Dr. Mark Duncan's practical lecture on basic science focused on what is "good" science. He emphasized the importance of finding a solid hypothesis and reviewed key elements of the scientific method required to conduct research. The quality of research should be the goal, more than the quantity of publications. Additionally, he touched upon conflicts of interest, analytical methods and contamination. His discussion also included the sensitivity of certain techniques and the peer review process of publications. Importantly, he provided wise advice on how to establish your role in collaborative research. Dr. Duncan was honest and pragmatic in guiding us through the skills required to practice good science in our careers.

Researchers should strive to adopt good scientific practices when conducting research. Science begins with a hypothesis and aims to prove or disprove it. Designing the correct experiment is fundamental to answering the question appropriately. Similarly, analysis is only as good as the sample used for analysis. To this end, one should always strive to obtain a representative sample and, at times, this may require multiple samples. Data and conclusions should be replicable. Interestingly, the landmark studies on which we base many of our assumptions or built many of our subsequent hypotheses have not been able to be replicated in most cases. This may be a reflection of the flaws of the current peer review system. Specifically, the current peer review environment is riddled with competing interests (time, other projects etc.) and is designed with little compensation/reward such that most reviewers do not have the capacity to verify all aspects of data. As such, it is incumbent that that the researcher do his/her best to adopt good clinical practices. Good clinical practices include the following: (1) conclusions that are logical and based on facts/data not opinions (2) represent data fairly and discuss findings (3) contain adequate power to exonerate chance (4) avoid bias (5) and cite references. Pseudo-science incorporates invalid data, is emotionally fueled, and fails to cite/acknowledge data that counters the findings. Skepticism is healthy as it pushes us to verify findings.

Dr. Mark Duncan talked about how science is a process of observing (sorting, classifying, measuring) and sharing results to encourage hypothesis testing by others. There is an ethical obligation in science to seek and report the truth. Good science has several important characteristics such as: the work should be logical and based on facts/data not opinions, the quality of the data should be accurately represented (e.g. limitations clearly specified and discussed), chance is eliminated as an explanation for the observations, and all relevant references should be cited (not just supporting references). Dr. Duncan discussed the need to avoid pseudo-science (poor quality research, no mention of contrary facts, uncontrolled bias, not subjecting claims to a meaningful test).

Being aware of and managing conflicts between industry and science is another key characteristic of good research. Dr. Duncan presented a study of review articles showing a strong correlation between authors’ tobacco industry affiliation and their conclusions about whether passive smoking is harmful (Barnes, JAMA 1998). Ensuring that chance is accounted for in your experiments is also essential. One infamous case illustrating this is a study (Petricoin, Lancet 2002) reporting extremely impressive accuracy of detecting ovarian cancer by serum proteomic signatures. This generated a lot of positive buzz, but an independent group of investigators could not reproduce the results. There were issues with experimental bias, equipment
calibration, and selection of a validation dataset that could not distinguish performance between the proposed proteomic classifier and one generated from randomly chosen training sets. Dr. Duncan also gave examples of issues surrounding contamination of lab experiments and sampling bias.

Peer review, the core process by which scientific findings are vetted for publication and acceptance, unfortunately cannot catch many of these errors. Reviewers rarely re-analyze data and cannot spot deliberate falsifications. Dr. Duncan noted an example in which a concocted paper with deliberate errors in study design, analysis, and interpretation of results was accepted in over 50% of the journals it was submitted to. In summary, it is incumbent on the researcher to be mindful about good research practices. We have the ethical obligation to be transparent and honest about our data and emphasize quality research with adequate accounting of bias, chance, and reproducibility.

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In Dr. Mark Duncan’s lecture, “Guidelines for a Good Scientific Practice,” he presented a philosophical discussion about what qualified as good scientific research. He defined science as “the process of trying to understand the world by making models or theories with predictive power.” He described the well characterized scientific method and how a successful hypothesis eventually becomes scientific theory.

To practice ‘good’ science, an important problem should first be identified with the research following a logical progression and not based on opinions or biases. Data collected should be represented accurately in sufficient detail and what is not clear should be identified. Other researchers should be able to replicate the work. All efforts should be made to eliminate chance and bias. Good science was contrasted to poor science, or ‘pseudo-science,’ which involves sloppy methods, only includes data that supports the hypothesis, and invalid data are incorporated into the process.

We studied several case reports in history to illustrate these examples including Barnet et al. article in JAMA about why review articles about the effects of passive smoking reach different conclusions and the use of a proteomic pattern in serum blood test that almost perfectly identifies ovarian cancer.

In conclusion, as physician scientists, Dr. Duncan reiterated that human nature has a profound effect on science and is inherently affected by aspects of human behavior. As scientists, we must recognize and separate facts from opinions and accept scientific ideas based on sound data that we and others can replicate, publication, and peer review.

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Dr. Mark Duncan’s talk focused on features of science, good and bad. His talk inspired me and other audiences to think deeply about the fundamental but often neglected question: what is science.

Science is a unique process of human being trying to understand the world by making models with predictive power. It includes observing patterns, generating hypothesis, conducting experiments, analyzing the data and sharing the data with the society. The scientific method is composed of a model (hypothesis) and a test to prove the model. A bad science could have many reasons such as a false hypothesis, biased conduct, invalidated data and conflict of interest. One examples of bad science is the finding of proteomic patterns in serum to identify ovarian cancer in 2002. The authors claimed their data by mass spectroscopy is 100% sensitive and 95% specific with a positive predictive value of 94%. The work gained significant positive interest from the society but two years later, an article from The New York Times by Andrew Pollack questioning about the results based on three statisticians from M.D. Anderson Cancer center in Houston. The major concerns are raised from detail investigations of the raw data: lack of randomization, biology implausible, instrument default calibration, and lack of reproducibility. Those facts were either ignored or neglected but very obviously missed in the first place.