Review of Ferguson et al "Impact of non-pharmaceutical interventions..."

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Neil Ferguson and an Imperial College team perform detailed simulations of outbreak response [1]. This is an important work because they model social/government response, not just contagion. They show suppression (lockdown so that $R_0 < 1$) is essential because mitigation ($R_0 > 1$, "flattening the curve") necessarily results in massive overload of hospitals and many dead. This is an important conclusion that should inform policy makers.

However, they make structural mistakes in analyzing outbreak response. They ignore standard Contact Tracing [2] allowing isolation of infected prior to symptoms. They also ignore door-to-door monitoring to identify cases with symptoms [3]. Their conclusions that there will be resurgent outbreaks are wrong. After a few weeks of lockdown almost all infectious people are identified and their contacts are isolated prior to symptoms and cannot infect others [4]. The outbreak can be stopped completely with no resurgence as in China, where new cases were down to one yesterday, after excluding imported international travelers that are quarantined.

Their assumptions are equivalent to ergodicity, as they consider new infections to be a function of infected fraction and immunity, and not influenced by where in the trajectory of the outbreak they are, distinguishing going up from going down.

They also don't specify whether achieving less than one case (extinction of the virus) is possible in their model. The actual minimal number for resurgence is larger than 1 because (1) a significant percentage of those in close contact with confirmed cases are not infected, indeed only 5% of close contacts of infected individuals traced in China subsequently tested positive [2], and (2) small outbreaks can be stopped by contact tracing, which is enhanced by the availability of testing [5]. The availability of testing is also not included in their analysis. These interventions imply the exponential growth they report after relaxing restrictions would require a significant number of initial cases.

Since lockdowns result in exponentially decreasing numbers of cases, a comparatively short amount of time can be sufficient to achieve pathogen extinction, after which relaxing restrictions can be done without resurgence. Since the exponential decay is highly sensitive to the interventions made by both government and social action, simulating their effects is less helpful than the advice to "go all out" and refine the effort over time with improved tracing, testing, and other protocols.

Finally, the use of geographic boundaries and travel restrictions allows for effective and comparatively low cost imposition and relaxation of interventions. Such a multiscale approach accelerates response efforts, reduces social impacts, allows for relaxing restrictions in areas earlier that are less affected, enables unifected areas to assist in response in the ares that are infected, and is a much more practical and effective way to stop otherwise devastating outbreaks [6]. If actions had been taken earlier, successful local lockdowns, as performed in China in Hubei province, would have been possible instead of national lockdowns.

A few other issues are of importance: They ignore the possibility of superspreader events in gatherings by not including the fat tail distribution of contagion in their model. This leads them to deny the importance of banning them, which has been shown to be incorrect, including in South Korea [7]. Cutting the fat tail of the infection distribution is critical to reducing R_0 [8].

The model they use appears to be in the general class of SIR differential equations used in epidemiology and is therefore not well suited for incorporating real world conditions at fine or large scale. These include (1) significant interactive local dynamics and travel restrictions that cannot be seen from aggregate quantities or averages across geographic locations, (2) non-normal distributions of the number of infections per person (superspreader events) as well as the infection period, and (3) dynamic or stochastic values of parameters that arise from variations in sampling of distributions as well as the impact of changing social response efforts. Despite including details of the contagion and response options, their model is several degrees of abstraction away from what is warranted by the situation.

While the efforts to model social response are important, leaving out critical aspects of the response yields incorrect answers. Focusing on details but using incorrect assumptions makes for bad policy advice. Where lives are at stake, it is essential for science to adhere to higher standards.

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