PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	A systematic review of guidelines for rigour in the design, conduct and analysis of biomedical experiments involving laboratory animals.
AUTHORS	Jan Vollert (Corresponding Author) Esther Schenker Malcolm Macleod Anton Bespalov Hanno Wuerbel Martin Christian Michel Ulrich Dirnagl Heidrun Potschka Kimberley Wever Thomas Steckler Bruce Altevogt Andrew SC Rice

VERSION 1 - REVIEW

REVIEWER 1	Kristina Thayer United States Environmental Protection Agency Conflict of Interest: None declared
REVIEW RETURNED	20-03-18

GENERAL COMMENTS	.Background and aims comment: maybe make more broad - preclinical and biomedical research? Search Strategy comment: would it be too broad for you to consider including OECD harmonized guidelines for conducting animal studies in toxicology? that would be a type of gray literature Inclusion and exclusion criteria comment: ah, so my previous comment on OECD might be out of scope...but it looks like it might fall into the side project Study quality, meta-analysis and risk of bias assessment comment 2nd sentence: this could be a bit clearer perhaps? I'm not sure which you would consider "best available" Reporting comment: I'm not sure I see appendix C?

REVIEWER 2	Marc Avey ICF Canada Conflict of Interest: None declared
REVIEW RETURNED	01-03-18

GENERAL COMMENTS	I have a number of suggestion that I hope will be helpful and more useful at the protocol stage than after the research is conducted. Note: I cannot access the supplemental materials and my emails to BMJ OS have thus far bounced so apologies if this is covered there. 1. Is the research question or study objective clearly defined? “The aim of this systematic review is to identify existing experimental design, conduct and analysis guidelines and associated reporting standards relating to preclinical animal research. The review will also identify literature describing (either through primary research or systematic review) the prevalence and impact of risks of bias pertaining to the design, conduct and analysis and reporting of preclinical biomedical research. This review will focus on internal validity of experimental design, conduct and analysis.” There is a lot being covered in the aims and it’s not clear how the search/inclusion/analysis will answer them based on the sections in the protocol. I suggest using the same language in the background with the ‘aims’ and the subsequent sections to make it clearer how they align. In particular, I was unclear how ‘prevalence’ and ‘impact’ were being assessed (inclusion/exclusion talks about validity/reliability; and the analysis talks about provenance and frequency). I’m also unclear as to how the authors intend to focus on internal validity? There also appears to be the intention to use this review to harmonize competing guidance but this is not explicitly listed as an aim of the review. If this is part of the aim I think it should be articulated more fully as it impacts how data may collected and analyzed. 3. Is the study design appropriate to answer the research question …? As above, I found the subsequent sections after the initial aims to not clearly link to the aims. Reporting standards are part of the aims but also just a side project? Terminology seems to change from one section to the next (aim vs key objective; prevalence/impact vs validity/reliability vs provenance/frequency). Apologies if this is described in appendix C but I can’t access it. Are the outcomes clearly defined?

	Again, the authors switch language in different sections (e.g. aims vs key primary objective?) in the protocol which makes it confusing. It would also be helpful to define what the authors means by prevalence, impact, internal validity and how the analysis relates. I found it unclear how the review is focused on internal validity or the relevance of suggesting that animal housing/welfare is not part of this. 13. Is the supplementary reporting complete (e.g. ARRIVE checklist, PRISMA checklist, study registration; funding details)? I strongly urge the authors (and editors of BMJ Open Science) to use PRISMA-P review: http://www.prisma-statement.org/Extensions/Protocols.aspx This is an evidence-based reporting standard for systematic review protocols. Although the review is labelled a 'systematic review' it appears methodologically to be more appropriately a scoping review by design. General Comments: Background: 1. The focus of this review is on internal validity. I assume the authors mean systematic variation? Search: 1. Consider explicitly searching for government design/reporting/analyses standards for these types of experiments. 2. Consider stating that there will be no start date limit on the search. I cannot access the search itself to review it. 3. I strongly recommend using the PRESS method to evaluate your search strategy prior to implementing it. It is better to peer review your search prior to implementation and use an evidence-based standardized process conducted by experts (information specialist). Inclusion and Exclusion Criteria: 1. To be clear, you are including guidelines themselves as well as articles/systematic reviews that describe/review guidelines? The purpose of the articles/systematic reviews is to identify guidelines (and maybe reporting standards?). 2. Should this also not clearly state that you will include literature (primary research/systematic reviews) that asses the prevalence/impact of risk of bias for design/conduct/analysis/reporting. This is the second part of the aim and is different from guidelines/reporting standards. Perhaps I'm being overly pedantic here though.

