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An Epidemic Enigma: Challenges in Modeling the Influenza Epidemic in a Boarding School

I will revisit a classical modeling example of an influenza epidemic in a boarding school in the UK, which was first described in the British Medical Journal (March 4, 1978). The application of an SIR model to describe the epidemic has appeared in well-known textbooks, as well as numerous lecture notes and presentations on the internet. It is shown that the number of infected $I(t)$ can fit the data very well, allowing estimation of the two model parameters and the basic reproduction number. What the modeling examples failed to check is that the final size, which is the total number or percentage of infected people during the epidemic, predicted by the calibrated models (close to 730 students or 96%) hugely overestimated the final size given in the BMJ paper (512 students or 67%). How to reconcile this huge discrepancy in model predictions and data? I will provide some explanations, outlining several challenges in mathematical modeling of general epidemics. For the influenza epidemic described in the BMJ, there is no known model of any kind in the literature that has correctly described both the time course of the epidemic ($I(t)$) and the final size, and it remains as an epidemic enigma for modellers.