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Vaccine-induced pathogen type replacement

Host immune systems impose natural selection on pathogen populations, which respond by evolving different antigenic signatures. Like many evolutionary processes, pathogen evolution reflects an interaction between different levels of selection; pathogens can win in between-strain competition by taking over individual hosts (within-host level), or by infecting more hosts (population level). Vaccination, which intensifies and modifies selection by protecting hosts against one or more pathogen strains, can drive the emergence of new dominant pathogen strains — a phenomenon called *vaccine-induced pathogen strain replacement*. In this talk reports of increased incidence of subdominant variants after vaccination campaigns are reviewed and the current model for pathogen strain replacement, which assumes that pathogen strain replacement occurs only through the differential effectiveness of vaccines against different pathogen strains, is extended. Our theoretical studies suggest that a broader range of mechanisms is possible including pathogen strain replacement even when vaccines are *perfect* — that is, they protect all vaccinated individuals completely against all pathogen strains. Pathogen strain replacement with perfect vaccination occurs when strains interact through super-infection or co-infection but does not seem to occur in simplest models when strains interact through cross-immunity. Super-infection, co-infection, and cross-immunity are some examples of coexistence mechanisms – mechanisms that lead to coexistence of pathogen variants. We address the question: Which coexistence mechanisms lead to strain replacement under perfect vaccination and which do not?