** of the studies reported the use of blinding.
- Studies that are not randomised or blinded during the assessment of the results have been shown to overestimate treatment efficacy.

Statistical analysis

- **70%** of the papers that used statistics described the method used and presented the results with a measure of precision or variability (standard deviation, standard error or confidence interval).
- **30%** of the studies were lacking the minimum information necessary to understand the results.
- Statistical methods used to analyse a study are extremely important as they influence the results and the conclusion of the study.

Reporting of studies

- Looked at a range of criteria such as how the experiments were described or the animal characteristics (e.g. sex, strain, age, weight), to allow experiments to be repeated.
- Only **59%** reported study hypothesis, number and characteristics of the animals used**.**

5 Why do we need to improve reporting of animal research?

Evidence suggests the poor quality of reporting of animal research is widespread across many fields of research. The highlighted papers show a lack of adequate reporting and describe the outcomes of failure to adequately report animal studies:

- **Cancer** (Hess 2011) – Reporting of animal studies in cancer research shows room for improvement (blinding, randomisation, sample size calculation).
- **Stroke** (Macleod et al., 2005) – Systematic review and meta-analysis to assess the evidence for a neuroprotective therapy (FK506) in experimental stroke. This study raised concerns about the quality of reporting in animal studies and its potential impact on estimated effect size of treatments.
- **Pain** (Rice et al., 2008) – Lack of methodological details hampers efforts to perform systematic reviews of the animal literature to determine the efficacy of novel compounds for neuropathic pain.
- **Multiple sclerosis** (Vesterinen et al., 2010) – Lack of reporting of measures to reduce bias (randomisation, blinding) in animal model studies of multiple sclerosis. Failure to translate pre-clinical findings to effective clinical treatments has been partially attributed to experimental bias.

6 Who supports the ARRIVE guidelines?

The ARRIVE guidelines are disseminated widely to allow as many people as possible to use them. The NC3Rs have engaged with the scientific community to get the ARRIVE guidelines endorsed by journals, funders, universities and learned societies. This includes:

Journals

- The most efficient way to improve reporting is for journals to advocate high reporting standards.

- Over **1000 journals** currently support the ARRIVE guidelines by incorporating the ARRIVE guidelines into their **Instructions to Authors** or **Editorial Policies**.
- As from 1 May 2013, all Nature journals require submission of a **checklist** with every manuscript. For research involving animals, this includes reference to the ARRIVE guidelines (Number 10 on the checklist).

Funders

- From a funders perspective, the guidelines are an opportunity to increase the output of the research being funded, and ensure that it results in high quality publications which genuinely add to the knowledge base and lead to scientific progress.
- In May 2012, the **major UK bioscience research funders** (MRC, BBSRC, Wellcome Trust) wrote an open letter to the Vice-Chancellors, and Principals of universities and Heads of research institutes urging them to ensure that their scientists make use of the ARRIVE guidelines and reiterating that compliance with the guidelines is a condition of grant funding.
- The role of the funders is crucial because they are in touch with researchers at the beginning of the process, before the experiment is conducted.

Learned Societies

Since 2013, the NC3Rs have been working with learned societies to widen the use of the ARRIVE guidelines.

- Learned societies can help disseminate the ARRIVE guidelines to their members to improve reporting in their field or research.

7 How can you use the ARRIVE guidelines?

The guidelines provide recommendations for reporting animal research in all areas of a manuscript (Title, Abstract, Introduction, Methods, Results, Discussion).

Specifically the ARRIVE guidelines include:

- Sufficient **scientific background to understand the motivation and context for the study** and a **clear description of the objective.**
- A **detailed description of the study design** including steps taken to **minimise subjective bias**, a comprehensive description of the experimental procedures and animal characteristics and housing.
- Recommendations on **how to report the results**, including **adverse effects** and details about the statistical analysis.
- Advice about what should be reported in the discussion, such as the **limitations**, the **scientific implications** and how the findings of the study are likely to **translate to other species and their relevance to humans.**

To view the full check list including a detailed description of each point, please visit the NC3Rs website: www.nc3rs.org.uk/ARRIVEpdf.

8 Why should you use the ARRIVE guidelines?

Using the ARRIVE guidelines can ensure maximal output from animal research is achieved to reduce the need for excessive animal use.

Specifically, using the ARRIVE guidelines can:

- Ensure that a study is reproducible. For an experiment to be reproducible, we need to know exactly what was done and the guidelines recommend reporting what experimental procedures were carried out, and exactly: **how** it was done / **when** it was done / **where** it was done / **why** it was done that way

	▪ Help to **translate findings from animal experiments** to **successful treatment strategies** in humans, by producing **robust and reliable preclinical evidence** In addition, the ARRIVE guidelines may be useful for **experimental design**. The ARRIVE guidelines: ▪ Can be used to prompt researchers to think about the issues that should be considered when planning their experiments. ▪ Provide a logical checklist with all the things that need to be considered when designing an experiment. ▪ Encourage researchers to think about the issues early on in the scientific process, well before the writing up stage.
9	What resources are available?
	The NC3Rs have prepared resources to facilitate adoption of the ARRIVE guidelines; these can be downloaded by visiting www.nc3rs.org.uk/ARRIVE. ▪ The ARRIVE checklist can be use when preparing a manuscript to ensure reporting criteria in the ARRIVE guidelines is met. The checklist can also be submitted with manuscripts to help reviewers and editors during the review process. ▪ The ARRIVE examples document demonstrates how the ARRIVE guidelines can be used in practice to report animal research, by providing specific examples for each point of the guidelines. The examples given are from a wide range of research using a range of animal species. ▪ The ARRIVE presentation can be used for training courses to provide background information for researchers. ▪ The ARRIVE guidelines Z cards are a handy pocket sized reference guide. Copies of the ARRIVE guidelines Z card are available upon request.
10	Conclusions
	The ARRIVE guidelines can be downloaded by visiting www.nc3rs.org.uk/ARRIVE. If you have any further questions, please contact the NC3Rs at enquiries@nc3rs.org.uk

1. The National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs) is an independent scientific organisation. Tasked by Government, the NC3Rs supports the UK science base by driving and funding innovation and technological developments that replace or reduce the need for animals in research and testing, and lead to improvements in welfare where animals continue to be used. The Centre promotes robust and ethical scientific practice by collaborating with research funders, academia, industry, regulators and animal welfare organisations, both in the UK and internationally. The NC3Rs is supported primarily by Government, but also receives funding from the charitable and industrial sectors. It is the UK's major funder of 3Rs research. Further information about NC3Rs activities and programmes can be found at http://www.nc3rs.org.uk