	3. By ‘both’ you mean all three of design/conduct/analysis? 4. I think it would help to define validity and reliability here (just internal validity since that is the focus?). I also assume this is for guidelines related to primary studies of in vivo preclinical research? 5. How will you handle guidelines/reporting standards that apply generally and include toxicity/veterinary uses? 6. The sentence: “Although reporting standards are not…” is entirely confusing for me. Reporting standards are listed as part of the aim of the review, but here they are a related side project? The language is also confusing because above there was just an aim, and now there is a key primary objective. I would suggest to standardize the language for aims in the above section and only include information about what is relevant to this research proposal. I don’t have access to appendix A, but if reporting standards are not part of this protocol than the search terms relevant for identifying them should be removed. Screening and Annotation “see below” should be “see above”? Data Management 1. Is the data stored in SyRF just the references/PDF or also the extracted data/text? Study quality, meta-analysis, and risk of bias assessment 1. Will this be done in duplicate? 2. The provenance (not an aim/outcome from above) appears to be a validity assessment. These examples of assessing study quality may be helpful (or not). https://www.ncbi.nlm.nih.gov/pubmed/24965222 http://onlinelibrary.wiley.com/doi/10.1002/14651858.MR000030.pub2/abstract;jsessionid=9C73024C83EB23B20F7EFEECB2BC24CB.f01t01 3. I see how the rating system above applies to guidelines and/or reporting standards, but what is the plan for the second aim to investigate the prevalence and impact of risk of bias/internal validity? I also don’t see how the author intend to focus (sort?) elements of guidelines into internal validity vs non-internal validity? Apologies if this is described in appendix C but I can’t access it. Reporting 1. The ranking based on frequency of elements in the guidelines is technically part of the analysis and should be in the above section.

	2. “Aadditionally, reporting will follow the PRISMA guidelines as far as applicable.” Yes.

VERSION 1 – AUTHOR RESPONSE

Dear Editor, dear Editor-in-Chief,
Thank you very much for your reply. We are grateful to you, the Section Editor and both reviewers for these very positive evaluations. We have revised the manuscript according to the reviewer's comments. All changes are described en detail per comment below. The modifications of our manuscript are shaded in yellow to allow easy recognition.

Reviewer 1: Background and aims comment: maybe make more broad - preclinical and biomedical research?
Author's response: We agree and have amended the wording.

Search Strategy comment: would it be too broad for you to consider including OECD harmonized guidelines for conducting animal studies in toxicology? that would be a type of gray literature
Inclusion and exclusion criteria comment: ah, so my previous comment on OECD might be out of scope...but it looks like it might fall into the side project
Author's response: Yes, we agree that the OECD harmonized guidelines are beyond the scope of this initial review, but will be of interest for the side project.

Study quality, meta-analysis and risk of bias assessment comment 2nd sentence: this could be a bit clearer perhaps? I'm not sure which you would consider "best available"
Author's response: We thank the reviewer for noting this ambiguity, we have inserted a clarifying statement in the text.

Reporting comment: I'm not sure I see appendix C?
Author's response: The appendix was in the initial submission, but seems to have gone lost on the way, as Reviewer #2 did not find it as well. We made sure it is included this time.

Reviewer 2: I have a number of suggestion that I hope will be helpful and more useful at the protocol stage than after the research is conducted. Note: I cannot access the supplemental materials and my emails to BMJ OS have thus far bounced so apologies if this is covered there.
1. Is the research question or study objective clearly defined?
"The aim of this systematic review is to identify existing experimental design, conduct and analysis guidelines and associated reporting standards relating to preclinical animal research. The review will also identify literature describing (either through primary research or systematic review) the prevalence and impact of risks of bias pertaining to the design, conduct and analysis and reporting of preclinical biomedical research. This review will focus on internal validity of experimental design, conduct and analysis."
There is a lot being covered in the aims and it's not clear how the search/inclusion/analysis will answer them based on the sections in the protocol. I suggest using the same language in the background with the 'aims' and the subsequent sections to make it clearer how they align. In particular, I was unclear how 'prevalence' and 'impact' were being assessed (inclusion/exclusion talks about validity/reliability; and the analysis talks about provenance and frequency). I'm also unclear as to how the authors intend to focus on internal validity?
Author's response: This topic relates to many other questions, which are handled below. We throughout the manuscript now use the terms "internal validity and reproducibility" only. We throughout the manuscript deleted the misleading wording of investigating prevalence and impact of risk of bias. Reporting standards are not part of the aim, which was not phrased carefully enough.

