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Guidelines for Good Scientific Research

Faculty Presenter
Mark W. Duncan, PhD, Visiting Professor of Medicine, University of Colorado, Denver, CO, USA

Scholars' Summaries

*Authored by **Anna Capasso, MD,** University of Colorado School of Medicine, Aurora, CO, USA*

Dr. Mark Duncan's lecture focused on the meaning of "good" science. He presented a very interesting discussion on good and bad science with many different examples. He emphasized the importance of good quality and reproducibility of science, rather than the quantity of publications, as a main goal for all the researchers. His talk was a very elegant overview on the real meaning of science and what qualifies as good scientific research. His talk was deeply inspiring and extremely educational, with the many different cases of contamination of data, falsifications, and other bias that may but should not affect scientific papers. Being interested in basic research, I really appreciated this talk in which Dr. Duncan was able to give a very honest view on what really is the difference between "good and bad" science and the importance of the ethical obligation that scientists should always keep in mind when performing their research.

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*Authored by **Joseph M. Caster, MD, PhD,** UNC Hospitals Radiation Oncology, Chapel Hill, NC, USA*

Dr. Mark Duncan gave an overview of the scientific process which highlighted many of the difficulties of doing good basic science. As both a basic scientist and a clinician, I felt that this talk was excellent for the pure clinicians in the room. Many clinicians have a tendency to assume that the peer review process helps to weed out bad science. Dr. Duncan and others in the room highlighted the many ways that even well-designed, well-intentioned work can be polluted at one of the many steps taken by the many people involved in laboratory research (even in the clinical setting). He and the other forum organizers presented us with a number of specific ways to approach collaborators and assess data to try to identify potential issues before data is published or released. This was all in addition to learning how to spot and avoid being associated with grossly fraudulent or unethical practices.

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*Authored by **Konstantinos Leventakos, MD,** Mayo Clinic College of Medicine, Rochester, MN, USA*

One can describe science as a process of trying to understand the world by making models (or theories) with predictive power. This is a process that starts with the observation of an event and the development of a model (or hypothesis) that makes a prediction. Then, the scientist tests the prediction and observes the result. The scientist can then revise the hypothesis and repeat the testing. A successful hypothesis thus becomes scientific theory. Unfortunately, there have been many examples of pseudo-science or poor science. Research misconduct and fraud can be defined as fabrication, falsification, plagiarism (of data, ideas, and words), deception in conduct, and gross carelessness. There are definitely different "grades" of misconduct, ranging from gross fabrication, falsification, plagiarism, and failing to get consent from an ethics committee for research to "less serious" research misconduct such as not attempting to publish completed research or not looking into existing research before conducting new research. Conflicts of interest are well-recognized as a factor that can influence the behavior of a scientist and the quality of published research. Nowadays, there is a good amount of criticism for the process of publication and peer review. Sometimes, particularly when it comes to the peer review process, the reviewers will be unable to re-analyze the data presented in a paper or spot deliberate falsifications. Finally, it is a personal responsibility of all authors to protect the quality of their research and live up to our role in society of promoting science.

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*Authored by **Janaki Parameswaran, MD,** Yale New Haven Hospital, New Haven, CT, USA*

In his lecture, Dr. Mark Duncan discussed the difference between "good" and "poor" science. He described the scientific method as the basis for "good" science, and then discussed numerous pitfalls that lead to "poor science." He defined four grades of research misconduct, including issues surrounding gift authorship and plagiarism. He provided surprising examples of deliberate misconduct from prominent research institutions across the world beginning with the 1970s and ending with Elizabeth Holmes. He also discussed less deliberate problems, including reproducibility of data (for example, due to new techniques/technology), contamination, and lack of citations. He provided striking examples of how "poor science" can affect patient care (by placing patients on trials based on pre-clinical research that was ultimately retracted) and even ruin careers. Overall, his talk stressed the importance of good, ethical, reproducible research, as "the truth will ultimately prevail."

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*Authored by **Despina Siolas, MD, PhD,** New York University Langone Medical Center, New York, NY, USA*

Science is a "way of knowing" that involves observing, developing a hypothesis, gathering new data through experiments, analyzing data, and finally revising the hypothesis before performing additional experiments. Features of good science include using a novel approach, basing work on logical facts, reproducibility, and minimal bias. Pseudoscience uses scientific words to promote false claims, often with anecdotal reports. When one reads a paper, he should question whether the authors fairly represent the data they present. Misconduct occurs due to fabrication of data, distortion of data, plagiarism, or failing to obtain consent from an ethics committee. Dr. Duncan then gave examples of prominent cases of researchers who falsified data, stole authorship, misinterpreted data, failed to test results for reproducibility, or had financial conflicts of interest. Good practice methods for conducting science include dealing with potential authorship issues well in advance, keeping a well-annotated lab notebook, and verifying all of the raw data oneself. Also, one should consider using multiple models or investigative routes to fully test a hypothesis.