

The HWB intends to review and report on the progress of the strategy on an annual basis. It is acknowledged that the entire strategy may need to be reviewed in the light of new information and may look very different in 2025. The HWB also state: “We are also conscious of the inevitable limitations in the Board’s own expertise”, and therefore suggest that they will be seeking greater collaboration both inside and outside the sport.

**A Life Well Lived: A New Strategic Plan for the Welfare of Horses Bred for Racing, 2020-2024** (2020). A4, 130 pages. Report available at: [http://media.britishhorseracing.com/bha/Welfare/HWB/WELFARE\\_STRATEGY.pdf](http://media.britishhorseracing.com/bha/Welfare/HWB/WELFARE_STRATEGY.pdf).

*E Carter,*

*UFAW*

### **ARRIVE 2.0: Updated guidelines to improve the reporting of animal research**

The aim of the original ‘Animal research: Reporting *in vivo* experiments (ARRIVE) guidelines’, published in 2010, was to highlight the minimum information required when describing *in vivo* experiments. Produced with the support of the National Centre for the Replacement, Refinement & Reduction of Animals in Research (NC3Rs), the guidelines consisted of “a checklist of information to include in publications describing *in vivo* experiments to enable others to scrutinise the work adequately, evaluate its methodological rigour, and reproduce the methods and results” (Percie du Sert *et al* 2020a). When a scientific experiment is reproduced and another researcher draws a similar conclusion, then it is more likely that the conclusion is correct — this is important when basing decisions on scientific findings. However, despite widespread endorsement by the scientific community (over 1,000 journals, funders and research institutes support the ARRIVE guidelines), the impact of the 2010 guidelines on the quality of scientific reporting in animal research publications has been limited and the majority of manuscripts continue to lack key information required for reproducibility.

In an effort to facilitate a greater uptake, the guidelines were reviewed and updated through an extensive and collaborative effort of an international working group (composed of funders, journal editors, statisticians and researchers from the UK, mainland Europe, North America and Australia (Percie du Sert *et al* 2018; Hair *et al* 2019) and ARRIVE 2.0 was published in July 2020. ARRIVE 2.0 builds upon the original guidelines and is complemented by an ‘Explanation and elaboration’ document which provides: “background and rationale for each of the 21 items of ARRIVE 2.0” (Percie du Sert *et al* 2020b). To ensure that the guidelines were relevant and accessible, the explanation and elaboration document was road-tested alongside the revised guidelines with researchers preparing manuscripts describing *in vivo* research.

The checklist for the updated guidelines is organised into two sets: The Essential 10 (which are considered the bare minimum required and without which reviewers and readers cannot completely assess the reliability of the findings), and an additional 11 Recommended Set (which provide context for the study described).

Within the elaboration and explanation document each item listed in the Essential 10 and the Recommended set is described in its own stand-alone section to allow users to access further information quickly and independently. The Item is simply defined, followed by a more extensive explanation, for example, Item 2 considers sample size, and Sub-item 2(b) specifically looks at how a sample size was decided. The explanation describes the pitfalls of both under- and over-powered studies and explains how if a sample size is too small (leading to an under-powered study) then there are three possible consequences: “first, within the experiment, real effects are more likely to be missed; second, when an effect is detected, this will often be an overestimation of the true effect size; and, finally, when low power is combined with publication bias, there is an increase in the false positive rate. In turn, low powered studies can contribute to poor internal validity of research and risk wasting animals used in inconclusive research” (Percie du Sert *et al* 2020b). It is hoped that by facilitating a greater appreciation of why each item is relevant, then scientists are more likely to report on it.

Additionally, extra, useful material is included in information boxes throughout the document, such as a glossary of common statistical terms in the Introduction, or information on randomisation within Item 4, including simple and block randomisation, other randomisation strategies, nuisance variables, and implications for analysis, reminding the reader that: “blocking uses up degrees of freedom and thus reduces the power if the nuisance variable does not have a substantial impact on variability.”