There also appears to be the intention to use this review to harmonize competing guidance but this is not explicitly listed as an aim of the review. If this is part of the aim I think it should be articulated more fully as it impacts how data may collected and analyzed.
Author's response: We agree and have amended the phrasing to "..Aim of this systematic review is to identify and harmonize existing experimental design, conduct and analysis guidelines…"

3. Is the study design appropriate to answer the research question …?
As above, I found the subsequent sections after the initial aims to not clearly link to the aims. Reporting standards are part of the aims but also just a side project? Terminology seems to change

from one section to the next (aim vs key objective; prevalence/impact vs validity/reliability vs provenance/frequency). Apologies if this is described in appendix C but I can't access it.
Author's response: We thank the reviewer to raising attention to this ambiguity. Reporting standards are not part of the aim, which was not phrased carefully enough. The purpose is to identify guidelines on conduction and analysis. We assume that some reporting standards will include information that should be considered rather at the experimental or even planning stage already, and not just at the reporting stage, which is why we will look at reporting standards. We phrased this more clearly throughout the protocol (see above and below as well).

Are the outcomes clearly defined?
Again, the authors switch language in different sections (e.g. aims vs key primary objective?) in the protocol which makes it confusing. It would also be helpful to define what the authors' mean by prevalence, impact, internal validity and how the analysis relates. I found it unclear how the review is focused on internal validity or the relevance of suggesting that animal housing/welfare is not part of this.
Author's response: We throughout the manuscript now use the terms "internal validity and reproducibility" only. We found that animal housing and welfare are best placed under a different domain than the experimental conduct and analysis, as it is a big body of literature on its own (see below as well).

13. Is the supplementary reporting complete (e.g. ARRIVE checklist, PRISMA checklist, study registration; funding details)?
I strongly urge the authors (and editors of BMJ Open Science) to use PRISMA-P review: http://www.prisma-statement.org/Extensions/Protocols.aspx This is an evidence-based reporting standard for systematic review protocols. Although the review is labelled a 'systematic review' it appears methodologically to be more appropriately a scoping review by design.
Author's response: While we generally agree that PRISMA-P is an important tool for systematic review protocols, it has been developed for what systematic reviews are mostly conducted in, which is clinical studies. This being a systematic review (systematic in the meaning of being based on a systematic, reproducible database search) of guidelines rather than outcomes we found some items to be not applicable for this particular protocol. Generally, we followed PRISMA-P as much as possible.

General Comments:
Background:
1. The focus of this review is on internal validity. I assume the authors mean systematic variation?
Author's response: Aim of the review is to find elements that relate to the question "to what extent do the study results reflect a true cause-effect of the intervention?" (what we consider internal validity, which is threatened by bias, i.e. systematic error), rather than to the question "can the study results be generalized to other studies / the population / patients /…?" (what we would consider external validity, threatened by indirectness). We tried to phrase more clearly throughout the manuscript (see above and below as well).

Search:
1. Consider explicitly searching for government design/reporting/analyses standards for these types of experiments.
Author's response: We agree that this is an important issue, which is why we explicitly search on the websites of major societies and funders as listed in Appendix B, which covers major governmental funding organizations.

2. Consider stating that there will be no start date limit on the search. I cannot access the search itself to review it.
Author's response: We agree and have amended.

3. I strongly recommend using the PRESS method to evaluate your search strategy prior to implementing it. It is better to peer review your search prior to implementation and use an evidence-based standardized process conducted by experts (information specialist).

Author's response: We agree that optimizing the search string is an important topic, and have done so with an information specialist. Hopefully, the reviewer will be able to find our search strings in the appendix in the revised submission.

Inclusion and Exclusion Criteria:
1. To be clear, you are including guidelines themselves as well as articles/systematic reviews that describe/review guidelines? The purpose of the articles/systematic reviews is to identify guidelines (and maybe reporting standards?).
Author's response: The purpose is to identify guidelines on conduction and analysis, and we will therefore also include systematic reviews that report on guidelines (and potentially give recommendations).

2. Should this also not clearly state that you will include literature (primary research/systematic reviews) that asses the prevalence/impact of risk of bias for design/conduct/analysis/reporting. This is the second part of the aim and is different from guidelines/reporting standards. Perhaps I'm being overly pedantic here though.
Author's response: We agree that these parts were not harmonized well enough. A sentenced is added here on including primary research as well.

