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# Timing is Everything: Comparing When and Whom to Vaccinate in Risk-Stratified Network Epidemics

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**Abstract**

We investigate epidemic dynamics and mitigation strategies in synthetic populations using the inhomogeneous SIRVD (iSIRVD) model on small-world networks. In our framework, individuals are divided into high- and low-risk groups with distinct probabilities of mortality upon infection. We implement pre-epidemic ("pulse") vaccination strategies, comparing random allocation to targeted vaccination of high-risk individuals. Simulations analyze how these strategies affect total mortality, considering varying vaccine coverage levels and intervention timing. Our results demonstrate that prioritizing high-risk individuals for vaccination consistently reduces epidemic mortality more effectively than random allocation, especially when vaccine resources are limited. These findings highlight the importance of risk-based mitigation measures in structured populations and illustrate the policy advantages of targeting vulnerable groups in public health interventions.

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