Longitudinal Trend Analysis of Static and Dynamic Surveillance Metrics of SARS-CoV-2 Transmission in the United States

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Background

The United States has been severely affected during the COVID-19 pandemic, accounting for the most cases and deaths globally. Without informed surveillance with actionable metrics, the U.S. is ineffective at preventing and mitigating the escalating COVID-19 pandemic. Existing surveillance suffers from incomplete ascertainment and is limited using standard surveillance metrics. While many COVID-19 data sources track infection rates, informing prevention requires capturing the relevant dynamics of the pandemic

Objective

The objective of this study is to develop dynamic metrics for public health surveillance that can inform world-wide COVID-19 prevention efforts. Advanced surveillance techniques are essential to inform public health decision-making and to identify where and when corrective action is required to prevent outbreaks.

Methods

1. We extracted COVID data from global public health registries.
2. We use an empirical difference equation to measure daily case numbers for our as a function of the prior number of cases, the level of testing, and weekly shift variable
3. This was based on a dynamic panel model estimated using the generalized method of moments (GMM) approach by implementing the Arellano-Bond estimator in R.

Dynamic Surveillance Variables

- **Speed**: number of (new) daily observed SARS-CoV-2 cases
- **Acceleration**: day-to-day change in speed, measured as a weekly average of cases. A positive value indicates that speed is increasing, and a negative value indicates that speed is decreasing.

Dynamic Surveillance Variables (cont.)

- **Jerk**: change in acceleration, measured as the difference between this week's acceleration and last week's acceleration. It is the "change in the change" of new rates. (A large jerk may indicate a shift in the course of the pandemic)
- **7-Day Lag**: The value of the specified variable or indicator seven days ago or the speed seven days ago.
- **7-Day Persistence**: The impact of the 7-fay lag of speed on today's value of speed

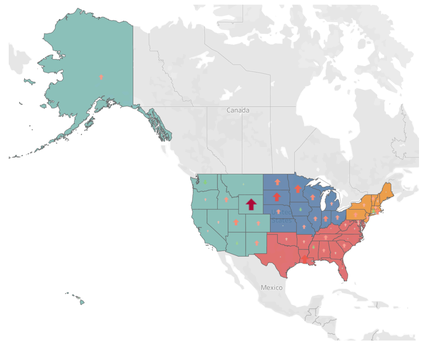

Figure 1. Acceleration Map of Week 46 of 2020

Figure 2. Weekly US State-Level Statistics

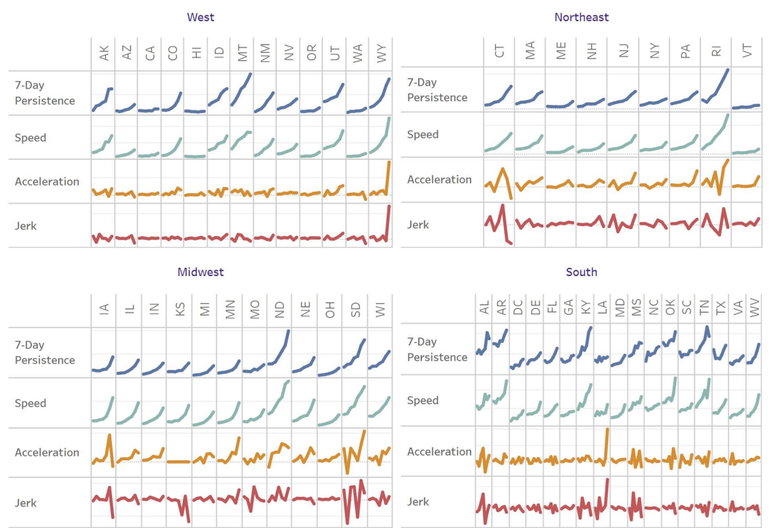

Table 2. Ranking of Top 5 States by Surveillance Metric

Date, State	Speed	State	Acceleration	State	Jerk	State	7-day persistence effect	State	7-day moving average
Nov 12, 2020									
ND	175.0	WY	18.3	WY	25.5	ND	195.3	IL	11,827.4
SD	154.5	SD	10.7	LA	12.8	SD	157.5	TX	8406.7
WY	125.1	LA	9.7	ND	6.5	WI	108.3	CA	6719.0
WI	112.9	MN	8.3	MN	5.6	MT	97.8	WI	6571.6
IA	112.6	UT	5.0	UT	4.0	WY	85.7	MI	5845.7
NE	103.8	ND	4.9	SD	3.8	IA	85.3	OH	5612.4

Findings

- The four states of greatest concern are Wisconsin, North Dakota, South Dakota, and Illinois.
- Wisconsin, North Dakota, and South Dakota have multiple data points indicating explosive growth.
- Wisconsin and Illinois both top the nation in daily new infections and have positive growth rates.
- California and Pennsylvania have positive speed, acceleration, jerk, and persistence, suggesting the outbreak in these two populous states will be significant in terms of caseload.

Implications

At the state level, the indicators suggested that explosive growth occurring in right now in many states could also have been identified as early as late October.

Public health actions taken at that time in those and other states and areas might have significantly reduced the number of new cases and prevented the severe overtaxing of hospital and medical resources that is now happening. A public health approach that focuses on prevention can prevent major outbreaks in addition to confirming when public health guidelines are effective and controlling the pandemic.

Subnational analyses on the dynamics of the pandemic allow us to zero in on where transmissions are increasing, meaning corrective action can be applied with precision on problematic areas.

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