3. By 'both' you mean all three of design/conduct/analysis?
Author's response: "both" aimed at "both validity and reliability", we phrased more clearly and changed to the terms now used throughout the manuscript, "internal validity and reproducibility" (see above and below as well).

4. I think it would help to define validity and reliability here (just internal validity since that is the focus?). I also assume this is for guidelines related to primary studies of in vivo preclinical research?
Author's response: This is indeed not an easy topic, and we have intensive discussions within our group on these questions. As a matter of fact, many items are not clearly and easily sorted to either internal or reproducibility or external validity, but may be considered gray areas. We throughout the manuscript deleted the misleading wording of investigating prevalence and impact of risk of bias. We throughout the manuscript now use the terms "internal validity and reproducibility". Aim of the review is to find elements that are linked to the question "to what extent do the study results reflect a true cause-effect of the intervention?", rather than to the question "can the study results be generalized to other studies / the population / patients /…?". We tried to phrase more clearly (see above and below as well).

5. How will you handle guidelines/reporting standards that apply generally and include toxicity/veterinary uses?
Author's response: In these cases, the guidelines would be considered, only specifically toxicity/veterinary only cases are excluded. We phrased more carefully.

6. The sentence: "Although reporting standards are not…" is entirely confusing for me. Reporting standards are listed as part of the aim of the review, but here they are a related side project? The language is also confusing because above there was just an aim, and now there is a key primary objective. I would suggest to standardize the language for aims in the above section and only include information about what is relevant to this research proposal. I don't have access to appendix A, but if reporting standards are not part of this protocol than the search terms relevant for identifying them should be removed.
Author's response: The purpose is to identify guidelines on conduct and analysis. We assume that some reporting standards will include information that should be considered rather at the experimental or even planning stage already, and not just at the reporting stage, which is why we will look at reporting standards. We phrased this more clearly throughout the protocol (see above as well).

Screening and Annotation
"see below" should be "see above"?
Author's response: Thank you for noting, yes, was corrected to "see above".

Data Management

1. Is the data stored in SyRF just the references/PDF or also the extracted data/text?
Author's response: We thank the reviewer for noting this ambiguity, all data, including full extracted guidelines and text will be stored in SyRF. We amended the text accordingly.

Study quality, meta-analysis, and risk of bias assessment
1. Will this be done in duplicate?
Author's response: Yes it will, we have clarified so in the text.

2. The provenance (not an aim/outcome from above) appears to be a validity assessment. These examples of assessing study quality may be helpful (or not).
https://www.ncbi.nlm.nih.gov/pubmed/24965222
http://onlinelibrary.wiley.com/doi/10.1002/14651858 Add to Citavi project by DOI.MR000030.pub2/abstract;jsessionid=9C73024C83EB23B20F7EFEECB2BC24CB.f01t01
Author's response: We thank the reviewer for this literature, which will be of interest for the study. The provenance at this stage will not be a validity assessment, but rather a method of documentation.

3. I see how the rating system above applies to guidelines and/or reporting standards, but what is the plan for the second aim to investigate the prevalence and impact of risk of bias/internal validity? I also don't see how the author intend to focus (sort?) elements of guidelines into internal validity vs non-internal validity? Apologies if this is described in appendix C but I can't access it.
Author's response: This is indeed not an easy topic, and we have intensive discussions within our group on these questions. As a matter of fact, many items are not clearly and easily sorted to either internal or reproducibility or external validity, but may be considered gray areas. We throughout the manuscript deleted the misleading wording of investigating prevalence and impact of risk of bias, as we are rather interested in, e.g., primary literature in a side-note describing a risk of bias and a possible solution or control mechanism. This would fall under the category Ia (primary literature, not endorsed). A systematic review of experiments, while not focusing on guidelines, might include similar information (and would fall under the category IIIa). Appendix C lists formerly described sources of experimental guidelines (following Henderson et. al.) as our primary list to follow, as we assume most guidelines will include elements of that fall under the categories of this list.

Reporting
1. The ranking based on frequency of elements in the guidelines is technically part of the analysis and should be in the above section.
Author's response: We agree, the sentence was moved to the section above.

