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Just a little analysis…

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Abstract

In this invited discourse it is argued that simple analyses of the most important components of a complex situation, providing logic and rationality, when communicated clearly and in a timely manner can have the greatest impact in decision-making for society and industry. Drawing on experience in global and public health, I call on scientists who wish to directly influence decisions, to reduce complexity and remember the key principle behind Daniel Bernoulli's public health approach, namely, that decisions be based on 'all the knowledge which *a little analysis* can provide'.

Discussion

In a presentation to the French Academy of Sciences in Paris in 1760, Daniel Bernoulli stated that "*I simply wish that in a matter which so closely concerns the wellbeing of the human race, no decision shall be made without all the knowledge which a little analysis and calculation can provide*". At the time, smallpox was endemic throughout Europe and the cause of large-scale mortality [1]. Bernoulli implored the Academy to consider mass vaccination against smallpox as a public health strategy. This was possibly the first time that a public health approach was considered rather than individual-level interventions purely for personal benefit. With simple calculations using life tables, and assumed probabilities for the risk of catching smallpox and its case fatality, he concluded that "*by adopting universal inoculation against smallpox, France would gain 25 000 additional useful 'Civil Lives' which would benefit the state and society".* This analysis was published in 1766 [2]; a recent commentary on Bernoulli's paper was published in 2004 [3].

In today's technological world of iPhones, computerized motor vehicles, and generation of 'big data' from Omics fields in biology, scientists usually employ complex scientific and analytical methods. This is necessary when designing the next iPhone or algorithm for a medical robot but it is not necessary for issues related to policy decisions. In my approach to public health research, I am inspired to not lose sight of the key principle behind Bernoulli's public health approach, namely, that decisions be based on 'all the knowledge which *a little analysis* can provide'.

It is important to acknowledge the actual manner in which policy and public programming decisions are made; quite simple, there is no systematic method. Ideally, governments aspire to make decisions that achieve the best overall outcomes, but there are numerous conflicting exogenous, ideological, and institutional influences in their decision-making and the process involves multiple stakeholders exerting varying degrees of influence [4]. Political factors, as well as historical precedent, are probably the primary drivers of many decisions rather than scientific-based evidence. Bernoulli besought that within this mix rational simple analytical arguments can provide insights to inform decisions and that there may be the potential for profound outcomes. Similarly, I exhort scientists who

wish to directly influence decisions, made by governments or industry leaders, to keep this principle at the fore in the conduct and communication of scientific investigation.

I was honoured to be presented with the Edgeworth David Medal by the Royal Society of NSW at a ceremony in May 2014 for my scientific contributions of applied mathematics in the area of infectious disease global health. It provided me with an opportunity to reflect on what I considered to be valuable in my contributions, what facilitated their translation to be influential, and my future research approach. I concluded that at least in my area of application, all it takes is just a little analysis, through conduct of good yet simple science on the most important broad questions being asked in the field, communicated in a straightforward manner, to lead to widespread change in policy and/or practice.

The allure of applied quantitative analysis for young scientists is often to the idea that intellectually stimulating mathematics can be useful for industry or society. Although there tends to be the promise of informing decisions, the field of applied mathematics in academic settings tends not to be about applying mathematics directly but often about exploring 'mathematically interesting' phenomena of complex systems of equations which may somewhat describe the dynamics or processes of a real-world system. The mathematical exploration does not advance, or provide insight into, the application and nor does it advance fundamental mathematical theory. Communication of findings may involve some esoteric and obscure mathematical description, alienating the discipline of application even further. In contrast, pure mathematicians often portray no deception about the uselessness of their complex theorems and mathematical research. In my opinion there are two fundamental shifts that are needed among quantitative scientists, which may also be relevant to other scientific disciplines, if they wish to be truly applied: (1) realize that simple approaches that directly address topics of relevance, and focus on the key factors of importance, are more useful than complex analyses that are difficult to investigate and understand; (2) realize that clear communication of the main messages and the essential components that explain these results are just as, or even more, important than the science itself. In my experience in the area of policy decisions, even if the analyses are only around 70% complete or precise but are communicated clearly and through appropriate channels then they are likely to inform the decision-making process. However, an analysis which is not able to meet the usually short timeframes in which decisions are made or not communicated well to compete with other advocacy arenas, even if conducted much more rigorously, will ultimately remain a purely academic exercise without influence.

Scientific analyses have been greatly influential in many spheres of industry and society. The purest of scientific methods, mathematics, can be powerful when applied well. However, due to the nature of the fundamental tool, mathematics, it is inclined to be largely theoretical and miss out on its great potential. It is important to remember that the emphasis in the term 'applied mathematics' is not in the word 'mathematics' but in that it is 'applied'. To realize aspirations of using science to change decisions, particularly mathematics to inform public health decisions, the process should involve collating available evidence, investigating the crux of the

decision area at hand and addressing it with just… a little analysis.

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Associate Professor David Wilson completed his PhD on infectious disease modelling in 2003, studying at Oxford University, ETH Switzerland and Queensland University of Technology. He then did a postdoctoral fellowship at UCLA on HIV epidemic modelling and optimal allocation of HIV antiretroviral drugs. From 2005, A/Prof Wilson has been based at UNSW where he coordinates Australia's national HIV surveillance and reporting. Winner of a Eureka Prize and the Royal Society of NSW's Edgeworth David Medal in 2013, he is also the leader of the UNSW and World Bank Optima team which conducts modelling, health economic and resource allocation studies for national governments around the world, as well as regional and global bodies and large international donors.

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