Spatial Epidemiology of Respiratory Syncytial Virus (RSV) in the USA

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The spatial patterns of epidemics associated with respiratory syncytial virus (RSV) are not well understood, despite the high disease burden of this acute viral infection among young children. Here we characterize the spatial patterns of RSV epidemics in the US and explore the impact of demographic, environmental and population factors.

We estimated the timing and periodicity of RSV epidemics in US states by applying center of gravity and wavelet analyses to weekly time series of RSV cases and hospitalizations, 1989-2009. We examined the association between RSV timing and various geographic (latitude, longitude), demographic (birth rate, population size, density and movements), and climatic factors (minimum and maximum temperature, relative and absolute humidity, precipitations). We also fit a mathematical transmission model to age- and state-specific RSV data.

RSV displays strong annual winter cycles throughout the US (center of gravity Nov 15 - Mar 8), and biennial periodicity in the Mountain region. Southeastern states consistently experience early RSV epidemic onset and high virus activity in summer, generating an apparent Northward RSV travelling wave out of Florida (P=0.001). Latitude, longitude, and population density were moderately correlated with RSV timing (Spearman $\rho=0.5-0.6$, P<0.01) while demographic factors were not. Fall temperature was the strongest predictor of RSV timing ($R^2=65-73\%$), and the positive association estimates were correlated with seasonal variation in temperature (P<0.05) and the model reproduced biennial RSV epidemic cycles given strong seasonal forcing.

Our findings suggest that the observed geographical variability of RSV disease patterns in the US may result from environmental forcing. The association between early RSV activity and high fall temperature could be a proxy for unidentified local factors or truly reflect increased RSV transmission at higher temperatures, which warrants further study.