VERSION 2 - REVIEW

REVIEWER 1	Kristina Thayer United States Environmental Protection Agency Conflict of Interest: None declared
REVIEW RETURNED	21-05-18

GENERAL COMMENTS	Authors have been responsive to reviewer comments

REVIEWER 2	Marc Avey ICF Canada Conflict of Interest: None declared
REVIEW RETURNED	02-06-18

GENERAL COMMENTS	The protocol is much clearer with the wording changes which is extremely helpful given the complexity of the topic area. I look forward to reading the final publication. Two minor quibbles for the authors to consider. 1) The list of societies to search in appendix B are exclusively professional neuroscientific organizations, but the protocol is more broadly focused on preclinical research in general. 2) The list of government organizaitons in appendix B appear to be exclusively academic funding agencies with no regulators (e.g. FDA).

A systematic review of guidelines for rigour in the design, conduct and analysis of biomedical experiments involving laboratory animals.

Authors: Jan Vollert (1), Esther Schenker (2), Malcolm Macleod (3), Anton Bespalov (4,5), Hanno Wuerbel (6), Martin C Michel (4,7), Ulrich Dirnagl (8), Heidrun Potschka (9), Kimberley E Wever (10), Thomas Steckler (11), Bruce Altevogt (12) and Andrew SC Rice (1) on behalf of the EQIPD WP3 study group

1 Pain Research, Department of Surgery and Cancer, Imperial College London, London, UK
2 Institut de Recherches Servier, Croissy-sur- Seine, France
3 Centre for Clinical Brain Sciences, University of Edinburgh, UK
4 Partnership for Assessment and Accreditation of Scientific Practice, Heidelberg, Germany
5 Valdman Institute of Pharmacology, Pavlov Medical University, St. Petersburg, Russia
6 Division of Animal Welfare, VPH Institute, Vetsuisse Faculty, University of Bern, Bern, Switzerland
7 Universitätsmedizin Mainz, Johannes-Gutenberg-Universität Mainz, Mainz, Germany
8 Department of Experimental Neurology, Charité Universitätsmedizin Berlin, Germany
9 Institute of Pharmacology, Toxicology, and Pharmacy, Ludwig-Maximilians- University, Munich, Germany
10 Systematic Review Centre for Laboratory Animal Experimentation, Department for Health Evidence, Nijmegen Institute for Health Sciences, Radboud university medical centre, Nijmegen, The Netherlands
11 Janssen Pharmaceutica NV, Beerse, Belgium
12 Pfizer Inc.

Background and aims

Within the last years, there has been growing awareness of the negative repercussions of unstandardized planning, conduct and reporting of preclinical research [1, 2]. Several initiatives have set the aim of increasing validity and reliability in reporting of (not only preclinical) studies and publications, such as CAMARADES [3], NC3Rs [4], SYRCLE [5] and the EQUATOR network [6]. Publishers have formed similar groups (e.g. The Lancet's REWARD initiative [7]). Additionally, several experts or groups of experts across the biomedical spectrum, both clinical and preclinical, have published experience and opinion based guidelines and guidance on potential standardized reporting [8–10]. While many of the points raised are identical or similar between these various guidelines (in fact many experts on the field are part of more than one initiative), they differ in details, rigour, and show especially distinct variance in generalizability or specific challenges for a single field. While all these guidelines cover reporting of experiments, an important step prior to this should be rigours planning and conduction of studies, which faces a similar situation [11]. Consequently, it is hard for researchers to decide which guidelines to follow, especially at the stage of planning future studies.

The aim of this systematic review is to identify existing experimental design, conduct and analysis guidelines and associated reporting standards relating to preclinical animal research. The review will also identify literature describing (either through primary research or systematic review) the prevalence and impact of risks of bias pertaining to the design, conduct and analysis and reporting of preclinical biomedical research. This review will focus on internal validity of experimental design, conduct and analysis. While we realize that factors like animal housing and welfare are highly important for reproducibility of experiments, they will not be considered in this initial SR, which focuses on internal validity. It is planned to analyse the influence of animal care and use at a later point in a separate SR.

Search strategy

PubMed, Embase and Web of Science will be searched systematically to identify guidelines published in English language in peer-reviewed journals before January 2018, using the search string found in Appendix A. Additional studies will be identified by searching the references of the included articles. As many of the researchers participating in this project are experts on the field of standardization, they will be contacted personally to submit in relevant publications, which will be included additionally, if not identified in the systematic approach. In addition, to capture standards set by funders or organisations that are not (or not yet) published, we will perform a customized google

search for guidelines published on the websites of major funders and professional organisations, listed in Appendix B.

Inclusion and exclusion criteria

This study will include all articles or systematic reviews in English language that describe or review guidelines on validity or the reliability or both of the design, conduct and analysis of preclinical animal studies. Articles that focus on toxicity or veterinary drugs only will not be included. Although reporting standards are not the key primary objective of this systematic review these will also be searched, screened and extracted as a side project, as they can contain useful information with regards to the research question.