Where appropriate, the guidelines also draw the readers’ attention to practical resources, such as The Experimental Design Assistant (EDA) in Item 1. Study design (EDA is an online platform that assists researchers when designing *in vivo* experiments), or a list of online nomenclature resources within Subitem 8(b) of Item 8, Experimental animals, which give detail on how to correctly report nomenclature of commonly used animal species. Again, reminding the reader why such detail is important: “Reporting the correct nomenclature is crucial to understanding the data and ensuring that the research is discoverable and replicable” (Percie du Sert *et al* 2020b).

Two new items which have been added to ARRIVE 2.0 are Item 19, Protocol registration, and Item 20, Data Access. Protocol registration has become an increasingly important means of improving both transparency of

animal research and scientific rigour. Data sharing has also gained increasing recognition and acceptance since the publication of the previous guidelines in 2010. Data sharing is considered useful as it: “allows the data to be repurposed and new datasets to be created by combining data from multiple studies... This allows others to explore new topics and increases the impact of the study, potentially preventing unnecessary use of animals” (Percie du Sert *et al* 2020b).

The aim is for ARRIVE 2.0 to be applied to all areas of bioscience research that involve living animals across a range of experiments: “Transparent reporting is clearly essential if animal studies are to add to the knowledge base and inform future research, policy, and clinical practice” (Percie du Sert *et al* 2020a). The revised checklist, along with the explanation and elaboration manuscript, are freely available online and easily navigable on a dedicated ARRIVE website. Other useful resources are also available, including an explanatory webinar. ARRIVE 2.0 is available in English, French and German (Chinese translation in progress).

## References

- Hair K, Macleod MR, Sena ES and Collaboration II** 2019 A randomised controlled trial of an Intervention to Improve Compliance with the ARRIVE guidelines (IICARus). *Research Integrity and Peer Review* 4: 12. <https://doi.org/10.1186/s41073-019-0069-3>
- Percie du Sert N, Hurst V, Ahluwalia A, Alam S, Altman DG, Avey MT, Baker M, Browne W, Clark A, Cuthill IC, Dirnagl U, Emerson M, Garner P, Katp NA, MacCallum CJ, Macleod M, Petersen O, Rawle F, Reynolds P, Rooney K, Sena ES, Silberberg SD, Steckler T, Würbel H and Holgate ST** 2018 Revision of the ARRIVE guidelines: rationale and scope. *BMJ Open Science* 2(1): e000002. <https://openscience.bmj.com/content/2/1/e000002>
- Percie du Sert N, Hurst V, Ahluwalia A, Alam S, Avey MT, Baker M, Browne WJ, Clark A, Cuthill IC, Dirnagl U, Emerson M, Garner P, Holgate ST, Howells DW, Hirst V, Karp NA, Lazic SE, Lidster K, MacCallum CJ, Macleod M, Pearl EJ, Petersen OH, Rawle F, Reynolds P, Rooney K, Sena ES, Silberberg SD, Steckler T and Würbel H** 2020b Reporting animal research: Explanation and elaboration for the ARRIVE guidelines 2.0. *PLoS Biology* 18(7): e3000411. <https://doi.org/10.1371/journal.pbio.3000411>
- Percie du Sert N, Hurst V, Ahluwalia A, Alam S, Avey MT, Baker M, Browne WJ, Clark A, Cuthill IC, Dirnagl U, Emerson M, Garner P, Holgate ST, Howells DW, Karp NA, Lazic SE, Lidster K, MacCallum CJ, Macleod M, Pearl EJ, Petersen OH, Rawle F, Reynolds P, Rooney K, Sena ES, Silberberg SD, Steckler T and Würbel H** 2020a The ARRIVE guidelines 2.0: Updated guidelines for reporting animal research. *PLoS Biology* 18(7): e3000410. <https://doi.org/10.1371/journal.pbio.3000410>
- New Arrive Guidelines 2.0** (July 2020). Available at: <https://arriveguidelines.org/news/new-arrive-guidelines>.
- E Carter,*  
*UFAW*