Inconsistencies in the reproducibility of research findings are of pertinent concern throughout the scientific community. Initially addressed in preclinical biomedicine studies [1, 2], the discussion has expanded to fields outside the natural sciences, questioning the reliability of data and subsequent published findings, proposing a “Crisis in Confidence” or “Reproducibility Crisis” within several (if not all) research areas [2-6]. The disclosure of an apparent and low degree of reproducibility has fuelled investigations of causal factors, ranging from behavioural preferences in decision-making/“human nature” and conviction bias to experimental constituents [5, 7, 8]. In its wake is the ongoing discussion on how to move forward and restore confidence in the scientific literature as a whole.

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The increased awareness has identified several aspects in data collection, analysis and subsequent interpretation to be carefully considered. Goodman et al. suggest three target descriptors of research reproducibility: methods reproducibility, results reproducibility and inferential reproducibility [9]. These refer to the ability to reach similar results by applying equal methodology (e.g. in data analysis), the ability to reproduce findings when conducting a novel study in similar experimental conditions (data replicability) and lastly, to reach concurrent conclusions when reproducing data; either by repeating the data analysis or the study [9]. This proposed subdivision in terminology illustrates the complexity and multifaceted origin of random or systematical error/bias easily incorporated in experimental design, analytical methods and decision-making. Counter-acting the virtues of randomization, blinding and control, factors such as HARKing (Hypothesizing After the Results are Known)[5, 10], P-hacking (choosing statistical methods to reach specific levels of significance) [9, 11] and publication bias [11] all contribute to mis-interpretation and over-estimation of findings. Although likely unintentional, the combined impact of these shortcomings undermines the validity and credibility of the scientific literature.

A range of preventive measures and considerations has been proposed to improve reproducibility. In this, research transparency has been highlighted as instrumental [4, 8]. Enhancing transparency enables independent replication of published findings, and for findings to be reviewed in greater detail, including comparisons of methodology, statistical applications and experimental protocols, raising the credibility and reducing the risk of unnecessary multiplications of performed studies. In this aspect, scientific journals can contribute by defining criteria to improve reproducibility as part of their pre-submission guidelines, in this way recognizing publication standards as an important tool in expanding documentation and encouraging authors to report and share their research in greater detail.

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Several journals and research institutions have recently taken steps towards such measures, but though concerns are shared, standardized guidelines have not yet been implemented on a global scale [8].

Basic & Clinical Pharmacology & Toxicology (BCPT) receives an increasing number of manuscript submissions each year. Through the efforts of reviewers assisted by the editorial team, the submitted manuscripts are scrutinized as part of the selection process prior to a putative acceptance for publication. Despite the high quality of many of the submitted manuscripts, the editorial team is frequently faced with rejecting submissions due to insufficient disclosure of experimental details and/or failure to comply with generally accepted standards of experimental design and data analysis. The editorial team has therefore decided to revise the BCPT guidelines for authors in order to ensure that research transparency and standards are uniformly communicated for both experimental/pre-clinical (Table 1) and for clinical studies (Table 2).

Experimental/pre-clinical studies

Extensive efforts have been made to implement an increased focus on the validity of pre-clinical and clinical studies, and to comply with ethical principles, such as the 3R principles for animals applied in research [12, 13]. This has resulted in several initiatives outlining good research practice, e.g. ARRIVE guidelines [14]; CIOMS-ICLAS principles (https://www.icsu.org/members/iclas-international-council-for-laboratory-animal-science visited April 2018) and the experimental design assistant (EDA)[15]. The recommendations propose several measures to improve reliability during all phases of experimentation starting in the early planning phase. This includes generating a hypothesis prior to designing the
experiment, determining statistical power and group sizes based on pre-experimental considerations, and diminishing sources of bias (e.g. blinding and randomization) to reduce the risk of flawed statistical analysis and the over-estimation of a hypothesized effect. Specifically for studies including experimental animals, considerations of animal welfare, such as husbandry, pain management and humane end-points are crucial in preserving animal health, hereby complying with welfare legislations and ensuring reproducibility of in vivo studies. The guidelines for experimental/non-clinical studies are shown in Table 1.

Clinical studies

A plethora of guidelines exists for clinical studies, i.e. studies with human participants. The EQUATOR network (Enhancing the QUAlity and Transparency Of health Research) is an international initiative that seeks to promote accurate reporting of health science globally. BCPT welcomes this initiative. The network has gathered knowledge and links to guidelines for main study types such as randomized trials (CONSORT), observational studies (STROBE), systematic reviews (PRISMA), study protocols (SPIRIT) and clinical practice guidelines (AGREE). The EQUATOR website (available at http://www.equator-network.org/-accessed April 2018) currently links to close to 400 reporting guidelines (Table 2). The General Data Protection Regulation (GDPR) implemented on 25 May 2018 covers human individuals within the European Union (EU) and the European Economic Area (EEA) (https://ec.europa.eu/commission/priorities/justice-and-fundamental-rights/data-protection/2018-reform-eu-data-protection-rules_en, accessed 8 June 2018). The reform offers stronger rules and gives people more control over their personal data. However, it does not go beyond the principles of The Declaration of Helsinki, which generally aims at

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promoting and ensuring research subjects’ health, dignity, integrity, right to self-determination, privacy and confidentiality of personal information.