Screening and annotation

After combining the search results from all sources, potential duplicates or publication of identical guidelines by the same author group in various journals will be identified prior to screening, based on PubMed ID, DOI, and title, journal and author list. Unique references will then be screened in two phases: 1) screening for eligibility based on title and abstract, followed by 2) screening for definitive inclusion based on full text. Screening will be performed in SyRF (http://syrf.org.uk). Each reference will be randomly presented to two independent reviewers. Reviewers are not blinded to the authors of the presented record. In the first stage, two authors will screen the title and abstract of the retrieved records for eligibility based on predefined inclusion criteria (see below). The title/abstract screening stage will focus on sensitivity ("could the paper be of any interest?").

Articles included after the title-abstract screening will undergo concurrent full-text screening for definitive inclusion. We will attempt to obtain full-text versions of all included articles through open access, interlibrary loan, or by contacting authors directly. Articles for which no full-text version can be obtained will be excluded from the review.

In both screening stages, disagreements between reviewers will be resolved by additional screening of the reference by a third, senior researcher, who is blind to the individual judgements of the first two reviewers.

Data management

All references returned from the searches will be downloaded, with entries organized by DOI (if available, or weblink alternatively), publication date, and title. All data will be stored in the SyRF platform.

Study quality, meta-analysis, and risk of bias assessment

These typical stages of systematic reviews are not relevant for this study, as it focusses on guidelines rather than experimental data.

However, provenance of suggested guidelines will be rated based on the following system:

I. Recommendations of individuals or small groups of individuals based on individual experience only
    a. Published stand-alone
    b. Endorsed or initiated by at least one publisher or scientific society
II. Recommendations by groups of individuals, including a Delphi process
    a. Published stand-alone
    b. Endorsed or initiated by at least one publisher or scientific society
III. Recommendations based on a systematic review
    a. Published stand-alone
    b. Endorsed or initiated by at least one publisher or scientific society

Reporting

Elements of the included guidelines will be identified using the extraction form from Appendix C. Across guidelines, the elements will be ranked based on the frequency of appearance across the included guidelines. Additionally, reporting will follow the PRISMA guidelines as far as applicable.

Acknowledgment

This work is part of the European Quality In Preclinical Data (EQIPD) consortium. This project has received funding from the Innovative Medicines Initiative 2 Joint Undertaking under grant agreement No 777364. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and EFPIA. The EQIPD WP3 study group members are: Jan Vollert, Esther Schenker, Malcolm Macleod, Judi Clark, Emily Sena, Anton Bespalov, Bruno

Boulanger, Gernot Riedel, Bettina Platt, Annesha Sil, Martien J Kas, Hanno Wuerbel, Bernhard Voelkl, Martin C Michel, Mathias Jucker, Bettina M Wegenast-Braun, Ulrich Dirnagl, René Bernard, Esmeralda Heiden, Heidrun Potschka, Ann-Marie Waldron, Maarten Loos, Kimberley E Wever, Merel Ritskes-Hoitinga, Tom Van De Casteele, Thomas Steckler, Pim Drinkenburg, Juan Diego Pita Almenar, David Gallacher, Henk Van Der Linde, Anja Gilis, Greet Teuns, Karsten Wicke, Sabine Grote, Bernd Sommer, Janet Nicholson, Sanna Janhunen, Sami Virtanen, Bruce Altevogt, Kristin Cheng, Sylvie Ramboz, Emer Leahy, Isabel A Lefevre, Fiona Ducrey, Javier Guillen, Patri Vergara, Thomas Ingraham and Andrew SC Rice.

REFERENCES

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8 Hooijmans CR, Leenaars M, Ritskes-Hoitinga M. A gold standard publication checklist to improve the quality of animal studies, to fully integrate the Three Rs, and to make systematic reviews more feasible. *Altern Lab Anim* 2010;38(2):167–82.

9 Smith AJ, Clutton RE, Lilley E, et al. PREPARE: Guidelines for planning animal research and testing. *Lab Anim* 2017:23677217724823.

10 Kilkenny C, Browne WJ, Cuthill IC, et al. Improving bioscience research reporting: The ARRIVE guidelines for reporting animal research. *PLoS Biol* 2010;8(6):e1000412.

11 Henderson VC, Kimmelman J, Fergusson D, et al. Threats to validity in the design and conduct of preclinical efficacy studies: A systematic review of guidelines for in vivo animal experiments. *PLoS Med* 2013;10(7):e1001489.

