Biased Research Prevention Plan

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No.	Biases	Prevention / *Detection*	Notes
Extrinsic			
1.	Sponsorship bias [1]	i. Sequestering investigators from private companies *ii. Disclosure of all relationships*	i. Whenever possible. Otherwise, be utmost careful and sceptical with every step of the whole research process. *ii. Limited by timing and disclosures by (un)involved people in a research project.*
2.	Flawed incentive structures and researcher performance metrics that 'preferentially value aesthetics over authenticity.' [2]	i. To prize authentic and robust research and their outputs whether their findings are positive or negative. ii. To encourage or educate both investigators and research institutions to recognise the extent to which they are entangled in the major conflict of commitment and interest between conducting authentic science and being successful and enjoying the individual and institutional rewards of success in 'aesthetic' science. iii. To show proof of inclusion or exclusion of research papers produced by the researchers or the research institutions from high-quality systematic reviews in the related topics, if available. Otherwise, may consider conduct or simulate one that apply risk of bias assessment and grading of the certainty of the evidence. iv. Institutional leaders will need to take responsibility for eliminating the conflicts of interest that promote bias in research by having institutional metrics of professional success that align with good science [3-5] v. Institution or a professional society to host a competition to develop the best prevention plan for respective department or discipline, respectively. vi. Research institutions to sponsor audits of the work or outputs of their research teams	i. A challenging transformation given the extent to which both the investigators and research institutions flourished under the current rewards structures. ii. Researcher's personal behaviours are often determined by the institution's policy that would risk career advancement if not complied. While the institution's policy is often determined by the high-level stakeholder or policymakers fixed and outdated concepts of research excellence. iii. Limited by the availability of related systematic reviews. The alternative approaches are limited by competent and availability of reviewers. If this were achieved, the findings could result in insightful and decisive prevention plan. iv. To convince the leaders that good science will lead to the desired outputs and research excellence [6], more satisfied and motivated researchers and vibrant research culture [7]. Can draw on existing resources such as the published 5 Hong Kong Principles for assessing researchers: 1) responsible research practices; 2) transparent reporting; 3) open science (open research); 4) valuing a diversity of types of research; and 5) recognizing all contributions to research and scholarly activity [8]. v. This requires sizeable interest, having critical mass of champions and participation from the institutional leaders. vi. Systematic reviews that are available would be used to inform the audits. The audits could be conducted at random or only on teams that volunteer. The launch of the audits would need to be preceded

			by a communication effort that outlined the aim and value of the audits in order that they are not perceived or experienced as punitive.
3.	Biases research practices have caused much scientific misconduct and diffused through the scientific community as an unhealthy condition to be handled *en masse* [9].	To impose a heavier responsibility than currently applied on all institutions and their leaders for ensuring ethical and sound research environments, and avoiding minor breaches of good scientific practice. i. Acknowledge and address scientific misconduct ii. Broad definition for prevention iii. Simplify guidelines and improve training iv. Establish independent investigation mechanisms v. Reform academic system of reward and merit	i. Scientific misconduct should not be downplayed, and its occurrence must be openly acknowledged. Regular seminars and discussions on the causes, outcomes, and consequences of scientific misconduct should be held by research institutions. ii. While a strict definition is suitable for legal action, a wider definition that includes all breaches of accepted scientific practice should be used for preventive measures. iii. Current guidelines and regulations should be simplified and readily accessible to researchers. Ethical and legal issues should be included in research training. Supervision of young researchers should be enhanced, with senior researchers serving as models for ethical behavior. Issues such as conflict of interest and guidelines for authorship should be addressed. iv. National-level mechanisms for investigating suspected incidents of serious scientific misconduct should be established. Clear methods to manage whistleblowers should be in place, with designated individuals to receive complaints. v. A thorough discussion is needed on the academic system of reward and merit. Emphasis on productivity and publication numbers should be reduced, while fostering a culture of transparency and ethics within academia.
Intrinsic			
4.	Biased design, conduct and reporting of preclinical studies	i. Peer reviewing the research proposal before study initiation (such as at the ethic committee or funding level), and manuscript for publication ii. Reporting guidelines such as the ARRIVE (Animal Research: Reporting of In Vivo Experiments) guidelines [10]. Many similar reporting guidelines and checklists are available on EQUATOR (**E**nhancing the **QUA**lity and **T**ransparency **O**f health **R**esearch) network for different study designs	i. Limited by availability of competent and fair reviewers. ii. Ensuring transparency of critical methodological aspects of animal studies.

		https://www.equator-network.org/.	
5.	Biased study designs due to incoherency in the whole research process	i. To provide field-specific courses focused on the fundamentals of research methodologies, techniques or tools such as experimental design and statistics, reproducibility, and other practical skills related to the robustness of different types of research [11-13]. ii. Having an introductory course on research integrity in a safe and non-punitive environment [13]. iii. Principal Investigators (PIs) could also lead an annual informal research integrity discussion with their team, demonstrating their commitment to instilling a culture of integrity in their group. iv. Involvement of PIs and senior researchers as role models.	i. To convince researchers and institutional leaders that research knowledge and skills can be learned. Participation in courses and workshops may be a challenge to busy clinicians. ii. Having competent trainers, dedicated and regular slots that are supported by all stakeholders may be a challenge if this topic is not valued more than the 'aesthetic' outputs [2]. iii. A system change is likely to be needed to require and to record this practice. However, effectiveness of this within every team would depend on the passion and genuine interest and input of the PIs. iv. This can be done quite easily with appropriate recognition to the role models.
6.	Cognitive biases [14]: i. Hypothesis myopia ii. *p*-hacking and HARKing iii. Asymmetric attention iv. Just-so storytelling/ JARKing (justifying after results are known)	i. Use the strong inference approach to explicitly considering competing hypotheses, and if possible, working to develop experiments that can distinguish between them. ii. Transparency in registering research protocols, or publishing research proposal on repository or journals to subject the research to public/open scrutiny. This is to reduce the unconscious temptation to warp the data analysis. Another approach is blind data analysis where important variables are hidden, or dataset is added with removable noises. iii. Use team of rivals (an adversarial collaboration) to quickly spot flaws such as hypothesis myopia, asymmetric attention or just-so storytelling. iv. To explicitly list alternative explanations for all observations to reduce tendency to tell just-so stories.	i. Researchers are to be always on the guard and prepared to be impartial when facing with the data and results. ii. Belief in pre-print and publishing research protocols before the initiation of the study require motivation and support. This could come from journals that accept publication of research protocol without or with minimal cost and practice open access. iii. This may be easier said than done. Such a practice demands big and open heart among the academic rivals and strive to support good science as the ultimate end. iv. Same to item (i).

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