It falls within the responsibility of any scientific journal to endorse that the published studies are reliable, for example that experimental groups include sufficient numbers to achieve an acceptable power, hereby allowing for confidence in the reported findings. The revised guidelines aim to aid authors in providing such sufficient information. Reflecting on the debate on transparency in research and means to regain confidence in published results, it is the hope of the BCPT editorial team that the issued guidelines may also be considered helpful in the early phases of an experimental design, providing input as to how reproducibility may be strengthened.

References
Table 1 BCPT guidelines for experimental/non-clinical research papers. The BCPT guidelines are based on, albeit modified from (16).

<table>
<thead>
<tr>
<th>Group sizes</th>
<th>1</th>
<th>The exact group size (n) for each experimental group/condition is provided, not a range, and ‘n’ refers to independent values, not replicates.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>A rationale for the chosen group sizes including e.g. power analysis is provided, and any variation, due to experimental losses or violation of predetermined exclusion criteria, is explained. An n-value of at least 5/group is recommended.</td>
</tr>
<tr>
<td>Randomization</td>
<td>3</td>
<td>A statement regarding randomization and group allocation of samples, animals or human subjects is provided. If randomization was not undertaken, a valid scientific justification is provided.</td>
</tr>
<tr>
<td>Blinding</td>
<td>4</td>
<td>A statement regarding blinding of operator and data analyst is provided. If blinding was not undertaken, a valid scientific justification is provided.</td>
</tr>
<tr>
<td>Normalization</td>
<td>5</td>
<td>Any data normalization (e.g., expression of values as ‘% of baseline’ or ‘fold mean of control’), is explained with a valid scientific justification (i.e. to control for unwanted sources of variation).</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Normalization that generates control or baseline values with no variance (SD/SEM = 0) is explained with a valid scientific justification and such data are not subjected to parametric statistical analysis.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Any data transformation (such as log transformation), is explained with a valid scientific justification (i.e. to generate a Gaussian-distributed data set amenable to parametric statistical analysis).</td>
</tr>
<tr>
<td>Statistical comparison</td>
<td>8</td>
<td>Details of any statistical package or program employed are provided, including manufacturer, model number and details of which tests (and which options) and which program (with full version number) were used.</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>If an experiment (e.g. assay) is undertaken in duplicate, triplicate etc., a statement is made that technical replicates were used to ensure the reliability of single values. Data analysis and data presentation used the single values (i.e., 5 samples each run in triplicate is n = 5 not n = 15). Provide within- and between-day coefficient of variation for employed methods.</td>
</tr>
</tbody>
</table>

If no animals were used in this study, go to item 16.

Animal model | 10 | A scientific justification for the animal species and model selected for study is provided. |

Ethical statement | 11 | A statement of ethical approval for experimentation is provided. The nature of the ethical review permissions, and national or institutional guidelines for the care and use of animals that cover the research is indicated (i.e. relevant license numbers and details of national and/or institutional approval board and relevant affiliations). |

Animals | 12 | The source, species, strain, sex, range of age and weight of animals and any additional data that are relevant to the study are provided. |

Housing and husbandry | 13 | Details are provided of housing (type of facility e.g., specific pathogen free [SPF]; type of cage or housing; bedding material; number of cage companions; tank shape and material etc., for fish) and husbandry (e.g. temperature, light-dark cycle, feed type and feed/water access). |

Experimental procedures | 14 | Details are provided of anaesthesia and analgesia, surgical procedures, how the animal was sacrificed and, if there is recovery following surgery, the methods of asepsis, and post-operative care. Welfare-related assessments, measurements and interventions (e.g., humane endpoints) that were carried out prior to, during, or after the experiment are included. |

Interpretation | 15 | A statement is made if the study has any implications for replacement, refinement or reduction (the 3Rs). |

Translation | 16 | A statement is made in the discussion concerning the possible clinical relevance of the study. |
Table 2  BCPT encourages authors to prepare clinical study manuscripts in accordance with a relevant reporting guideline. Examples of guidelines are provided in the table.

<table>
<thead>
<tr>
<th>Examples of reporting guidelines</th>
<th>Title</th>
<th>Web address</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQUATOR network (library of reporting guidelines)</td>
<td>Enhancing the QUAlity and Transparency Of health Research</td>
<td><a href="http://www.equator-network.org/">www.equator-network.org/</a></td>
</tr>
<tr>
<td>CONSORT (reporting guideline for randomized trials)</td>
<td>Consolidated Standards of Reporting Trials</td>
<td><a href="http://www.consort-statement.org/">www.consort-statement.org/</a></td>
</tr>
<tr>
<td>STROBE (reporting guideline for observational studies)</td>
<td>STrengthening the Reporting of OBservational studies in Epidemiology</td>
<td><a href="http://www.strobe-statement.org">www.strobe-statement.org</a></td>
</tr>
<tr>
<td>PRISMA (reporting guideline for systematic reviews)</td>
<td>Preferred Reporting Items for Systematic Reviews and Meta-Analyses</td>
<td><a href="http://www.prisma-statement.org/">www.prisma-statement.org/</a></td>
</tr>
</tbody>
</table>