Appendix A – Search String

Web of Science

(guideline OR recommendation OR recommendations) AND

(“preclinical model” OR “preclinical models” OR “disease model” OR “disease models” OR “animal model” OR “animal models” OR “experimental model” OR “experimental models” OR “preclinical study” OR “preclinical studies” OR “animal study” OR “animal studies” OR “experimental study” OR “experimental studies”)

Pubmed

((Consensus[mh] OR Consensus development conferences as topic[mh] OR Guidelines as topic [Mesh] OR Practice guidelines as topic[mh] OR guideline[pt] OR practice guideline[pt] OR consensus development conference[pt] OR position statement*[tiab] OR policy statement*[tiab] OR practice parameter*[tiab] OR best practice*[tiab] OR standards[ti] OR guideline[ti] OR guidelines[ti] OR recommendation[ti] OR recommendations[ti]) AND ("Animal Experimentation"[Mesh] OR "Models, Animal"[Mesh] OR Preclinical model[tiab] OR Pre-clinical model[tiab] OR Preclinical models[tiab] OR Pre-clinical models[tiab] OR disease model[tiab] OR disease models[tiab] OR animal model[tiab] OR animal models[tiab] OR experimental model[tiab] OR experimental models[tiab] OR preclinical study[tiab] OR pre-clinical study[tiab] OR preclinical studies[tiab] OR pre-clinical studies[tiab] OR animal study[tiab] OR animal studies[tiab] OR animal experiment*[tiab] OR experimental study[tiab] OR experimental studies[tiab])) OR ((Consensus[mh] OR Consensus development conferences as topic[mh] OR Guidelines as topic [Mesh] OR Practice guidelines as topic[mh] OR guideline[pt] OR practice guideline[pt] OR consensus development conference[pt] OR position statement*[tiab] OR policy statement*[tiab] OR practice parameter*[tiab] OR best practice*[tiab] OR standards[ti] OR guideline[ti] OR guidelines[ti] OR recommendation[ti] OR recommendations[ti]) AND ((Preclinical[tiab] OR Pre-clinical[tiab] OR Experimental[tiab] OR animal[tiab]) AND (Study[tiab] OR Studies[tiab] OR Model[tiab] OR Models[tiab]) AND animals[Mesh:noexp])) OR ((("Methods"[Mesh] OR "methods"[Subheading]) AND (tool[ti] OR protocol[ti])) AND ("Animal Experimentation"[Mesh] OR "Models, Animal"[Mesh] OR ((Preclinical[tiab] OR Pre-clinical[tiab] OR Experimental[tiab] OR animal[tiab]) AND (Study[tiab] OR Studies[tiab] OR Model[tiab] OR Models[tiab])) AND animals[Mesh:noexp])) OR ((position statement*[tiab] OR policy statement*[tiab] OR practice parameter*[tiab] OR best practice*[tiab] OR standards[ti] OR guideline[ti] OR guidelines[ti] OR recommendation[ti] OR recommendations[ti]) AND ((Preclinical[tiab] OR Pre-clinical[tiab] OR Experimental[tiab] OR animal[tiab]) AND (Study[tiab] OR Studies[tiab] OR Model[tiab] OR Models[tiab])) NOT medline[sb])

EMBASE

(Consensus/ or consensus development/ or practice guideline/ or position statement*.ti,ab,kw. OR policy statement*.ti,ab,kw. OR practice parameter*.ti,ab,kw. or best practice*.ti,ab,kw. OR standards.ti. OR guideline.ti. OR guidelines.ti. OR recommendation.ti. OR recommendations.ti.) AND (exp animal experiment/ or exp animal model/ or Preclinical model.ti,ab,kw. OR Pre-clinical model.ti,ab,kw. OR Preclinical models.ti,ab,kw. OR Pre-clinical models.ti,ab,kw. OR disease model.ti,ab,kw. OR disease models.ti,ab,kw. OR animal model.ti,ab,kw. OR animal models.ti,ab,kw. OR experimental model.ti,ab,kw. OR experimental models.ti,ab,kw. OR preclinical study.ti,ab,kw. OR pre-clinical study.ti,ab,kw. OR preclinical studies.ti,ab,kw. OR pre-clinical studies.ti,ab,kw. OR animal study.ti,ab,kw. OR animal studies.ti,ab,kw. OR animal experiment*.ti,ab,kw. OR experimental study.ti,ab,kw. OR experimental studies.ti,ab,kw.) OR ((Consensus/ or consensus development/ or practice guideline/ or position statement*.ti,ab,kw. OR policy statement*.ti,ab,kw. OR practice parameter*.ti,ab,kw. or best practice*.ti,ab,kw. OR standards.ti. OR guideline.ti. OR guidelines.ti. OR recommendation.ti. OR recommendations.ti.) AND ((Preclinical.ti,ab,kw. OR Pre-clinical.ti,ab,kw. OR Experimental.ti,ab,kw. OR animal.ti,ab,kw.) adj2 (Study.ti,ab,kw. OR Studies.ti,ab,kw. OR Model.ti,ab,kw. OR Models.ti,ab,kw.)) AND animal.mp.) OR ((methodology/ or experimental design/ or study design/) and (tool.ti. or protocol.ti.) and (exp animal experiment/ or exp animal model/ or ((Preclinical.ti,ab,kw. OR Pre-clinical.ti,ab,kw. OR Experimental.ti,ab,kw. OR animal.ti,ab,kw.) adj2 (Study.ti,ab,kw. OR Studies.ti,ab,kw. OR Model.ti,ab,kw. OR Models.ti,ab,kw.))) AND animal.mp.)

Appendix B – List of funders and organisations

Professional neuroscientific organizations:

Society for Neuroscience (US)

Cognitive Neuroscience Society (US)

American College for Neuropsychopharmacology (US)

Federation of European Neuroscience Societies (EU)

European Brain and Behaviour Society (EU)

European College of Neuropsychopharmacology (EU)

British Neuroscience Association (UK)

Major funders:

US - National Institute of Health & Howard Hughes Medical Institute

China - Chinese Academy of Sciences & National Natural Sciences Foundation of China

Japan - Japan Society for the Promotion of Science & Japan Neuroscience Society

EU - European Research Council & Horizon 2020 & Innovative Medicines Initiative

UK - Wellcome Trust & Medical Research Council

Germany - Deutsche Forschungsgemeinschaft

France - L'agence Nationale de la Recherche & Pasteur Foundation

Spain - Dirección General de Investigación Científica y Técnica & Instituto de Salud Carlos III

Italy - Ministry of Instruction, Universities, and Research

Russia - Ministry of Education and Science & Russian Science Foundation & Russian Foundation for Fundamental Research

Poland - Ministry of Science and Higher Education

Switzerland - Swiss National Science Foundation

Netherlands - ZonMw

Appendix C – Extraction form

1. Matching or balancing treatment allocation of animals
2. Matching or balancing sex of animals across groups
3. Standardized handling of animals
4. Randomized allocation of animals to treatment
5. Randomization for analysis
6. Randomized distribution of animals in the animal facilities
7. Monitoring emergence of confounding characteristics in animals
8. Specification of unit of analysis
9. Addressing confounds associated with anaesthesia or analgesia
10. Selection of appropriate control groups
11. Concealed allocation of treatment
12. Study of dose-response relationships
13. Use of multiple time points measuring outcomes
14. Consistency of outcome measurement
15. Blinding of outcome assessment
16. Establishment of primary and secondary end points
17. Precision of effect size
18. Management of conflicts of interest
19. Choice of statistical methods for inferential analysis
20. Recording of the flow of animals through the experiment
21. A priori statements of hypothesis
22. Choice of sample size
23. Addressing confounds associated with treatment
24. Characterization of animal properties at baseline
25. Optimization of complex treatment parameters
26. Faithful delivery of intended treatment
27. Degree of characterization and validity of outcome
28. Treatment response along mechanistic pathway
29. Assessment of multiple manifestations of disease phenotype
30. Assessment of outcome at late/relevant time points
31. Addressing treatment interactions with clinically relevant co-morbidities
32. Use of validated assay for molecular pathways assessment
33. Definition of outcome measurement criteria
34. Comparability of control group characteristics to those of previous studies

35. Reporting on breeding scheme
36. Reporting on genetic background
37. Replication in different models of the same disease
38. Replication in different species or strains
39. Replication at different ages
40. Replication at different levels of disease severity
41. Replication using variations in treatment
42. Independent replication
43. Addressing confounds associated with experimental setting
44. Addressing confounds associated with setting
45. Pre-registration of study protocol and analysis procedures
46. Pharmacokinetics to support treatment decisions
47. Definition of treatment
48. Inter-study standardization of end point choice
49. Define programmatic purpose of research
50. Inter-study standardization of experimental design
51. Research within multicentre consortia
52. Critical appraisal of literature or systematic review during design phrase
53. (multiple) free text